CONSORTIUM
"DICON – ACCIONA ING."

Environmental Impact Assessment Report

for Investment Proposal:

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

ANNEX 3: TERMS OF REFERENCE FOR THE SCOPE AND CONTENTS OF THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Updated version

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PREPARED BY:	NELLY GROMKOVA - TL VERJINIA DIMITROVA - PM	VERSION: 05
VALIDATED BY:	TZVETANKA DIMITROVA – TQ CONTROL EXPERT	DATE: AUGUST 2013

Approved by:		
Prepared by:	**Team Leader**	**Project Director**
Nelly Gromkova – Team Leader **Verjinia Dimitrova – Project Manager**		
Validated by:		
Tzvetanka Dimitrova – Technical quality control expert		

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NA	Statement Ref. No D(S) 299/08.04.2013, N. Bonov, Rusian Tsibranski, Radiological Monitoring Department, Safety Division about the Terms of Reference for the Scope and Contents of the Environmental Impact Assessment Report, version 03 of 18.03.2013Consortium Dicon – Acciona Ing.	04

NA	Statement No 310/10.04.2013, Valentina Stancheva, Chief Expert on RP	04
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NA	Statement Ref. No 790/01.08.2013, Bilyana Simeonova, ecologist	04
NA	Statement Incoming No 73 /05.08.2013, Daniela Georgieva, Head of S&A sector, Kozloduy NPP EAD	04

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NAMES AND ABBREVIATIONS

COMPANIES

Kozloduy NPP – New Builds EAD subsidiary of Kozloduy NPP EAD	Hereinafter together referred to as the Client
Consortium Dicon – Acciona Ing.	Hereinafter referred to as the Contractor

ABBREVIATIONS

AA	Appropriate Assessment
AER	Atomenergoremont
AIS AMB	Automated information system "Archaeological map of Bulgaria"
AMS	Automatic Meteorological Stations
AQ	Air Quality
ASSCEC	Accelerograph system for seismic control of the equipment and constructions
ASUNE	Act on Safe Use of Nuclear Energy
BDWMDR	Basin Directorate for Water Management Danube Region
BPS	Bank Pumping Station
BRPS	Basic Radiation Protection Standards
C DTC	Diagnostics and Control Test Center
CC	Cold (intake) channel
CH	Central Hall
CHL	Cultural Heritage Law
CM	Cultural Monument
CPB	Common Purpose Building
CPS	Central Pumping Station
CZ	Monitored Area
CZ	Clean Zone
DBE	Design Basis Earthquakes
DeC	Decommissioning
DFC	Degree of Flammability Coefficient
DGS	Diesel Generator Station
DIAR	Degree of Impact Assessment Report
DSNFSF	Dry Spent Fuel Storage Facility

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
EES	Electrical Energy System
EG	Electricity Generation
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
ELB	Engineering Laboratory Building
EMF	Electromagnetic Fields
ENS	European Nuclear Society
EP	Environmental Protection
EPA	Environmental Protection Act
EPSW	Emergency Pumps for Service Water
EU	European Union
EUR	European Utility Requirements
FP	Fission Products
FP	Fire Protection
FPM	Fine Particulate Matter
FPS	Fire Pumping Station
FS	Fire Safety
GIS	Geographical Information System
GSR	General Safety Rules
HA	Health Act
HC	Hot (outlet) Channel
HLW	High Level Waste
HM	Heavy Metal
HMS	Hydro meteorological station
HPD	High Pressure Deaerators
HTF	Hydro Technical Facilities
IAEA	International Atomic Energy Agency
ICPDR	International Commission for the Protection of the Danube River
ICRP	International Commission on Radiation Protection
ICV	Immovable Cultural Valuables
IED	Individual Effective Doze
IEL	Individual Emission Limits
ILRAW	Intermediate Level RAW
Inv	Inventory
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 waste
LWR	Light water reactor
MAC	Maximum Admissible Concentrations
MC	Council of Ministers
MDA	Minimum Detectable Activity
MDBE	Maximum Design Basis Earthquake
MDC	Main Drainage Channel
MoEW	Ministry of Environment and Water.
MH	Ministry of Health
MRDPW	Ministry of Regional Development and Public Works
MRS	Maintenance and Repair Shop
MSK	Medvedev-Sponheuer-Karnik scale
NAIM – BAS	National Archaeological Institute and Museum – BAS
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
NIMH	National Institute of Meteorology and Hydrology
NIRECH	National Institute for Immovable Cultural Heritage
NNU	New Nuclear Unit
NPP	Nuclear Power Plant
NPP	Nuclear Power Plant
NRA	Nuclear Regulatory Agency
NSEM	National System for Environmental Monitoring
NSR	Nuclear Safety Rules
OMO	Occupational Medicine Office
OS	Outdoor Switchgears
PA	Protected Areas
PAZ	Precautionary action zone
PB	Plant Building
PCB	Polychlorinated biphenyls
PFA	Potential Fire Areas
PMG	Project Management Group
PPE	Personal Protective Equipment
PS	Pumping Station
PSA	Preliminary Safety Analysis

PSC.	Pool for spent casks
PWR	Pressurised Water Reactor
PA	Protected Areas
RA	Road Accident
RAW	Radioactive Waste
RAWPS	RAW Processing Shop
RBMP	River Basin Management Plan
REM	Radioecological monitoring
RES	Renewable energy sources
RHI	Regional Health Inspectorate
RHM	Regional Historical Museum
RIEW	Regional Inspectorate Environment and Water
RP	Radiation Protection
RPG	Radioactive Noble Gases
RPS	Radiation Protection Standards
S and SF	Supplies and Storage Facility
SB	Sanitary 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”	Specialized Enterprise for Radioactive Waste
SEWRC	State Energy and Water Regulatory Commission
SG	Steam Generators
SIASP	System for Industrial Anti-Seismic Protection
SMM	System for Meteorological Monitoring
SNF	Spent Nuclear Fuel
SNFSF	Facility for Spent Fuel Storage Under Water
SP	Spray Pond
SpB	Special building
SS	Sewerage System
STV	Specialized Transport Vehicles
SWT	Special Water Treatment
SZ	Surveillance Zone (30 km zone allotted for Radioecological monitoring, coincides with urgent protective action planning zone (UPAPZ)
TCS	Toxic Chemical Substances
TLD	Thermoluminiscent Dosimeters

TS	Technical Safety
TS	Technical Supervision
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	Water Act
WFD2000/60/EC	Water Framework Directive
WHO	World Health Organization
WMA	Waste Management Act
WWER	Water-Water Energy Reactor (Pressurised Water Reactor)
WWER	Water-cooled water-moderated power reactor
WWTP	Waste Water Treatment Plant

INTRODUCTION

These Terms of Reference for the Scope and Contents of the EIA for the **Investment ProposalBuilding a new nuclear unit of the latest generation at the Kozloduy NPP site** are drawn up pursuant to art. 95, clause 2 of the Environmental Protection Act and art. 10, clauses 1-3 of the Regulation on the terms and procedure for performing an environmental impact assessment (SG, No. 3/2006, amended and supplemented, SG No. 94 of 30.11.2012)

The investment proposal (IP) of Kozloduy NPP – New Builds EAD envisages the building of a new nuclear unit of the latest generation (Generation III or III+) with installed electrical power of about 1200 MW. As it falls within the scope of Appendix 1 of EPA, item 2.2. “Nuclear power plants and other nuclear reactors, including dismantling or decommissioning of such power plants and reactors, with the exception of installations for the production and treatment of fission or enriched materials whose maximum power does not exceed 1 kilowatt continuous thermal load”, the IP is subject to obligatory EIA and the competent authority to make a decision on EIA is the Minister of Environment and Water.

The project for the nuclear unit shall comply with the European requirements set out in the European Utility Requirements for LWR Nuclear Power Plants and with the Bulgarian legislation in the field of nuclear energy.

The new nuclear unit will be a reliable and secure diversification power source for providing the necessary electrical energy balance (production – consumption) for the Republic of Bulgaria and will contribute in the long term to:

- → ensuring a reliable source of electrical energy to guarantee the electrical energy balance in the country;
- → maximum economic effect and minimum risk in the supply of energy resources;
- → diversification of energy sources;
- → maintaining acceptable and stable price of the electrical energy;
- → ensuring a reliable source of electrical energy without greenhouse gas emissions in the environment;
- → possibility to sell greenhouse emissions quotas to third countries;
- → capacity to export electrical energy.

The scope of the Terms of Reference is completely in compliance with the requirements of art. 10 of the Regulation on the terms and procedure for the performance of an environmental impact assessment, and includes:

- characteristics of the investment proposal, including: a description of the physical characteristics of the investment proposal and the required areas, a description of the basic characteristics of the production process, determination of the type and quantity of the expected wastes and emissions as a result of the operation of the investment proposal;
- alternatives for the realization of the investment proposal;
- characteristics of the environment in which the investment proposal will be realised and an assessment of the impact it may have on it;
- significance of the environmental impact, determination of the unavoidable and long-term environmental impacts as a result of the construction, operation and decommissioning of the object of the investment proposal, which could turn out to be considerable, so they should be studied in detail in the EIA report;
- cumulative effect;
- risk of incidents;
- monitoring;
- transboundary effects;
- structure of the EIA report with a description of the expected contents of the items included in it;
- list of the necessary annexes, lists etc.;
- stages, phases and schedule for the drawing up of the EIAR;
- other terms or requirements.

The main objective of the Terms of Reference is to determine the scope and contents of the EIAR, including a specification of the methodology to be used for forecasting and assessment of the individual components and factors of the environment, and the risks for human health from the construction of the new nuclear unit, taking into equal consideration two major technical and layout solutions[1] for reactor installations of the newest generation and of 4 potential sites for the building of the new nuclear unit. In this context, **the specific goals of the these Terms of Reference for the scope and contents of the EIA report** are as follows:

- to determine the potentiality and nature of the impacts which the investment proposal could have on the environment during the construction, the operation and the decommissioning of the unit for each of the sites, and for each of the technical and layout solutions for the reactor installations;

[1] Layout – layout of the different sites, buildings and facilities and the technological links between them.

→ to determine the resulting cumulative effect from the realization of the IP combined with the existing operational facilities at the Kozloduy NPP site and the expected transboundary impact of the IP;

→ to determine the significance of the impacts on the movable and immovable cultural heritage and human health risk based on criteria which reflect the basic characteristics of all components and factors of the environment.

Pursuing the main objective and the specific goals, the EIA report has to identify the components and factors of the environment which may suffer potential impact in consequence of the realisation of the IP, possible accumulation of the impacts, risk of accidents and potential transboundary impact, which will be examined in detail in the EIA report. The main task of the assessment is to substantiate and motivate the most suitable alternative solution by considering three main technical and layout solutions for reactor installations of the latest generation and 4 potential sites for location of the new nuclear unit, and offer mitigation measures to reduce, prevent or possibly fully eliminate the identified impacts on the environment and human health.

The Terms of Reference for the scope, contents and format of the EIA for the investment proposal for Building a new nuclear unit of the latest generation at the Kozloduy NPP site are in compliance with the instructions given by the Ministry of Environment and Water (MoEW) based on the notification about the IP (letter outgoing No EIA -220/05.07.2012 by MoEW) and the additional information presented in letter No EIA -220/09.01.2013.

The Terms of Reference are also compliant with the Bulgarian, European and international legislation concerning EIA in a transboundary context: EPA, the Regulation concerning the terms and procedure for performing an EIA, Directive 85/337/EEC and its three amendments dated 1997, 2003 and 2009, transposed into Directive 2011/92/EU, the Convention on EIA in a transboundary context (Espoo Convention), as well as with the requirements of Appendix I of the Recommendations of the Commission dated October 11th, 2010 concerning the implementation of art. 37 of the EURATOM Treaty.

The Terms of Reference for the scope and contents of the EIA report fully incorporate the outcome (comments and proposals) from the consultations held with the specialized administrations, organisations and representatives of the public in accordance with the provisions of art. 95, clause 3 of the EPA.

Additionally, in the process of drawing up the Terms of Reference, the intermediate results and conclusions obtained in the course of the current projects for performing feasibility study to substantiate the construction of a new nuclear unit at the Kozloduy NPP site, and the examination and selection of the location for the new nuclear unit at the Kozloduy NPP EAD site were also taken into consideration.

The site selection is the subject of a related project, which is being executed in parallel to the present EIA for the IP for the NNU. The assessment in EIAR shall be made in accordance with the provisions of art. 25, item 1 of the Regulation on ensuring the safety of nuclear power plants (2004), which specifies that the sites favourable for the construction of NPPs are the ones which comply with the following terms: compliance with the legislation on environmental protection, the requirements for radiation protection, fire safety and physical protection.

INFORMATION ABOUT THE CLIENT

Legal entity:	**"Kozloduy NPP – New Build" EAD**
Executive Director:	**Valentin Iliev**
Address:	3321 Kozloduy
City:	Kozloduy
Municipality	**Kozloduy**
Phone:	+359 973 72104
Fax:	+359 973 72422
Internet page:	http://www.npp-nb.bg/
E-mail:	newbuild@npp.bg
Contact Person:	**Bilyana Simeonova**
Telephone GSM:	+359 973 72104
Fax:	+ 359 973 72422
E-mail:	b.simeonova@npp-nb.bg

1 DESCRIPTION OF THE INVESTMENT PROPOSAL

1.1 HISTORY OF KOZLODUY NPP

The beginning of the nuclear power generation in Bulgaria was laid on 15th July 1966 by signing a cooperation agreement between Bulgaria and the former Soviet Union for the construction of a nuclear power plant. Following a detailed feasibility analysis, the construction site for the nuclear power plant was selected near the town of Kozloduy. The sod-turning ceremony for the construction of Kozloduy NPP was held on 14th October 1969. The construction of the main building of units 1 and 2 of Kozloduy NPP began on 6th April 1970.

The official opening of the Kozloduy NPP took place on 4th September 1974. The construction and commissioning of the units of the Bulgarian nuclear power plant was implemented in three stages:

- → Stage I: 1970 – 1975 – Construction and commissioning of units 1 and 2 with water pressurised reactors WWER-440, model V-230, with two independent trains of the safety systems;
- → Stage II: 1973 – 1982 – Construction and commissioning of Units 3 and 4 with Pressurised Water Reactors WWER-440, upgraded model V-230 with three-fold redundancy of the safety systems.
- → Stage III: 1980- 1991 – Construction and commissioning of Units 5 and 6 with WWER-1000 reactors, model V-320 with containment and three-fold redundancy of the safety systems.

Because of the commitments made by Bulgaria in connection with its accession to the EU, Kozloduy NPP closed the first four units before the expiry of their design lifetime that is 30 fuel campaigns.

TABLE 1.1-1: DATA ABOUT UNITS 1÷4 OF KOZLODUY NPP

Unit	Type of reactor and power, MW	Year of connection to the grid	Closure of units	Fuel campaigns	Electricity generated for the period, MWh
Unit 1	WWER-440	1974	31.12.2002	23	66 675 397
Unit 2	WWER-440	1975	31.12.2002	24	68 905 334
Unit 3	WWER-440	1980	31.12.2006	22	68 703 260
Unit 4	WWER-440	1982	31.12.2006	21	66 711 966

Electricity Generation

In 2002, the last year when all the six installed capacities of the nuclear power plant were in operation, a record quantity of electricity was generated – 20 221 719 MWh, which accounted for 47.3% of the total electricity generation in the country.

In 2006, with four operating units, the NPP approached its highest production, providing for the energy system of the country 19 493 219 MWh or 42.6 % of the energy generated on a national scale –*Figure 1.1-1: Annual production of Kozloduy NPP.* Since the beginning of 2007 units 5 and 6 of the NPP have remained in operation: reactors WWER-1000, model V-320 with containment and three-fold redundancy of the safety systems.

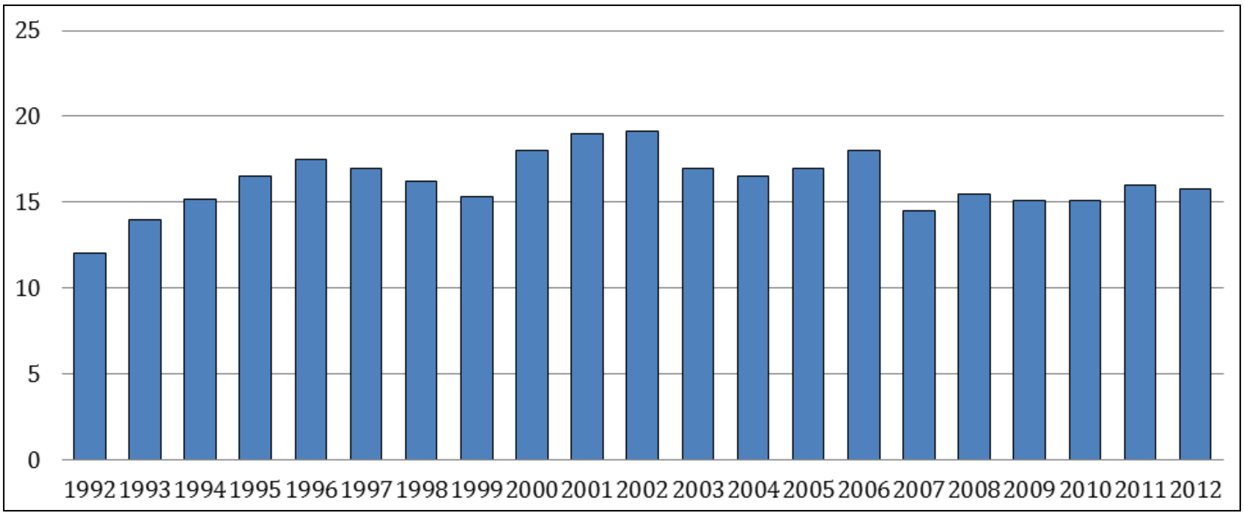

FIGURE 1.1-1: *ANNUAL PRODUCTION OF KOZLODUY NPP*

Figure 1.1-2: Electricity generation for the period january – december 2012 shows the annual electricity generation of units 5 and 6 for 2012.

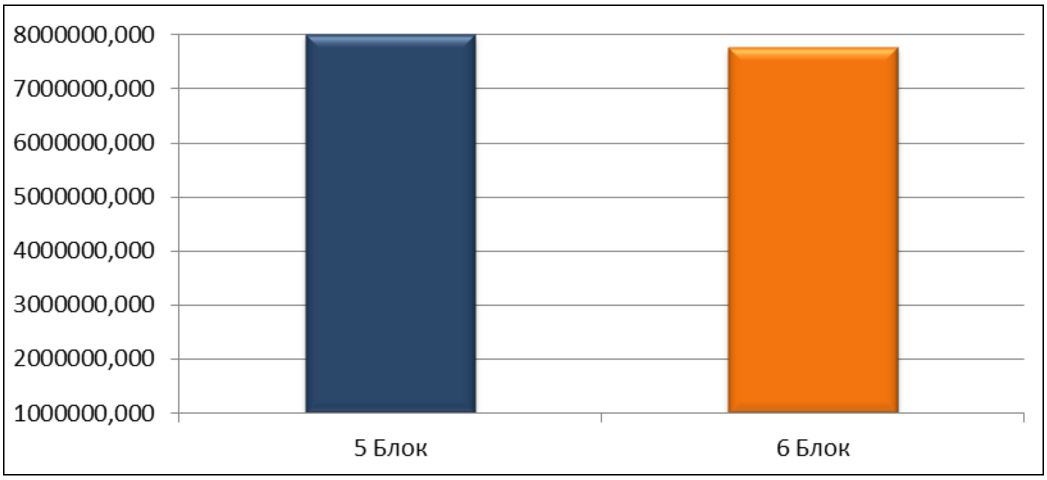

FIGURE 1.1-2: ELECTRICITY GENERATION FOR THE PERIOD JANUARY – DECEMBER 2012

Kozloduy NPP is one of the main factors for the sustainable development of electricity generation in Bulgaria today and is a particularly important component of the energy mix of the country. The nuclear power plant has the largest share of the national power production.

1.2 NUCLEAR FACILITIES AND COMMON PURPOSE BUILDINGS AT THE KOZLODUY NPP SITE

The Kozloduy NPP site is located in Northwestern Bulgaria on the territory of Vratsa region and the municipality of Kozloduy, mainly on the territory of the town of Kozloduy and the village of Harlets. The site is located at about 2.6 km south-east of the town of Kozloduy, 3.5 km northwest of the village of Harlets, 65 km north of the regional center – the town of Vratsa and 200 km north of the town of Sofia. It is located on the second non-flooded river terrace of the Danube, with absolute elevation + 35 m, about 3.5 km from its right bank, where the direction of the river flow is in the northwest – southeast. To the north, the site of Kozloduy NPP borders on the Danube Lowland, and to the south-southwest – on the watershed plateau at an altitude of 90 m.

On the territory of Kozloduy NPP there are no natural water bodies. The inland rivers closest to the plant on the territory of the Republic of Bulgaria are Ogosta and Skat to the east and Tsibritsa – to the west. Only the Danube is of significant importance for the operation and security of Kozloduy NPP. The elevation of the site is formed on a non-flooded area of significant size, which in the design of the plant is determined with non-flooding reserve for a 10 000-year high wave on the Danube River.

Between the site of Kozloduy NPP and the Danube there are dikes dimensioned to withstand 1000-year high tide on the Danube River with the required normative reserve. The draining systems in the area are dimensioned for removal of surface water due to intense rain of different duration and rain height of 0,01 %.

At present, the more important sites and facilities built at the Kozloduy NPP site (*Figure 1.2-1: General plan of Kozloduy NPP and location of the proposed sites for NNU*) are:

- → Main building (reactor building and the turbine hall)- units 1 and 2 as well as 3 and 4 have a common main building (all of the 8 turbogenerators for units 1÷4 are in a common turbine hall);
- → Main building of units 5 and 6;
- → Specialized buildings 1 and 2 (SpB-1,-2)- servicing respectively units 1,2 and 3,4 of of EG-1; Special building 3 (SpB-3) – servicing units 5 and 6 of EG-2;
- → CWTF-1 – provides services to units 1÷4;
- → CWTF-2 – provides services to units 5 and 6;
- → CPS-1 and 2 provide services to units 1÷4 and CPS–3 and 4 provide services to blocks 5 and 6;
- → 2 DGS provide services to units 1÷4 and 3 DGS provide services to units 5 and 6;
- → OS – composed of three parts: 110 kV, 220 kV, 400 kV;

- Cold (intake) channel (CC-1);
- Hot (outlet) channel (HC-1,2);
- Spray ponds for units 1÷6;
- Spent fuel pond (SFP);
- Dry spent fuel storage facility (DSFSF)
- Oil and Diesel Facility in EG-2;
- Fire Pumping Station – 2 (FPS-2);
- Storehouse;
- Landfill for non-radioactive municipal and industrial waste – LNHIW;
- Common purpose building (CPB – 1) and Maintenance and repair shop (MRS) – EG-1, CPB-2 in EG-2 (units 5 and 6);
- Waste Water Treatment Plant (WWTP) – EG-2
- Sanitary buildings (SB -1,-2) – in EG-1;
- Engineering Laboratory Building (ELB) – in EG-2
- Training and Technical Center (TTC);
- Information center;
- Administrative buildings: NPP Management; EG-2 Division; Investments Division, Engineering Building for „D&M“ Directorate;
- Warehouses (in the security area and outside it).

The area within the construction boundaries of Kozloduy NPP is 4 471.712 daa. It is divided in the following main zones:

I. Electricity generation -1 (EG-1) with 1÷4 power units, specialized buildings 1 and 2 and auxiliary facilities. On this territory is located a spent fuel pond (SFP) and dry spent nuclear fuel storage facility (DSFSNF). Power units 1 and 2 were decommissioned in 2002 and units 3 and 4 – in 2006. At present, units 1÷4 are declared as radioactive waste management facilities and are owned by SE "RAW".

II. Electricity generation -2 (EG-2) with units 5 and 6, special building 3 and auxiliary facilities. On the territory of this zone is located an Enterprise for radioactive waste processing owned by SE "RAW".

III. Territory of the intake (cold) channel CC-1, the outlet (hot) channels HC- and HC-2 as well as the facilities of the Bank pumping stations (BPS) – they all supply service water to the plant.

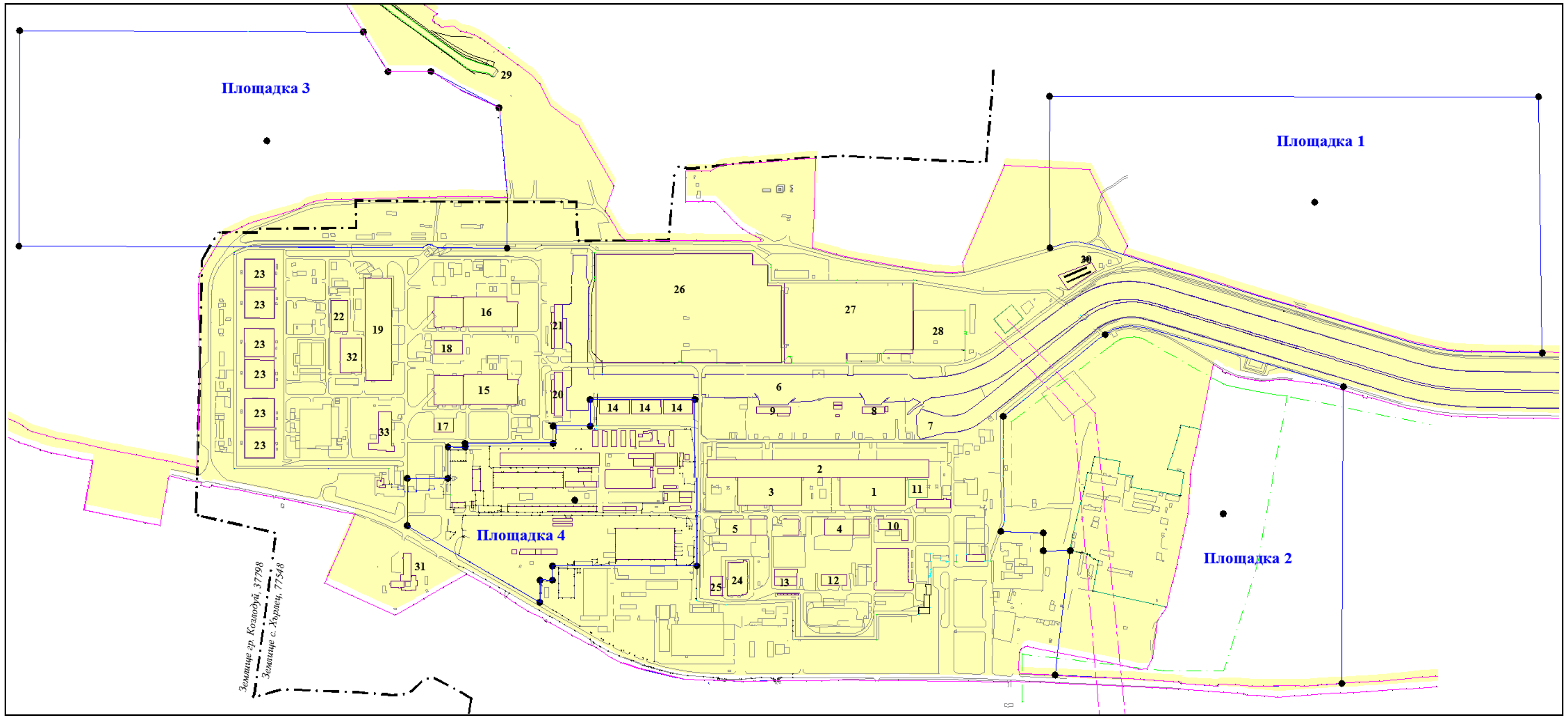

FIGURE 1.2-1: GENERAL PLAN OF KOZLODUY NPP AND LOCATION OF THE PROPOSED SITES FOR NNU

Legend:

1. Reactor building – units 1,2.
2. Machine hall units 1÷4 .
3 Reactor building units 3,4.
4. Special building 1.
5. Special building 2.
6. Cold (intake) channel
7. Hot (outlet) channel 1.
8. Circulation pumping station 1.
9. Circulation pumping station 2.
10. Chemical shop.
11. Size reduction and deactivation shop- project.
.
12. Diesel Generator Station 1.
13. Diesel Generator Station 2.
14. Spray ponds units 3,4
15. Power unit 5.
16. Power unit 6.
17. Diesel Generator Station unit 5.
18. Diesel Generator Station unit 6.
19. Special building 3.
20. Circulation pumping station 3.
21. Circulation pumping station 4.
22. Storage facility for RAW
23. Spray ponds units 5,6
24. Spent fuel storage facility (SFSF).
25. Dry SNF 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 domestic and industrial waste – LNHIW.
31. Fire Protection Service.
32. SD RAW shop – SE RAW.
33. Occupational Medicine Centre

1.2.1 NUCLEAR FACILITIES AT THE KOZLODUY NPP SITE

At the Kozloduy NPP site are built: 6 power units with total power capacity of 3760 MW equipped with pressurised water reactors, spent nuclear fuel storage facility (SNFSF) and dry spent nuclear fuel storage facility (DSNFSF) This category also includes other facilities and sites owned by SE RAW.

1.2.1.1 UNITS 1 AND 2

Under Council of Ministers' decision of 20.12.2008, units 1 and 2 were declared as radioactive waste management facilities and along with the necessary movable property were given over to the Radioactive Waste State Enterprise, which is an independent company. On 18.10.2010, NRA issued licences to the Radioactive Waste State Enterprise for the operation of units 1 and 2 as radioactive waste management facilities which are subject to decommissioning and revoked the licences of Kozloduy NPP for the operation of the first two units in the E mode of operational regime . No nuclear fuel is stored at the site of units 1 and 2.

1.2.1.2 UNITS 3 AND 4

Units 3 and 4 were decommissioned on 31.12.2006. Under decision No 1038/19.12.2012 of the CM units 3 and 4 of Kozloduy NPP EAD were declared as RAW management facilities which are subject to decommissioning. Their property was given over to SE RAW to operate and manage it. On 26.02.2013 NRA issued licences to the Radioactive Waste State Enterprise for the operation of units 3 and 4 as radioactive waste management facilities which are subject to decommissioning and revoked the licences of Kozloduy NPP for the operation of the two units in the E-mode of operational regime. No nuclear fuel is stored at the site of units 3 and 4.

Currently, the spent nuclear fuel (SNF) of the four units after being removed from them is stored in the spent fuel storage facility (SNFSF).

Units 1÷4 have been given over to SE RAW EAD Sofia and are managed by two specialized departments: Specialised department for Decommissioning (SD DE – Kozloduy for units 1 and 2) and Specialised department for RAW management – units 3 and 4 (SD RAWM 3 and 4)

1.2.1.3 UNITS 5 AND 6

Units five and six are in operation, unit five being in its 19th fuel campaign and unit six – in the 18th. Both units operate in a basic regime at nominal capacity adhering to the licence conditions of operation.

Units 5 and 6 of Kozloduy NPP are built with reactors WWER-1000, type V-320. The reactors are Russian – second generation with pressurised water. According to the concept for ensuring the safety, the design characteristics and the structure of the units are analogical to the western designs of reactors of the PWR type. The WWER-1000/V-

320 units are designed in compliance with the standards established in Main Safety Rules (MSR-73), later updated as Nuclear Safety Rules for NPP (NSR-04-74), Main Safety Rules (MSR-82) and Radiation Protection Standards (RPS-76) of the former USSR. The main safety concept of defence-in-depth is realised through design solutions characterized by redundancy, diversity, independence, protection against failure and passive elements. Each WWER-1000/V-320 reactor has a containment with protection steel cladding resistant to mechanical stress similar to western reactors. Procedures are under way for both units for extending their operational life as well as increasing their capacity.

An Enterprise for Radioactive Waste Treatment, property of the SE RAW is built on the territory of this area, under the management of the Specialized Division for RAW (SD RAW).

1.2.1.4 SNFSF

The spent nuclear fuel storage facility is located south-west of units 3 and 4 at the Kozloduy NPP site. The spent fuel pond provides for temporary storage under water of SNF from WWER-440 and WWER-1000 for a 10 year period of operation of all the units of Kozloduy NPP and for the transport and technological activities related to its reception, placement in the storage sections, storage and transporting out of the SNFSF following the sfety requirements.

1.2.1.5 DSNFSF

The DSNFSF site is located north-northwest of the SNFSF building. The storage technology in DSNFSF of Kozloduy NPP uses casks for air cooled storage on the principle of natural convection. The casks are CONSTOR 440/84 type with a capacity of 84 fuel assemblies from WWER-440. DSNFSF is situated within the existing boundaries of Kozloduy NPP and is an extension to the temporary storage of spent nuclear fuel in SNFSF being carried out so far at the NPP site.

1.2.1.6 OTHER FACILITIES AND BUILDINGS OWNED BY SE RAW

At present, pursuant to the licence for operation of nuclear unit for RAW management issued by NRA to Radioactive Waste State Enterprise, the latter is granted the right to carry out main, auxiliary and servicing activities through its specialized division (SD) for Radioactive Waste – Kozloduy. The nuclear facility for RAW management of SD RAW – Kozloduy includes the following main facilities:

1. **RAW treatment shop (RAWTS)** main facility designed for *pretreatment activities, treatment and conditioning* of RAW from Kozloduy NPP.

   The main component unit for making the packages for the conditioned RAW is a steel and concrete container (StCC) which is made and tested according to the terms of the permt issued by NRA.

The packages of the conditioned RAW are temporarily stored in a Storage for conditioned RAW (SCRAW), site No 1 and site No 2 /should not be confused with the numbers of the sites for the building of the new nuclear unit/ and are subject to disposal without additional treatment.

The main systems of RAWTS are:

- ✓ Solid RAW line – sorting and treatment by pressing the solid RAW to reduce their volume and prepare them for the following conditioning and inclusion;
- ✓ Liquid RAW line – treatment and conditioning of the liquid RAW. The RAW packaging line is a component part of Liquid RAW line.

2. **Storage for conditioned RAW (SCRAW) –** its purpose is to temporarily store (until their disposal) the conditioned RAW from Kozloduy NPP. It is an on-ground reinforced concrete facility providing for the required engineering barriers between the stored RAW and the environment and personnel. It is built in the proximity of RAWTS.
3. **Lime Plant site**

The following are located at the Lime Facility site:

- → Trench storage for temporary solid RAW storage [non-treated and treated (pressed and closed in barrels)];
- → Storage for treated solid RAW ("baskets" with pressed RAW closed in barrels);
- → Site No1 (should not be confused with the numbers of the sites for the building of the new nuclear unit) for solid RAW storage in steel and concrete containers (StCC) – (packages StCC-1 or StCC-2 according to the Technical specification of the packages for the conditioned RAW (see below);
- → Site No2 (should not be confused with the numbers of the sites for the building of the new nuclear unit) for solid RAW storage in steel and concrete containers (StCC) – (packages StCC-2) ;
- → Site for solid RAW storage in large ton containers (LTC);
- → Storage for contaminated soil (SCS) – designed for storage of low level radioactive soil masses.

The facilities not included in the composition of the nuclear power units, planned to be built at the Kozloduy NPP site are as follows:

1. Plasma melting facility – phase of work project and completed ISAR.
2. Size Reduction and Deactivation Shop – at the stage of technical design.
3. National storage for short-lived low and medium active radioactive waste. Radiana site is not located on the territory of the Kozloduy NPP site, but is close enough so that the present EIA report should take account of its impact.

The national repository is a facility with a multi-barrier protection for long-term storage of radioactive waste that is pre-processed, safeguarded and packed in reinforced concrete cube packages. The repository will be of the trench type at the ground surface with capacity of 138 200 m^3 . It will consist of several steel and concrete ground embedded structures (modules) divided into chambers by internal partitions. After being filled up with packages, the chambers will be covered with a reinforced concrete plate and insulated from the atmospheric waters by piling up multiple layers of earth. It is envisaged that the repository could be operating, i.e. will be gradually filled up for a period of 60 years. So far the detailed spatial development plan (DSDP) – Regulation and Building Development Plan (RBDP) for the Radina site for the construction of National repository for low and intermediate level radioactive waste (NRRAW) has been approved. Its commissioning is expected in 2015.

1.2.2 COMMON PURPOSE BUILDINGS AND FACILITIES

1.2.2.1 OUTDOOR SWITCHGEAR

Kozloduy NPP is connected to the electricity grid (EG) of Republic of Bulgaria through three own outdoor switchgears (OS) with voltage of 400 kV, 220 kV and 110 kV. They are connected to each other by auto transformers. Switchgear 400 kV is implemented as a double sectioned busbar arrangement, Switchgear 220 kV – as a double busbar system, Switchgear 110 kV – as a double busbar system with a bypass busbar.

1.2.2.2 DRINKING WATER SUPPLY

There is a very good water supply network at the Kozloduy NPP site for drinking, domestic and technical purposes. The drinking water for NPP is supplied from three Raney Collector wells located in the terrace of the Danube river before Kozloduy under Agreement with V&K (Water supply and Sewerage) EOOD – Vratsa. They also provide reserve water supply for the villages of Harlets and Glojene. For these groundwater intakes, the municipality of Kozloduy has been issued a Permit for abstraction under the WA by BDWMDR. From the reservoirs of the town of Kozloduy, the water reaches the pumping station (PS) by gravity through a pipeline 11 km long, diameter Ø 500 mm, and maximum water quantity of 260 l/s. The pumping station pumps the water to the reservoir of the plant to elevation 93.0 m (with a volume of 2x2000 m^3) from where it reaches the individual consumers by gravity. The length of the thrust water pipeline from PS to the reservoir is 0.5 km. The external water system – wells, pumping stations, water pipelines and other facilities to the first distribution shaft are supported by V&K EOOD – Vratsa. Every year, Kozloduy NPP EAD enters into an agreement with V&K utility for the supply of drinking water. The consumed water quantity is measured with water meters. The external consumers of drinking water at the plant’s site are supplied with water from the internal water pipeline of NPP and the consumed water is measured.

The calculations of the average monthly drinking water consumption by consumers from NPP show that the real quantity of drinking water consumed amounts to about 35÷40 l/s.

Balance of the drinking water supplied to the consumers at the Kozloduy nPP site:

1. Drinking water pipeline to Kozloduy NPP- **Ø=500** mm and capacity **260** l/s
2. Consumers:

CONSUMERS	BRANCH – - Ø mm	CONSUMPTION l/s
EG-1	315	73.00
EG-2	315	73.00
AER	150	17.50
PB	60	5.00
INV.	57	3.40
INSTALLATION	100	8.00
FPS – unit 5	125	9.20
	TOTAL:	**189.10**

3. Reserve – **70.90 l/s.**

For the shower bathrooms of EG-1 a shaft well in the Valyata area is used. A Permit is issued for this facility under the WA by BDWMDR.

1.2.2.3 WATER SUPPLY FOR TECHNICAL PURPOSES

The water supply for technical purposes provides cooling water /circulation – for the turbine's condensers and service water for other facilities/. It is done by 3 bank pumping stations from the Danube river, as well as from 6 shaft pumping stations, located in the terrace of the Danube. – for emergency water supply to units 5 and 6. Service water for technology needs, and for the system of fire extinguishing in the BPS 1, 2, and 3, is provided from a Raney collector 5.

Water intake from the Danube river and the bank pumping stations are located at km 687 from the mouth of the Danube after the island at the town of Kozloduy. Water intake is in deep water. BPS-1,-2 and -3 provide NPP with service water. The capacity of the cold channel is 180 m^3/s with maximum capacity of 200m^3/s[2] . For the use of water from the Danube as well as from the ground sources there are Permits for abstraction issued by BDWMDR.

Water from the Danube River is supplied to the plant by the hydrotechnical facilities, which are crucial for the normal operation of the power plant. The cold channel

[2] Energoproekt 1991 r . - Existing channels for service water supply of Kozloduy NPP.

connects the discharge basins of BPS with CPS-1/circulation pumping station/ 7023 m long. At the end of curve 8 a bottom transverse threshold is built reaching elevation 29.25, which provides emergency volume in case of blackout. The power units being built sequentially, it has been extended to CPS-2 and later to CPS-3 and CPS-4 where it is plugged up. The CPS /circulation pumping stations/ are located in front of the machine halls of the respective power units. The supply cold open channel for the water from the Danube River is 19.50m wide at the bottom, with slopes of 1:2 and depth of 5.6m.

The used water from the power units is discharged back to the Danube River by a hot outlet channel HC-1. The hot channel HC-1 begins at the outlet shaft of the low pressure channels and ends at the spillway of the bypass channel for discharging the hot waters into the Danube. It is 6930m long. The capacity of the hot channel is 180 m^3/s with proven maximum capacity of 200 m^3/s and depends on the elevation of the spillway after the low pressure channels and the water level in the Danube River. The outlet hot channel passes parallel to the cold CC-1 along the largest part of the route. The two channels have a common dike and form a double channel. There is also a HC-2 dimensioned for 110 m^3/s for the purposes of power units 5 and 6.

There is a bypass channel serving as a connection between HC-1 and the riverbed of the Danube and for damping the energy of the water flow. A WPP is built with $Q_{develop}=95m^3/s$ for which there is a permit for abstraction issued by BDWMDR. It has a rectangular cross section 35.00 m wide and vertical metal and concrete enclosing walls. Its bottom is at elevation 27.40. At its beginning there is a bridge-barrier facility with nine openings fitted with sluice gates. The channel ends with a spillway and chute with a stilling basin with energy dissipator as well as a hot water battery which supplies hot water from HC-1 to the fore chambers of BPS-1,-2 and 3 in the winter months. The purpose is to reduce the losses from overcooling of the steam condensate from the turbines. It consists of 6 pipelines with a diameter of 1.20 m and is dimensioned for water volume of 12 m^3/s. Hot water abstraction is by a channel discharging before the spillway at the end of HC-1.

The route of the channels is crossed by the water pipelines supplying drinking water to the village of Harlets and service water from the Valyata PS.

There is a reference monitoring system for monitoring the deformations along the double channel.

There are 44 drainage wells (17 in the non-floodable terrace and 27 in the lowland) built for monitoring the ground waters. They are used for monitoring the water levels and isotope measurements.

Besides these HTF, there are spray ponds built on the territory of the plant, which serve for cooling the water from the service water systems of EG-1 and EG-2. For each of units 5 and 6 there are 3 SP (with dimensions of 68x65m and a depth of 3m).

Service water consumers fall in two groups – important and non-important depending on the responsibility for nuclear safety they bear. The important consumers are those that work with the safety systems and normal operation systems and are directly related to safety. In emergency situations when water cannot be conveyed to CC-1 from the Danube, service water from the fore-chambers of CPS is supplied only to the important consumers, its cooling being provided by the spray ponds. In such cases water reserve is provided from the partition wall-spillway in the region of curve 8. In the cases where the water from the fore chambers of CPS is insufficient, it is possible the losses of water in SP (from evaporation and wind blowing) to be compensated from other sources. For units 1÷6 are used 3 emergency pumps for service water (EPSW) installed in BPS 2 and 3, which pump water from the Danube to the fore chamber of CPS, and for units 5 and 6 – additionally from ground sources (GWPS 1÷6)

The protection dikes built along the Danube in the region of Kozloduy lowland are also important for the safe operation of the plant.

From the point of service water provision, according to Letter No 236 of 11.03.2013 by Kozloduy NPP – New Build EAD if we take into consideration that the first 4 units have been decommissioned, there will be free capacity to 100 m^3/s for the new unit, the accepted necessary conservative value being 60 m^3/s. So, it is not expected that due to the operation of the new nuclear unit the quantity of the water used for technological needs will exceed those defined in the permit for abstraction.

The water supply system of Kozloduy NPP for service and industrial water is well designed and reliable and well maintained by the operating personnel.

TABLE 1.2-1: ANNUAL QUANTITIES OF WATER MASSES USED FOR SERVICE AND DOMESTIC WATER SUPPLY

Abstraction location	Permitted quantity [thous. m^3]	Used quantity [thous. m^3]					
		2006	2007	2008	2009	2010	2011
Surface waters from the Danube	5 000 000	3 334 722	2 323 800	2 629 876	2 593 459.52	2 564 530	2 660 788
Six shaft wells (GWPS 1÷6)	7 884	-	-	0	0	0	24.779
Raney collector well – 5	1 600	190	314	75	15.929	24.000	2.729
Shaft well Valyata	788.4	291	183	204	192.27	193.000	216.700
Urban water network	-	1 805	1 846	1 259	1 460	1 435	1 379

Source : Annual Report for ONM of environment in Kozloduy NPP for the period 2006-2011.

The information presented (***Table 1.2-1:*** *Annual quantities of water masses used for service and domestic water supply*) shows that the water quantities applied for considerably exceed the actual consumption, so the given water body is not used too much and there will be enough water quantities available for drinking, domestic and industrial water supply upon the implementation of the Investment proposal.

1.2.2.4 SEWERAGE SYSTEM

Kozloduy NPP has a sewerage of domestic, industrial and rain waters – mixed for EP-1 and separated for EP-2. It covers the whole territory of the plant and collects all types of wastewater.

The different sewerage branches were built at different times during the construction of EG-1 and EG-2.

1.2.2.4.1 Non-radioactive wastewater

The non-radioactive waste waters at the Kozloduy NPP site include household, industrial and rain waters. They come from the administration buildings, the energy buildings, the sanitary personnel buildings, the specialized buildings, the common purpose building, the engineering laboratory building, the CWTF, the oil and diesel facility, the diesel-generator stations, vehicle fleet, etc.

The following main streams are formed at EP-2:

- → household wastewater – from the sanitary facilities and laundries in the "controlled area" and the "clean area", which are conveyed via separate collectors to WWTP for EP-2;
- → industrial waste waters – these comprise acidic and alkaline waste waters from CWTF, waters contaminated by crude petroleum products and oils, which are conveyed via separate collectors to the local waste water treatment facilities for the various types of waters;
- → rain waters – from the drainage of the roofs, streets and grass areas within the territory of the power plant, which are conveyed to the MSC via the rain water sewerage.

A stream of cooling non-contaminated waters from various sub-facilities is also arranged on this territory, which are conveyed to the rain water sewerage.

These waste waters are discharged into the Main Sewerage Channel (MSC) of the Kozloduy drainage and irrigation system, where the four streams of waste waters from the whole NPP site discharge, from which by means of a pump stations (PS) the waters from the MSC are discharged into the Danube River:

Stream 1: Mixed from of household-faecal wastewater (untreated), industrial and rain wastewaters, conveyed to the MSC by means of a trapezoidal open channel (from the mixed sewerage of EP-1 – household-faecal wastewaters from the energy buildings of units 1÷4, Special buildings 1 and 2, DGS and other administration and staff buildings, part of which are the property of SD DC – a division of SE RAW; industrial waters from EP-1, excluding the installations in HC-1; rain waters from EP-1; part of the industrial, household-faecal wastewater and rain waters from the EP-2 site; household-faecal wastewaters from the office buildings and sites of Atomenergoremont PL (AER), Atomenergo-Stroyprogress EAD, Zavodski Stroezhi – Kozloduy AD (ZS), Energomontazh

OOD, Energomontazh-KNPP AD; waters from the carwash of AESP EAD and rain waters– after treatment in the local sludge and oil retainer).

Stream 2: Household-faecal wastewaters from the so-called "clean area" of EP-2, from SE RAW – Kozloduy and AESP EAD, discharged (untreated) into the MSC by means of Ø300 mm collector during repair works, or in emergency situations.

Stream 3: Mixed flow of household-faecal wastewater from the "controlled area" and the "clean area" treated at the treatment facility of EP-2 (TF), industrial wastewaters from the MH, DGS and the Oil and Diesel Facility (treated by the sludge and oil retainer at the TF), as well as rain waters from EP-2 and from SD RAW – Kozloduy, discharged into the MSC via collector of Ø1000 mm.

Stream 4: Household-faecal wastewaters and rain waters, coming from the OS, discharged into the MSC by means of a collector with an egg-shaped profile of 130/195 cm and an open channel with lining.

A permit for discharge into the MSC was issued by the BDWMDR for these waste water streams.

Besides the above four streams, waste waters are discharged also into the Danube River through HC-1 and HC-2, for which a permit for discharge has been issued by the BDWMDR. This is primarily cooling water after the condensers and from the service water systems. Other waters, discharged through the HC, include:

- debalanced waters discharged from the Special Water Treatment (SWT-3, SWT-5, SWT-7), including heating steam condensate;
- waters from the deminirelised water installations (after treatment in the neutralizing pits);
- waters from the expansion vessels of the overflowing high-pressure deaerators (HPD) and from the expansion vessels of steam generators (SG) blowdown ;
- waters from the secondary circuit drainage tanks and from the main condensate system flushing;
- flushing water from the circulation water filters.

Water treatment facilities

There are various water treatment facilities on the territory of the NPP for treating the waste waters from the individual sub-facilities.

Waste water treatment facility for EG-2

There is a Treatment Facility (TF) for the purification of the household-faecal wastewaters from EG-2. It consists of two plants – one for the waters from the "controlled area" (CA) and one for the waters from the "clean area" (ClA). They are equipped with similar treatment facilities, which differ only as regards their capacity.

The waste water treatment plant for the CA is designed for a mean daily water discharge of 106 m^3. It is equipped with an installation for dosimeter control. In case the radioactivity of the water exceeds the admissible values, it is returned to the CA for re-processing.

The treatment plant for the "clean area" is dimensioned for 146 m^3 per day.

The treated waters from both areas are discharged via a collector of Ø1000 into the MSC of the Kozloduy drainage system.

There are instructions available for the proper operation of the waste water treatment plants, which state the requirements for normal operation mode and in case of potential failures. In emergency situations or while repair works are being carried out, a possibility is provided to discharge the household-faecal wastewaters from the CA into the MSC without treatment.

Sludge and oil retainers

There is a sludge and oil retainer immediately next to the TF for treatment of the industrial waste waters from TH, DGS and the oil and diesel facility. Its capacity is 50 l/s. The concentration of oil at its outlet is less than 0.5 mg/l. The waters treated in the sludge and oil retainer flow into a collector of Ø1000 of the sewerage, via which they are discharged into the MSC. It was commissioned at the end of 2011.

The sludge and oil retainer (with a capacity of 14.0 l/sec.) used earlier is currently used only for treating individual small quantities of waters contaminated by crude oil products (e.g. from washing of various engines) delivered by tanker trucks.

Neutralization pits

The installations for chemical water cleanup facility (CWTF) of Electricity generation 1 (units 1÷4) and Electricity generation 2 (units 5 and 6) of Kozloduy NPP EAD treat the water from the Danube River (raw water), using precipitation tanks, mechanical and ion-exchange filters. The waste waters from this treatment, as well as the solutions from the regeneration of the filters may contain sulfuric, hydrochloric and nitric acids, sodium hydroxide, calcimine, ferrous chloride.

The organization of the neutralization process and its technology are identical for EG-1 and EG-2. The waste waters are collected for neutralization in one of the two chambers (neutralization pits), where they are mutually neutralized. After the pH control (if values are6.5 – 8.5), they are discharged as follows:

→ for units 1÷4 – into HC-1;

→ for units 5 and 6 – into DSh-1, and from there – into HC-1 or HC-2.

If they do not satisfy the above requirement, they remain in the pits until they reach the required degree of neutralization.

The following permits have been issued by MoEW/BDWMDR for the water abstraction facilities along the Danube River, the water abstraction facilities for ground waters, as well as for the discharge of the waste waters:

- → Permit No0562/14.03.2005;
- → Permit No11590203/30.05.2008;
- → Permit No11530128/30.05.2008;
- → Permit No 11530127/30.05.2008;
- → Permit No 13750001/20.04.2007 with its subsequent amendments;
- → Permit No13120037/22.11.2010.

Permit No 11530127/30.05.2008 for water abstraction from six shaft wells – SWPS 1÷-6 regulates the water abstraction for reserve (emergency) service water supply for the spray ponds of units 5 and 6 at Kozloduy NPP. During normal operation, the losses of water in the spray ponds of units 5, 6 are refilled from CPS 3 and CPS 4. A system for emergency service water supply has been built to increase the level of safety, which provides water for the spray ponds in the cases when it cannot be provided by the CPS. The emergency service water supply system is designed for a water discharge of 280 l/s and consists of 6 shaft pumping stations (SPS). The SPS are located on the terrace of the Danube River at approximately 25 – 30 m to the south of the base of the state dike. They are equipped with 2 submersible pumps each.

Under the permit for water abstraction No 11530128/30.05.2008 the Ranney-5 well supplies service water – for technological needs and for the fire-fighting system of the BPS-1, – 2 and -3. The well has a diameter of 4 m and is located at approximately 1 200 m to the southeast of the BPS site. The design discharge rate of the pumping station is 116 l/sec, distributed as follows:

- → for technological needs – 46 l/s; two pumps are installed, each with a discharge rate of 50 l/s (one operational, and one standby);
- → water for fire-fighting – 70l/s; two pumps are installed, each with a discharge rate of up to 140 l/s.

Permit No 11590203/30.05.2008 for water abstraction from the Valyata shaft well provides for the sanitary domestic water supply for units 1÷4 of Kozloduy NPP.

The discharge permits issued according to the WA for water abstraction and use of a water body for discharge can be modified in case during the realization and operation of the IP some parameters and terms specified therein cannot be complied with. The prohibition for new discharges of waste waters into the irrigation drainage systems shall also be taken into consideration pursuant to art. 6, clause 1, items 3 and 4 of Regulation No 2/ 08.06.2011 (SG No 47/ 21.06.2011) on the issuance of permits for wastewater discharge into water bodies and determination of the individual emission limits for point sources of contamination.

1.2.2.4.2 Radioactive contaminated waste waters

During the operation of the power units, industrial radioactive waste waters are generated from:

- nuclear reactors primary circuit leaks;
- ponds and spent fuel storage facility;
- decontamination of equipment;
- regeneration and flushing of ion-exchange filters;
- Protective clothing laundry and hot shower personnel access;
- radiochemistry laboratories, etc.

These waters are treated (purified) in evaporation installations and ion-exchange filter complexes (special water treatment systems SWT -3) in special buildings – 1, – 2 and -3. The treated waters, called “debalanced”, are collected in intermediate tanks and after checking their radioactivity, they are discharged into HC-1 and HC-2, if they comply with the norms. Otherwise, they are returned for further treatment.

The purpose of the special water treatment systems is:

- SWT-3 – designed for purification of the floor drain from the Controlled Area (CA). The sources of such waters are the unorganized leaks in the primary circuit, decontamination of equipment and systems, flushing and regeneration of filters, the SWT-3 itself – if the treated waters do not satisfy the NPP water chemistry standards or debalanced water discharges norms, etc.;
- SWT-5 – designed for constant and periodical purification of the water from the steam generators blowdown;
- SWT-7 – designed for purification of the radioactive waters from the laundries and shower baths;

The waters from the expansion vessels of the dearators and the steam generators blowdown are also debalanced waters. These waters are purified by means of ion-exchange filters and in case they cannot be used again in the technological cycle, they are discharged (after dosimeter control) into the HC.

The radioactive sludge from the SWT is collected and stored in special tanks with evaporation liquid concentrate. It is subjected to additional processing and disposal as RAW.

1.2.2.5 LINKS BETWEEN UNITS 1÷4 AND UNITS 5, 6 (STEAM, WATER, FIRE PROTECTION RING)

There are links provided between the technological systems of the first 4 units (1÷4), on the one hand, and those of units 5 and 6 on the other hand, which ensure the supply of chemically demineralized water, steam, water for fire-extinguishing in case of technological necessity:

- the fire-extinguishing systems for units 1÷4 and for units 5 and 6 make up firefighting rings connected with each other and if required there is a possibility to transfer water for fire-extinguishing between them;
- the steam systems, for own needs of units 5 and 6, are connected with those of units 1÷4 for the purpose of supplying steam for technological needs;
- the deminieralized water systems of units 5 and 6 are connected to those of units 1÷4, with a possibility to share demineralized water between the units, whenever necessary.

1.3 EMERGENCY PLANNING ZONES OF KOZLODUY NPP

On the basis of the calculation analyses of the maximum design-basis accidents and possible beyond design basis accidents of units WWER-440 (V-230) and WWER-1000 (V-230), and the radiological consequences, in accordance with risk categories I,II,III and the boundary dose criteria under the REGULATION for Emergency planning and emergency preparedness in case of nuclear and radiological emergencies (prom, SG, No 94 of 29.11.2011) the following zones for emergency planning are defined according to Appendix 3.1-1 of the Emergency Plan of Kozloduy NPP EAD:

- **On-site emergency planning zone – *protected zone* No 1,** Kozloduy NPP EAD site)**.**
- **Precautionary action zone (PAZ) – zone No 2,** with a radius of 2 km and geometric centre between the ventilation stacks of units 5 and 6**.** The area of the zone is 12 566 daa of which 3 012 daa or 24% is occupied by the production site of Kozloduy NPP and the site for storage and treatment of radioactive waste of SE RAW Kozloduy. Its purpose is limiting the irradiation in emergency.
- **Urgent protective action planning zone (UPAPZ)**[3] **– zone No 3,** with a provisional radius of 30 km around Kozloduy NPP EAD and area of 284 874 daa. Its role is carrying out the required control for the purposes of the radiation protection:
  - On the territory of R of Bulgaria this zone includes the whole of the following municipalities: Kozloduy Valchedram, Hayredin, Mizia and partialy the municipalities of Lom, Byala Slatina, Oryahovo, Boychinovtsi, Krivodol and Borovan. Within the zone there are no large Bulgarian industrial and military sites;

[3] UPAPZ of 30 km is defined for the purposes of emergency planning. The same zone of 30 km for the purposes of the radiation monitoring is called Surveillance Zone (SZ).

- ✓ On the territory of the R of Romania, 19 settlements in total fall within the zone from the districts Dolj and Olt[4].:

  (Kozloduy NPP EAD has the obligation to perform environmental monitoring in case of emergency in a zone of 12 km)

The emergency planning zones are divided into 16 sectors of 22.5˚ each and are marked with the first 16 letters of the Latin alphabet clockwise from north (A, B, C, D, E, F, G, H, J, K, L, M, N, P, R and S) Depending on the emergency state in the emergency planning zones, the actions undertaken for the protection of the personnel and the population are different in nature.

[4] Updated data about the territory of the R. of Romania – Letter by Kozloduy NPP– NB EAD, 297/01.04.2013

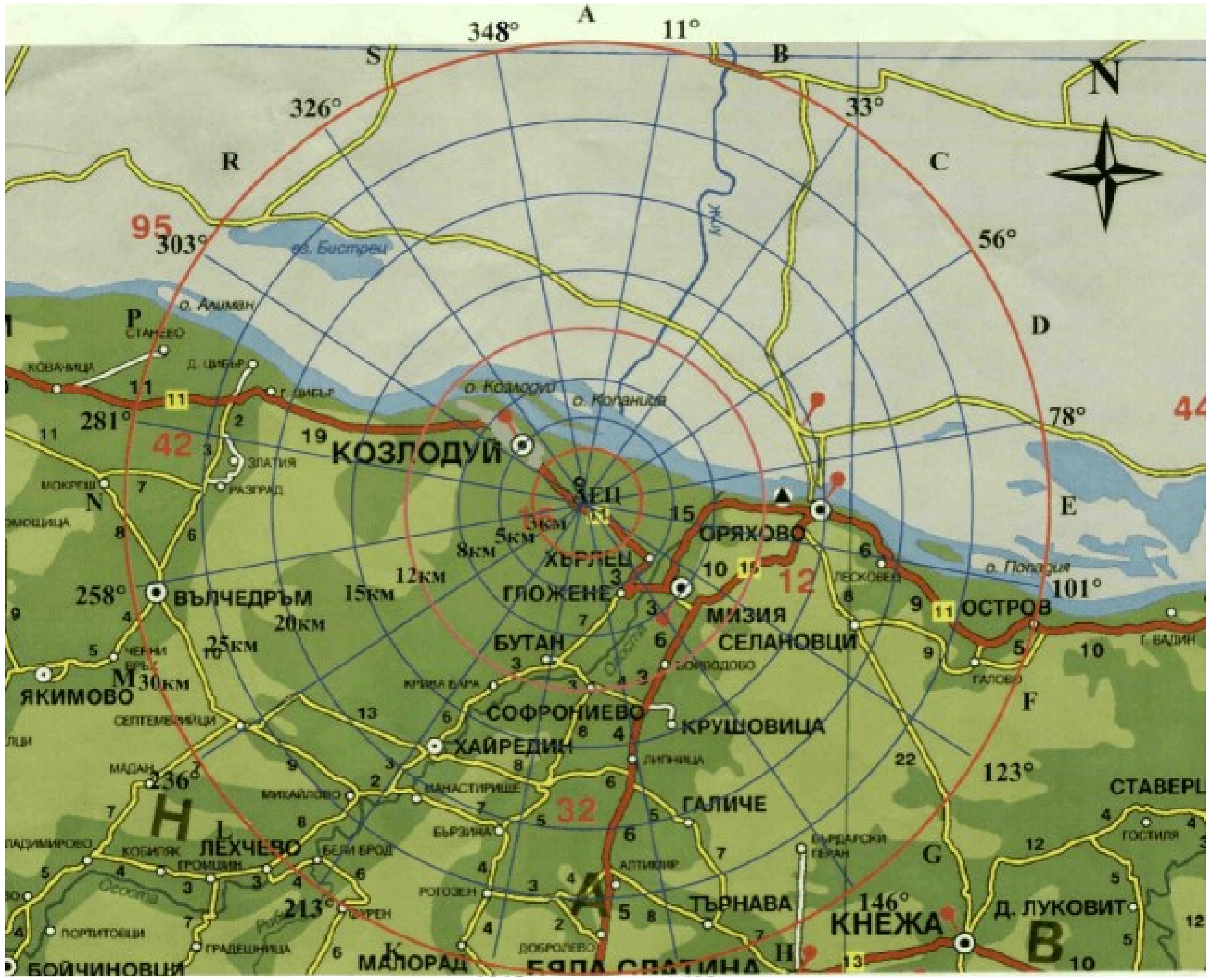

FIGURE 1.3-1: *EMERGENCY PLANNING ZONES*

1.4 RADIOECOLOGICAL MONITORING

The radiological monitoring performed by Kozloduy NPP covers all the main components of the environment (air, waters, soil, vegetation etc.) within a radius of 100 km around the power plant on the Bulgarian territory.

The quantity, scope and controlled parameters are specified in a longterm programme for radioecological monitoring under normal operation of the NPP coordinated with the control and supervising authorities in the country – NRA, the National Centre for Radiobiology and Radiation Protection (NCRRP) at the Ministry of Health (MH) and the Environmental Executive Agency (EEA) at the Ministry of Environment and Water (MoEW). The programme fully complies with the national and European regulatory requirements in the field, including art. 35 of the EURATOM Treaty, Recommendations of the EU 2000/473/EURATOM and 2004/2/EURATOM.

The monitoring zone includes the territory of the NPP industrial site, the 2-kilometer precautionary action zone (PAZ), the 30-km surveillance zone (SZ) and reference points within a 100-kilometer radius around the power plant.

The establishment of special status zones around Kozloduy NPP is associated with the necessity of creating an instrument for special development and regulation of the territory in accordance with the regulatory framework in the country and the common European safety and protection standards pursuant to the requirements of art. 104, para. 1 of the Safe Use of Nuclear Energy Act (SG No 63 2002, last amendment SG No82 2012).

1.5 SUBSTANTIATION OF THE NECESSITY OF THE INVESTMENT PROPOSAL

The Republic of Bulgaria has operated nuclear power reactors of the pressurised water type (PWR) at Kozloduy NPP since 1974, which proves that it possesses the required scientific and technical engineering capacity to derive benefits from such a highly technological production as the nuclear power generation. The rationale behind the investment proposal is to successfully utilize the whole capacity of Kozloduy NPP site, including the available infrastructure and the experienced and highly qualified personnel.

1.5.1 MAIN OBJECTIVES, PRINCIPLES AND SAFETY CRITERIA

The investment proposal envisages the building of a new nuclear unit of the latest generation (Generation III or III+) with pressurised light-water reactor (of the type PWR – Pressurised Water Reactor) with an installed electric power of approximately 1200 MW at one of the 4 potential sites and applying one of three main technical and layout solutions for reactor installations of the latest generation.

The key advantage of the design of the said generation of nuclear facilities as compared to the designs of the previous one, second generation operated worldwide today, including units 5 and 6 of the Kozloduy NPP operating reactors of the type WWER- 1000/V320, is that it will employ mainly passive safety systems, new design solutions for the structure of the containment and specific safety means such as the design solution based on the concept of corium catching in case of beyond design basis accidents, which achieves a considerable improvement of the nuclear unit safety.

As regards safety, the design of the construction of the new nuclear unit at the Kozloduy NPP site will take into consideration the requirements of the Bulgarian legislation in the field of nuclear energy utilization, the requirements of the IAEA, as well as the European requirements on safety, specified in the European Utility Requirements for LWR Nuclear Power Plants.

1.5.2 SUBSTANTIATION OF THE NEED FOR THE INVESTMENT PROPOSAL

The need of building a new industrial nuclear reactor at the Kozloduy NPP site is directly related to the maintaining of the energy balance of the Republic of Bulgaria, on the one hand, and the need to export electricity on the other, thus also covering the growing deficit of electric power in the Balkan Region.

Since the new nuclear unit that is planned to be built is designed for the generation of electric and low-potential thermal power, this item of the Terms of Reference is focused on the determination of the scope and contents of the EIA as regards the evaluation of the need for a new nuclear unit. It has to be proven that the IP will bring benefits to the society from the point of view of the energy balance as regards the two types of energy mentioned above while taking into account all the impacts on the environment and the risks to human health, as well as the social and economic impacts.

The electric power at its end consumption point is environmentally pure (its use does not produce any hazardous emissions) and it has an universal application (i.e. it can be transformed into other types of energy). The functioning of all sectors of the economy and the lifestyle of the population depend on the availability of electricity. An eventual shortage, respectively failure/defect in the electric power supply will affect the whole population, so the public concern regarding the reliability of electric power supply is fully justified.

According to the forecast for the energy balance of the country for the 2020 – 2030 period, based on the development of the energy sector in line with the current energy policy (the so-called Basic scenario, developed and periodically updated for Bulgaria under an order of the Transport and Energy DG of the European Commission), the electric power consumption in the country is expected to grow by, respectively, 8% in 2020 and by 23% in 2030 as compared to the consumption levels, accounted in 2005.

In addition to the growth of energy consumption forecast, the Bulgarian energy sector at present faces the necessity to cope with three basic challenges:

<u>High energy intensity of GDP:</u> Notwithstanding the positive trends for improvements, the energy intensity of the national GDP is by 89% higher than the average for the EU (taking into account the purchasing power parity);

<u>High dependence on energy resources import:</u> Bulgaria provides for 70% of its gross consumption of energy resources by means of import. The dependence on imports of natural gas, crude oil and nuclear fuel is practically complete and has a traditional one-sided orientation towards the Russian Federation;

<u>Necessity of environmentally friendly development:</u> The world faces challenges related to climate changes influenced by the growing volume of greenhouse gas emissions. The consumption of energy resources is one of the main sources of the greenhouse gas emissions such as the carbon intensity of the electric power, defined as a ratio of the total emissions of the power plants in relation to the total production of electric power in Bulgaria in 2008, which amounted to 555 kg/MWh.

In this context, the investment proposal is a considerable and reliable mechanism for overcoming all the mentioned restrictions, and meeting the growing energy needs of the country. According to the energy balance forecast for the country, the growing consumption of energy during the 2020-2030 period can be fully satisfied by domestic production, which is increasing at faster rates – respectively, by 13% in 2020 and by 32% by 2030. These expectations, however, are based on the forecast that during the 2025 – 2030 period replacement lignite power plants will be built applying a technology for carbon dioxide capture and storage, as well as that new nuclear power facilities will be commissioned on a national scale, which once again proves the rationale behind the IP and the importance of its implementation. Considering the above, the scope of the EIA will include an analysis to substantiate the IP selection, providing arguments for the necessity of the investment proposal derived from an assessment of the state and development of the electric power mix in Bulgaria, which will be performed for this purpose, as well as an assessment of the contribution of the new nuclear unit for achieving the priorities related to the transition to low-carbon energy generation, reduction of the dependence on imported energy resources and improvement of the national rating according to the GDP energy intensity indicator.

This analysis will produce conclusions as part of the EIA scope concerning the following:

1. **The new nuclear unit planned to be built at the Kozloduy NPP site in the context of the state and development of the existing electric power generating facilities in the country**

Bulgaria has a varied electric power production mix, including, in addition to Kozloduy NPP, thermal power plants and RES (hydroelectric, wind-powered and solar energy) power plants. The electric power is generated by power plants, which were separated from NEC EAD in 2000, a part of which is currently included in the structure of the Bulgarian Energy Holding EAD (BEH EAD), while the rest are the property of private companies.

The major difficulties with the increase of the installed power capacity of the existing thermal power plants in the country are due firstly, to the operation of very depreciated electricity generating facilities and, secondly, to the considerable investments required for their bringing into compliance with the environmental protection norms. As the priority of the Energy Strategy of the Republic of Bulgaria by 2020 is the efficient use of the local energy resources, its focus from the point of view of security and sustainability is on the protection and development of the coal industry. In this connection, the intention is to use the existing coal potential of Bulgaria to the maximum possible degree. The state is going to support the coal-fuelled power plants by providing support for the full compliance with the ecological requirements, including the restrictions for the maximum admissible norms for hazardous emissions (sulphur, nitrogen oxides and dust), it will perform monitoring and will seek international aid for projects for the construction of new and/or replacement power facilities fuelled with local coal, imposing the use of contemporary highly effective and low-emission technologies for carbon dioxide capture and storage. With a view to developing the national energy sector in an environmentally friendly aspect and in compliance with the Bulgarian and European legislation, a time-schedule will be prepared for the modernization or shutting down of power production facilities that are defined as highly polluting, and their owners will be required to comply with the accepted ecological norms.

In this context, the task of the EIA is to perform a comparative analysis and produce a forecast for the installed capacity of the electricity generation facilities to 2030 compared to the baseline considering two scenarios – with or without realisation of the investment proposal for building od a new nuclear unit at the Kozloduy NPP site.

2. Impact of the IP on the energy dependence indicator

The energy dependence shows the dependence of the country on imports of energy and resources (**Table 1.5-1:** *Energy Dependence of Bulgaria*). Imports account for 70% of the gross consumption in Bulgaria.

TABLE 1.5-1: ***ENERGY DEPENDENCE OF BULGARIA***

	2005	2006	2007	2008	2009	2010
Energy dependence, coal, %	36.1	34.0	37.6	42.0	26.9	-
Energy dependence, crude oil, %	97.7	99.8	100.2	101.0	98.6	-
Energy dependence, natural gas, %	87.4	89.8	91.5	96.3	98.6	-
Energy dependence, total, %	**47.4**	**46.0**	**51.7**	**52.5**	**45.6**	**40.4**

The data is from the Energy Balances for 2010 of the NIS

Coal

Lignite coal prevails in the structure of coal yield – 93.6% (they comprise the main local energy resource), followed by the brown coal – 6.3% and black coal – 0.1 % (Figure **1.5-1***: Coal yield in 2011 by type*).

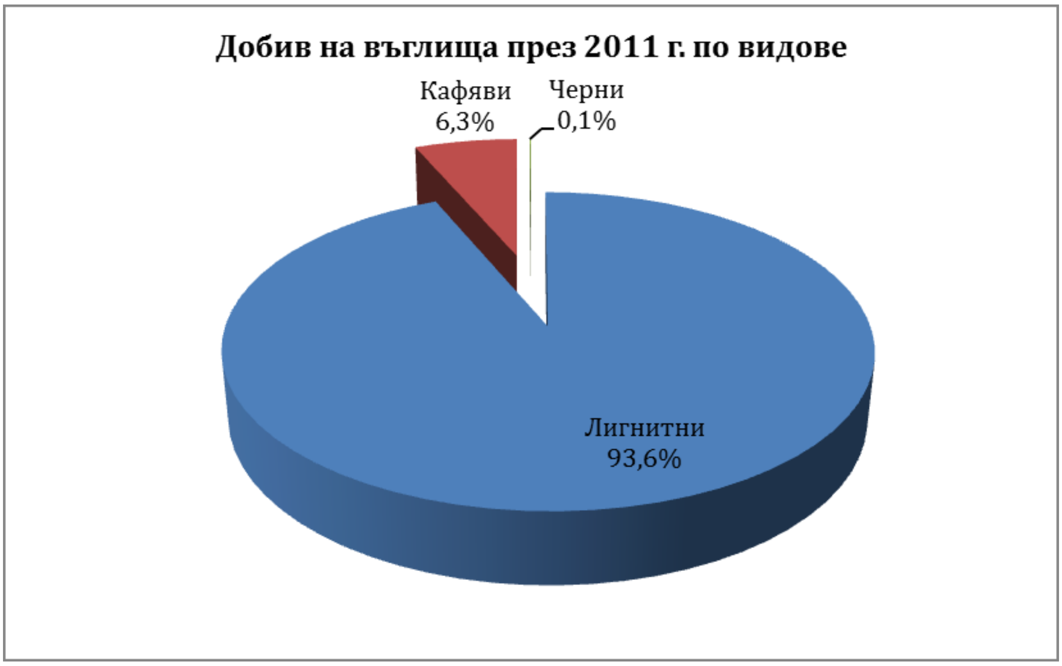

FIGURE 1.5-1: ***COAL YIELD IN 2011 BY TYPE***

The total yield of lignite coal amounts to 34.5 mln tons, their main producer being the Maritsa Iztok Mines EAD with a share of 95.7%. The total yield of brown coal amounts to 2.3 mln tons, mined mainly at the Bobov Dol (0.99 mln tons) and Pernik (1.06 mln tons) basins. and Pernishki (1.06 mln. t.) basins. The total yield of black coal is insignificant (14.1 thous t) and is realised mainly by the Balkan 2000 Mines EAD.

Natural gas

Natural gas import of Bulgaria amounted to 2 811 mln m^3 in 2011 (including 248 mln m^3 of fuel gas for the functioning of the transit system), which exceeds by 6% the import in the preceding year. It is imported from Russia – the sole supplier of this resource for Bulgaria. The local natural gas yield in 2011 amounted to 443 mln m^3, realised by Melrose Resources S.a.r.l. and Oil and Gas Exploration and Production EAD. In comparison, the yield in 2010 was only 74 mln m^3. The considerable growth of the natural gas yield in the country is due to the two new fields in Kaliakra and Kavarna developed by Melrose Resources S.a.r.l. Although the reserves of natural gas in the country are modest, they are of interest as a domestic source, which to a certain degree may limit the price growth of imported natural gas.

Crude oil

Crude oil yield in the R of Bulgaria is insignificant – 22 thous t in 2011. It is realised by Oil and Gas Exploration and Production in the town of Dolni Dabnik, which became the property of a private company in 2004.

The domestic needs of crude oil are satisfied predominantly by imports. The main importer and petroleum processor is Lukoil Neftochim Bourgas EAD.

Uranium ores

The quantity and potential of uranium ores are only approximated estimates. Their mining was terminated and the mines were closed down due to high costs, obsolete technologies and radioactive pollution.

In order to optimize the country's ranking by the energy dependence indicator, the Energy Strategy of the Republic of Bulgaria by 2020 includes measures for the encouragement of energy production from renewable energy sources, as well as for promoting projects for the construction of new facilities fuelled by local coal and nuclear fuel. The nuclear energy is considered a local source and in this sense, the IP will affect positively the energy dependence indicator in the long term, and in support of this statement, the EIA will present forecasts and analyses of the change of the dependence on energy resource imports as the result of the construction and commissioning of the new nuclear unit at the Kozloduy NPP site.

3. The investment proposal in the context of the international trends

The population growth on a worldwide scale from 6,5 bln today to approximately 8.7 bln in 2050 will be accompanied by an energy demand growth by 1.7%, according to data from the International Energy Agency (IEA). There is no single source that will be capable of satisfying all the energy needs of the future generations. In Europe, 1/3 of the generated energy is electric power, including 31% generated by nuclear power plants and 14,7% from renewable energy sources. Although the contribution of RES has been significantly growing since 1990, the demand for electric power cannot be satisfied without the contribution of nuclear power generation worldwide. The new nuclear unit at the Kozloduy NPP site will contribute to the strengthening of Bulgaria's position among the countries which develop reliable and secure diversified energy sources based on contemporary nuclear technologies for ensuring the required balance (production – consumption) of electric power.

The scenarios for the future worldwide energy sources are the subject of numerous studies and analyses today. The scenario for a sustainable IEA development forecasts the progression shown on ***Figure 1.5-2****: Scenario of the world energy sources for a sustainable future* below, in Gtpe (1 Gtpe = 1 Giga-ton crude oil equivalent = 11.63 MWh) at a growth of the worldwide population from 6.5 billion to approximately 8.7 billion in 2050. In order to provide for the increased demands of energy, all the presently available energy sources will have to increase their contribution. After the year 2030, when the contribution of solid fuels to primary energy generation is expected to decrease, the nuclear sources, the sources using bio-mass, and other renewable energy sources (hydro-electrical, wind-powered, geo-thermal) will have to be used increasingly more. According to IEA[5] forecast for the worldwide energy demand by 2030 and the emission of CO_2 due to it will be growing by 1.7% annually.

[5] International Energy Agency

It has to be taken into consideration that the main renewable source of electric power is the hydraulic energy, the contribution of which cannot be increased significantly in Europe in the foreseeable future. The same applies to the geo-thermal energy sources. Despite the fact that a large number of wind-powered generators have been constructed in Europe since 1990 to date, at present it is difficult to forecast how this production will be capable of replacing the electric power generated from gas, oil or coal or, respectively, nuclear energy.

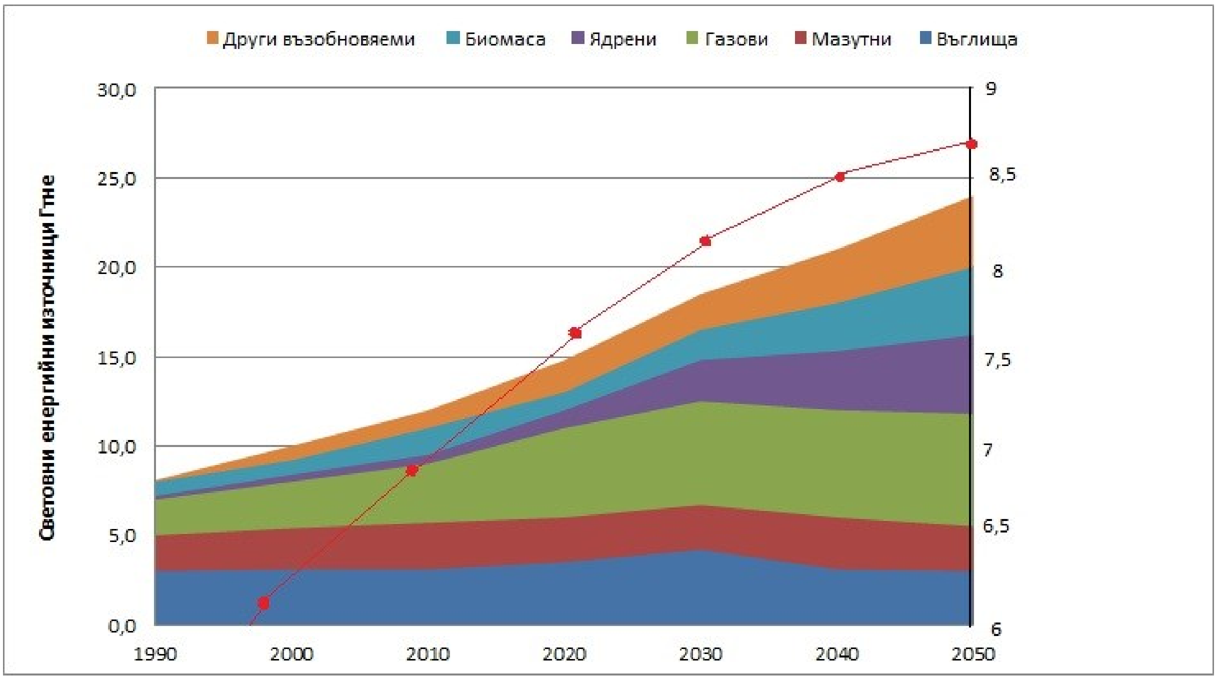

FIGURE 1.5-2: SCENARIO OF THE WORLD ENERGY SOURCES FOR A SUSTAINABLE FUTURE

The latest ambitious aim of the EU to reduce the CO2 emissions by 20% by 2020 as compared with the level of emissions for the year 1990 is based on a considerable reduction of the emissions in the transport sector, as well as on an increased number and capacity of the photovoltaic and wind-powered power plants. For example, the electricity generation by wind-powered plants must grow approximately 17 fold to reach the amount of electricity generation by nuclear power plants. It is hard to forecast how such growth will be provided by 2020, moreover, these calculations do not include the expected annual energy demand growth by 1.7%. For that reason, notwithstanding the encouragement of the RES development, the achievement of the EU plan for reducing the CO_2 emissions practically depends to a great extent on electricity generation by nuclear power plants.

In Bulgaria, the share of greenhouse gas emissions from all energy generation activities included in the sectors of power engineering, industry, transport, agriculture and households, represents 70% (according to the Energy Strategy of the Republic of Bulgaria by 2020, ***Figure 1.5-3****: Greenhouse gas emissions by sectors of the bulgarian economy, mln tons co2 equivalent, 1990 – 2008).* The emission values for the power engineering sector amount to 40% of the total greenhouse gas emissions in the country. The electric power plants and thermal power plants are the main source emitting more than 25 mln tons of CO_2 annually, the quantities of emissions for the year 2009 only from the coal-powered plants amounts to 19.8 mln tons of CO_2.

FIGURE 1.5-3: GREENHOUSE GAS EMISSIONS BY SECTORS OF THE BULGARIAN ECONOMY, MLN TONS CO_2 EQUIVALENT, 1990 – 2008

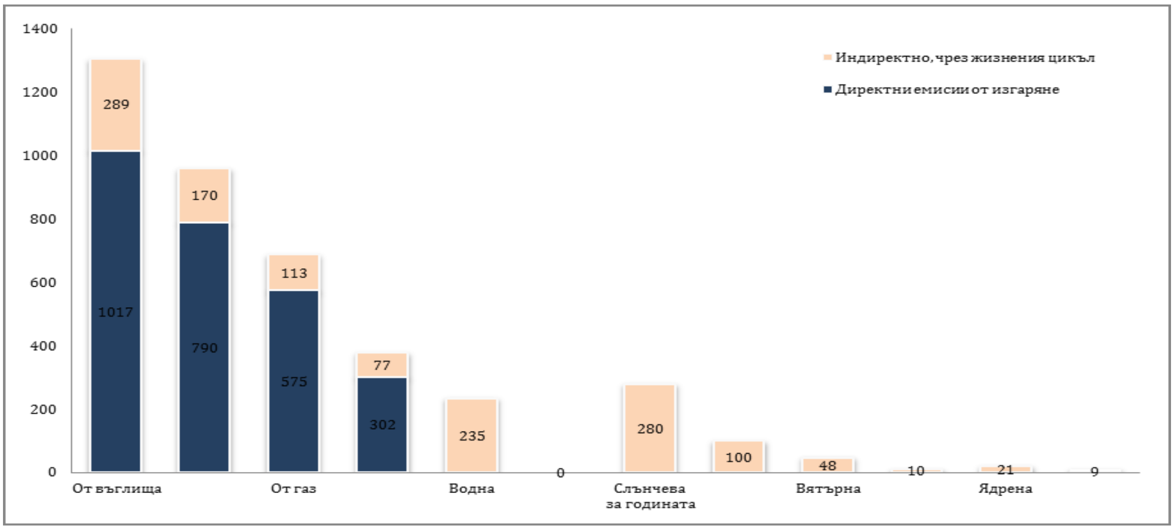

FIGURE 1.5-4: RESULTS FROM THE ANALYSIS OF THE LIFE CYCLE FOR EMISSION OF CO_2 EMITTED FROM ELECTRICITY GENERATION BY DIFFERENT METHODS

The quantity of CO_2 emissions per 1 KWh produced electric power can be calculated as a sub-product of the analysis of the lifecycle. The obtained results depend on the examined electric power plant and are shown on ***Figure 1.5-4:*** *Results from the analysis of the life* *cycle for emission of co2 emitted from electricity generation by different methods*, as coupled columns for each type of fuel.

As could be seen, the main contributor to the emissions is the burning of mined/fossil fuels, while the share of nuclear power generation is practically insignificant. The further growth of CO_2 emissions will have a decisive impact on the life on the planet, so the fight against climate changes will depend in the first place on the utilization of an energy cycle with the lowest possible emissions of CO_2. Considering the scenario of a similar cycle, the construction of a new nuclear unit at the Kozloduy NPP site is fully justified, since it will ensure the generation of an additional amount of energy without any CO_2 emissions. In this regard, the scope of EIA will include analysis and forecast for the IP influence on the emission intensity in the context of the international tendencies for limiting the greenhouse gas emissions and the fight against climate change.

4. Impact of the IP on the implementation of the commitments undertaken by the Republic of Bulgaria in relation to the European energy policy

The starting point of the European energy policy lies in several priority areas:

- → overcoming climate change;
- → reducing the energy consumption rates of the economy and improvement of the energy efficiency;
- → limiting the European Union dependence on energy resources imports; and
- → encouraging economic growth and employment, thus providing a reliable and accessible source of power for the consumers.

Sustainable energy development is the pivotal issue of energy policy. Its achievement depends on the following long-term quantitative targets for the year 2020:

Target 1: 20 percent reduction of the greenhouse gas emissions as compared to 1990;

Target 2: 20 percent share of RES in the total energy mix and 10 percent share of energy from renewable sources in the field of transport;

Target 3: Energy efficiency improvement by 20%.

In compliance with the current European energy policy framework and the world tendencies in energy technology development, the respective commitments of our country are incorporated in the Energy Strategy of the Republic of Bulgaria by 2020. The main priorities in the Energy Strategy can be summarized under the following five directions: ensuring the security of the power supply; achieving the targets related to renewable energy sources; improving the energy efficiency; developing a competitive energy market and policy, aiming at satisfying the energy needs and protecting the interests of consumers. These priorities also determine the vision of the development of the energy sector during the next few years, namely:

- → Maintaining a reliable, stable and secure energy system;

- The energy sector will keep its leading position in the Bulgarian economy with an explicit export orientation;
- Accent on clean and low-emission energy production – nuclear and from renewable sources;
- Balance of the quantity, quality and price of the electric power generated from renewable sources, nuclear power, coal and natural gas.

The European energy policy is formed on the basis of two main strategic documents – the Green Book – European strategy for sustainable, competitive and reliable energy and the Communication of the European Commission concerning the Energy Policy of Europe, which is part of the so-called Energy package 2007. The European strategy for sustainable development, competitiveness and energy security was published on 8 March 2008. Through it, the Commission entrusts the Member states to implement the European energy policy, which should contribute to the overcoming of the main problems in the field of energy, namely: the increasing dependence on imports of energy and energy raw materials, rising prices of oil and natural gas, climate changes, constantly growing energy consumption.

The energy policy of the EU according to the Green Book is based on three basic principles:

- Stability – combatting climate change by encouraging the production of energy from renewable energy sources and improving the energy efficiency;
- Competitiveness – guaranteeing the efficiency of the European energy sector by creating a common energy market;
- Security of the supplies – improved coordination between the production and consumption of energy in the EU and on an international scale.

In the first half of 2007, the European Commission published the so-called Energy package as a continuation of the policies and priorities set out in the Green Book. This package consists of 9 interrelated documents, which represent the new conceptual framework of the European energy policy for the next decade. Its main pillars are:

- Combat climate change;
- Reducing the dependence of the EU on imported energy supplies of oil and natural gas;
- Limiting the greenhouse gas emissions of the developed countries by 30% by 2020 as compared to 1990, with the EU undertaking unilaterally to achieve a reduction of the emissions by a minimum of 20% by 2020.

The realisation of a new nuclear unit at the Kozloduy NPP site fully complies with the national priorities in the field of the development of the electric power supply system of Bulgaria as a part of the common European energy strategy. In fact, NNU in conjunction with the power capacities for production of energy from RES will ensure approximation to the goals for achieving an emission-free energy cycle, as well as providing for an optimum mix of energy sources.

1.6 DESCRIPTION OF THE PHYSICAL CHARACTERISTICS OF THE INVESTMENT PROPOSAL AND THE REQUIRED AREAS

1.6.1 LOCATION OF THE NEW SITES AND EXISTING INFRASTRUCTURE

The Kozloduy NPP site is located on the right bank (at the 694th km) of the Danube river. It is situated at 3.7 km to the south of the river midstream and the state border with the Republic of Romania. .Romania Along a straight line, it is situated at approximately 120 km to the north, and along the republican road network at approximately 200 km from the capital city of Sofia. .

The site is located in the northern part of the non-flooded terrace of the Danube River (elevation +35.0m m according to the Baltic Altitude System) and has an area of 4471.712 daa.

To the north, the site borders on the Danube lowland. To the south of the site the slope of the watershed plateau is comparatively high (100 – 110 m), to the west it is approximately 90 m, and to the east it goes down to 30 m above the sea level.

The closest settlements to Kozloduy NPP are: . 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 to the southeast, the town of Mizia – 6.0 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 sites envisaged for the installation of the NNU in the area of Kozloduy NPP are shown on ***Figure 1.6-1****: Location of the sites for the IP*

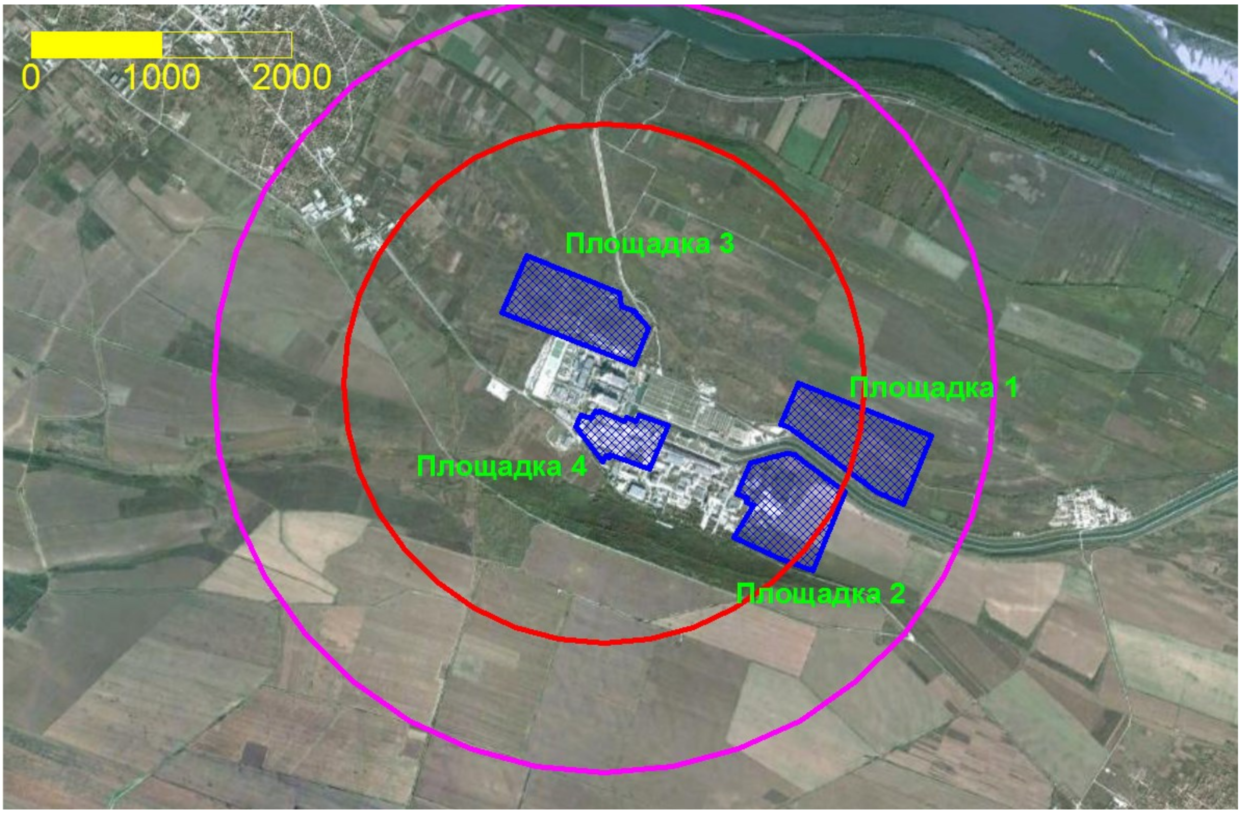

FIGURE 1.6-1: ***LOCATION OF THE SITES FOR THE IP***

(The red circle ( ) is a 2000-meter precautionary action zone (PAZ), and the pink circle ( ) is a 3000-meter zone around the Kozloduy NPP)

Provisionally called site 1 – The site is located to the northeast of units 1 and 2 of the Kozloduy NPP, between the OS and Valyata, in the vicinity of the cold and hot channels (to the north of them). The area of the plot is approximately 55 ha. The terrain is flat with a slight slope from the southwest to the northeast. There are open drainage channels within the area of the site, which will have to be restructured. The humus loess layer of the arable lands will have to be removed in advance.

The land to be expropriated is used for growing agricultural crops.

Provisionally called site 2 – The site is located to the east of units 1 and 2 of Kozloduy NPP in the direction of the village of Harlets, to the south of the cold and hot channels. The area of the plot is approximately 55 ha. The terrain is hilly with a considerable slope from the south to the north, steeper in the southeastern part of the site. A former farm yard is located within the area of the site. The remaining area is used for growing agricultural crops.

Provisionally called site 3 – The site is located to the northwest of units 5 and 6 of Kozloduy NPP, in the vicinity of the bypass road of the existing power plant. The area of the plot is approximately 53 ha. The terrain is flat with a slight slope from the south to the north. There are open drainage channels within the area of the site, which will have to be restructured. The humus loess layer of the arable lands will have to be removed in advance.

From an engineering point of view and connection to the electric grid a large number of activities and complex reconstruction works of the 400 kV OL tower will have to be done.

The land to be expropriated is used for growing agricultural crops.

Provisionally called site 4 – The site is located to the west of units 3 and 4 of Kozloduy NPP and the SNFSF, to the south of the cold and hot channels. The available area is about 21 ha, within the borders of the expropriated lands of Kozloduy NPP. The terrain covers the existing service facilities: the Equipment Office, the Vehicle Repair Shop and the Assembly Shop. In order to use the site it is envisaged to reconstruct and dislocate the main underground communications of the NPP, and evacuation and dislocation of the above mentioned facilities.

None of the sites infringes upon any land from the forest fund.

All the main and auxiliary buildings and facilities, the equipment required for the operation, as well as all the local treatment facilities and WWTP will be located within the borders of the proposed sites. The general plans with elaborated layout solutions will be consistent with the functional purpose of the buildings and the facilities, and the respective areas will be differentiated.

The site, selected for the installation of the new nuclear unit, will be fenced in and secured in compliance with the requirements of the Regulation for the provision of physical protection of nuclear facilities, nuclear material and radioactive substances (SG No 44 of 9.05.2008) and will be established as a protected zone, PAZ and UPAPZ in compliance with the requirements of the Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies (Prom.SG, No . 94 of 29.11.2011)

The necessary areas according to the layout solutions will be examined and analysed in the EIA report.

1.6.2 NECESSARY AREAS FOR THE IMPLEMENTATION OF THE IP

According to the Terms of reference of the Client for the implementation of the IP, three main technical and layout solutions are being considered for reactor installations of the newest generation (Generation III or III+): alternative A1 (reactor AES-92) and alternative A2, which includes 2 models of completely new reactors designs – AES-2006 and AP-1000.

The necessary areas according to the layout solutions for the building of NNU at the potential sites are determined by criteria related to the special arrangement of the buildings from the point of construction and maintenance, construction structures to hold equipment and systems important for the safe location of the individual components of NNU, the ALARA principle for achievement of the target doses by separating the contaminated systems or components from each other and from the non-contaminated systems, in different rooms, etc.

The necessary areas for the building of NNU with one unit are presented below:

	AP-1000	AES-92	AES-2006
Stage	1 Unit	1 Unit	1 Unit
	21	35	35
Operation	7	15÷25	15÷25

Each of the alternative sites is large enough to accommodate the NNU. At sites 1, 2, and 3, the necessary areas can be provided for the construction of temporary buildings during the stage of construction. At site 4, the design itself will take into account the area required by the Client for the temporary buildings and they will have to be located outside the site where the new unit will be built.

1.6.3 NECESSARY AREAS DURING OPERATION OF NNU

Each of the alternative sites is large enough to accommodate NNU. The necessary areas for the operation of NNU with one unit are: 7 ha for AP-1000 and between 15 and 25 ha for AES-92 and for AES-2006. At Site 4 the design itself will be adapted to the area offered by the Client.

1.6.4 NECESSARY AREAS DURING DECOMMISSIONING

The process of decommissioning of nuclear installations is a long and complicated process. It is part of the technical design of a NNU, which is drawn up after the selection of a given reactor, continues with a licensing process, the building and operation of the nuclear facility. Depending on the approved strategy for dismantling, the technical design envisages the necessity of additional areas with a view of the need to construct additional buildings for the facilities related to the decommissioning and removal of the radioactive materials from a given reactor.

The process of decommissioning of a NNU is an activity which has to be independently analysed and assessed from the point of its impact on the environment

1.7 DESCRIPTION OF THE BASIC CHARACTERISTICS OF THE PRODUCTION PROCESS

1.7.1 TECHNOLOGY

The new nuclear unit envisaged to be built at the Kozloduy NPP site will be a highly technological energy facility for electricity generation on the basis of the nuclear fuel cycle.

The parameters for the construction of such an energy facility presuppose the existence of two basic groups of sub-sites and facilities:

- → nuclear power sub-sites and facilities, implementing the main technological process – generation of electric power, as well as those that are sources of radiation impact;
- → other production sub-sites and facilities, implementing support/accompanying technological processes, important for the maintaining of the main nuclear

power process and/or being sources of various types of non-radiation impact on the environment.

The technology, which will be used for the generation of electric power from a nuclear source, will be a Pressurised (Light) Water Reactor (PWR), with light water as moderator and coolant.

The technological diagram of the new nuclear unit is with two circuits and will include:

- Primary circuit – with circulating radioactive medium, consisting of one power reactor and circulation loops Each loop includes a main circulation pump, a steam generator and circulation pipelines;
- secondary circuit – with non-radioactive medium, including the steam-generation part of the steam generator, the turbine and the auxiliary equipment of the turbine hall.

The new nuclear unit will have:

- high availability (more than 90%) and long operational lifetime – at least 60 years;
- possibility for operation with quick changes of the loads within 80% – 100% of the rated power, without worsening of the efficiency;
- highly reliable systems, realizing the defence in depth concept in all operating modes, including passive safety systems;
- possibility to perform fundamental safety functions – reactivity control, heat removal from the core; retention of the radioactive substances within the defined limits in all operating modes and in emergency conditions;
- design, which uses the principle of diversity and self-diagnostics;
- design which provides for technical facilities to ensure avoidance of human errors or restriction of the consequences they entail;
- high resistance to internal and external impacts, including earthquakes, aircraft crash, floods, etc.;
- in case of a fire – ensuring the performance and long-term maintenance of the safety functions and control of the state of the nuclear unit. The fire-fighting measures applied will ensure defence in depth by preventing the occurrence and expansion of a fire, the localization of a fire and restriction of its consequences;
- technical means and solutions for management of severe accidents and minimizing their consequences, reduced probability for core meltdown;
- higher discharge burnup, leading to a reduction of the fuel consumption and the quantity of waste;
- burnable absorbers for extending the nuclear fuel resource.

The most significant advantage of the design for the new nuclear unit as compared to the second generation designs is that the design of the power unit envisaged to be constructed **will include passive and specific protection provisions**, including a core catcher concept, which will considerably increase the safety of the nuclear unit.

The technology envisaged in the present investment proposal to be used for electricity generation from a nuclear source will be reactors with light water under pressure ((PWR – Pressurised Water Reactor) with light water as moderator and coolant. The technological diagramme of the new nuclear unit is with two circuits (***Figure 1.7-1****: Technological diagramme of a water pressurised reactor*)*:*

→ **The Primary circuit** is designed to remove the heat from the reactor core and to transfer it to the secondary circuit. The more important components of the primary circuit are:

- ✓ reactor;
- ✓ main coolant loops;
- ✓ steam generators, which produce saturated steam;
- ✓ pressuriser;
- ✓ main coolant pumps (MCP).

The nuclear fuel, in the form of fuel assemblies, is placed in the reactor core. In the space around the fuel assemblies circulates water which removes the thermal power generated during the nuclear reaction.

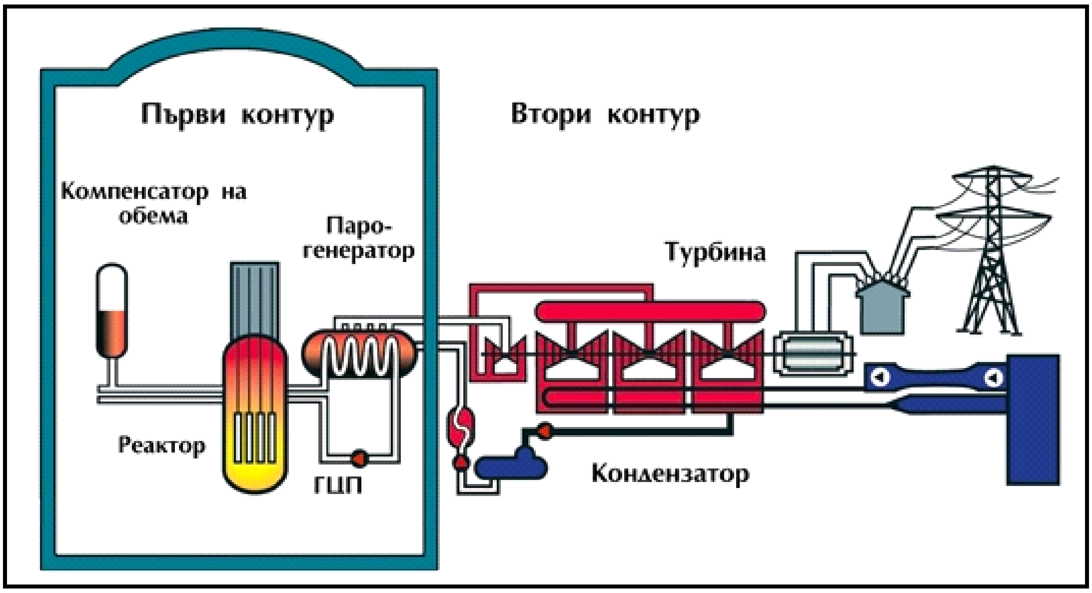

FIGURE 1.7-1: TECHNOLOGICAL DIAGRAMME OF A WATER PRESSURISED REACTOR

As a result of the forced circulation provided by the main coolant pumps, the primary circuit transfers the heat generated in the reactor core via the steam generators to the secondary circuit, so that the core and the primary circuit coolant are kept within a specified thermal range. At the same time, it provides sufficient natural circulation, required for transferring sufficient heat from the core to the steam generators when the reactor is stopped and the main coolant pumps are not operating.

The primary circuit is designed so as to perform the following functions:

- ✓ core cooling and heat transfer from the core to the steam generators by means of:
  - control of the coolant temperature in the core;
  - control of the coolant pressure in the core;
  - control of the coolant flow rate in the core;
  - control of the reactivity in the core,
- ✓ retention of the radioactivity by means of a third barrier (the borders of the primary circuit).

The fuel assemblies of the reactor are fully immersed in pressurised water, so that its boiling temperature is higher than the normal operational temperatures. The fuel is a slightly enriched uranium dioxide (UO_2) or MOX (nuclear fuel, which contains more than one oxide of a fission material).

→ **Reactor –** The typical solution for the reactor set is shown on ***Figure 1.7-2****: Possible design solution for a reactor of the PWR type.* It is a pressurized vessel, consisting of a reactor pressure vessel and closure head assembly of the reactor. The reactor internals are located within the reactor pressure vessel (e.g. the support core barrel, the neutron reflector, etc.), and the control rod drive mechanisms are located on the reactor head.

In the core takes place a chain reaction of fission producing heat that is transferred to the coolant. The core consists of fuel assemblies sitting in most cases in square or hexagonal lattices. The fuel assembly consists of fuel rods, guide thimble tubes, fuel alignment plates and top nozzle.

The fuel rods consist of fuel pellets placed in tubes of special alloy, in most cases based on zirconium. The purpose of this cladding is to maintain the geometry (shape) of the fuel rod in order to allow the transfer of the heat from the fuel to the coolant and at the same time to retain the radioactive fission products in the fuel.

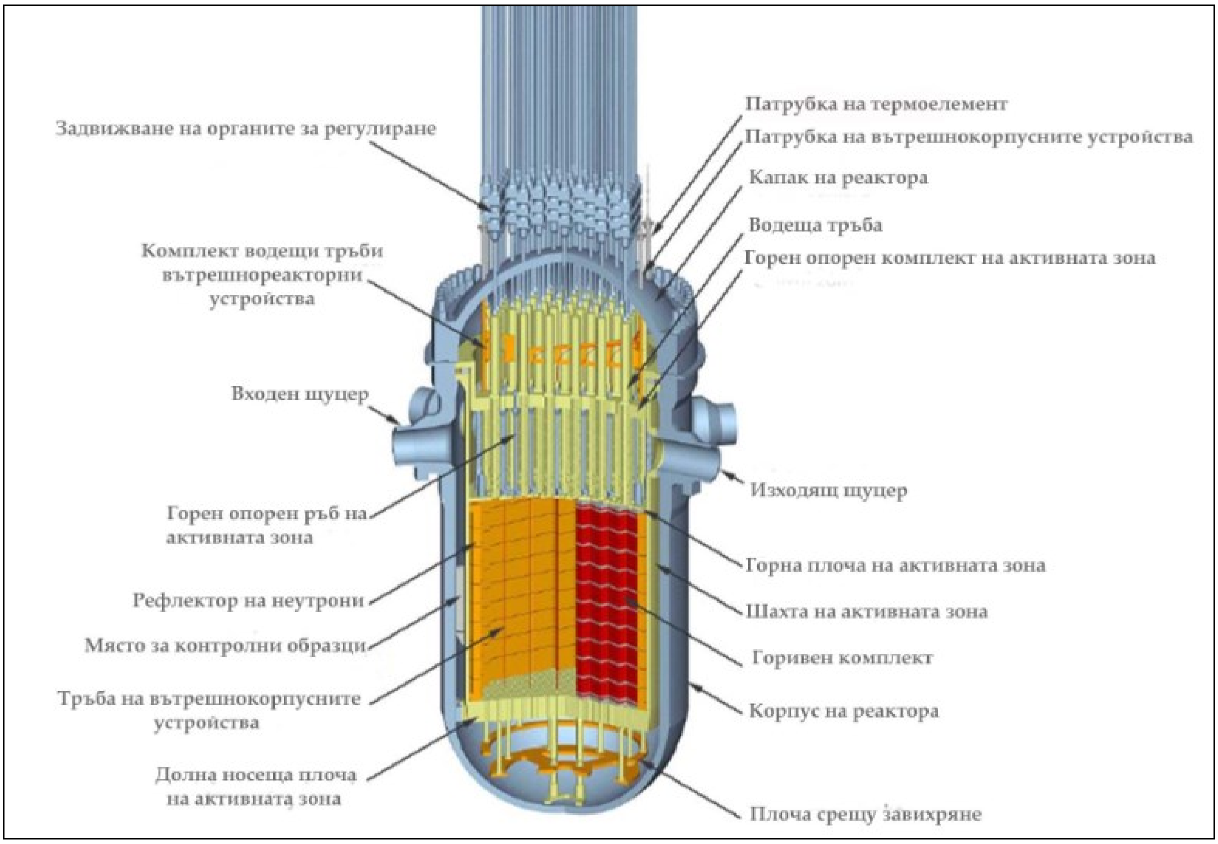

FIGURE 1.7-2: *POSSIBLE DESIGN SOLUTION FOR A REACTOR OF THE PWR TYPE*

The guide thimbles form channels for the introduction of either a control rod cluster or control rods containing neutron absorbing material. The measuring tube is located in the central position and is a channel for the introduction of an internal neutron detector.

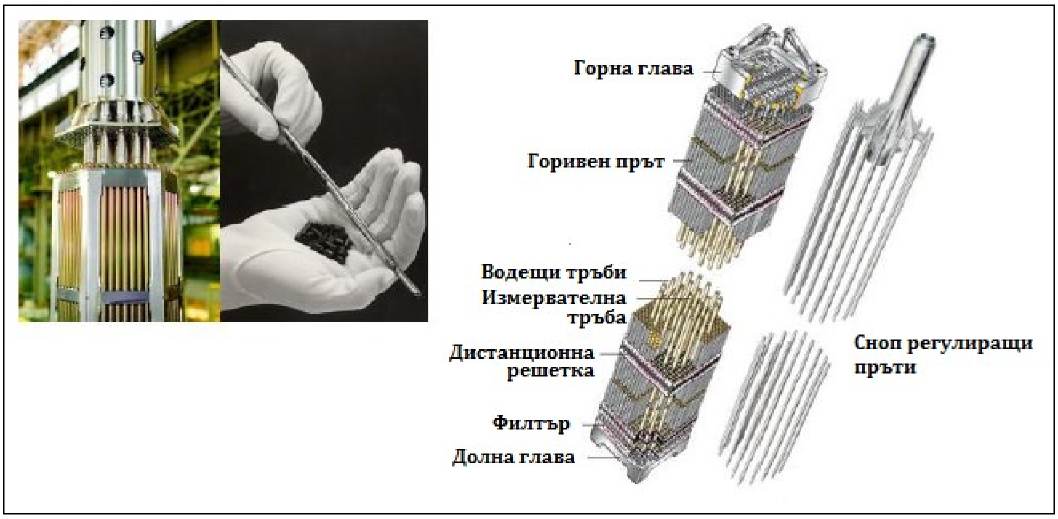

FIGURE 1.7-3: *FUEL PELLET, FUEL ROD AND FUEL ASSEMBLY*

The power capacity of the reactor is controlled by means of control rods (***Figure 1.7-3:** Fuel pellet, fuel rod and fuel assembly*) and the rapid reactor shutdown system(emergency protection).

Inside the reactor, with the aid of a refuelling machine, the fuel is placed according to the calculated optimized refuelling scheme. The thermal-hydraulic design limits, such as, e.g. the maximum linear thermal power capacity of the fuel rod, the minimum margin up to a critical boiling point, the maximum temperature of the fuel and the cladding, will be determined and checked during the preparation of each refuelling in such a way as to provide a sufficient margin.

→ **Steam generator** – The steam generator is a pressurised vessel that comes in two designs- horizontal or vertical, with a feed water and emergency feed water distribution system, a heat- exchange surface system consisting of tubes and a steam header. In the nuclear power plant with a pressurised water reactor (PWR), the steam generator serves as a heat-exchanger between the primary and the secondary circuit. The heated coolant of the primary circuit enters the hot header, and then is conveyed to the heat-exchange tube bundles. When passing through these bundles, the coolant transfers heat to the feed water and after cooling, flows to the cold header. After that, it flows to the cold loop of the primary circuit and then back to the reactor. In the secondary circuit of the steam generator, the feed water evaporates into saturated steam, which is transferred to the turbine.

→ **Main coolant pump** – The main coolant pump is generally a vertical centrifugal single-stage pump with a sealing unit on the shaft and asynchronous electric drive. It is equipped with a flywheel to provide for the required continuation of its movement in case of power failure. The main coolant pumps ensure the circulation of the required quantity of coolant in the primary circuit in accordance with the thermal power capacity of the reactor in various operating modes.

→ **Pressure Control System** – The pressure control system includes a pressuriser, pressuriser relief tank, relief valves unit and pipelines, connecting the individual components to the linked systems. The pressuriser is a vertical welded vessel with an elliptic bottom. The pressuriser set includes electric heaters and a spray system. The pressuriser serves to maintain the pressure and to restrict the pressure deviations in the primary circuit and to prevent uncontrolled pressure increase in emergency modes, as well as to provide for the smooth increase and decrease of the pressure during heating and cooling of the primary circuit. The pressure in the primary circuit is created and maintained by heating the water in the pressuriser by means of electric heaters. In case of high pressure, it is reduced by spraying coolant from the primary circuit into the steam space of the pressuriser. The relief valves unit is designed to reduce the undesired increase of the pressure in the primary circuit in case of abnormal modes.

→ **Primary circuit auxiliary systems**

- *Primary circuit make-up and maintaining the chemical regimes*

For the long-term control of the fission reaction and for maintaining the required quality and quantity of the coolant, coolant make-up and draining systems and a system for coolant chemistry treatment are installed.

The systems perform the following functions:

- by draining and make-up the required balance of the coolant in all operating modes of the unit is maintained;
- controlling the boric acid quantity in the coolant;
- removing the fission products and radioactive products from the coolant;
- dosing the chemical reagents in the coolant for the purpose of control of the chemical regimes (pH of the coolant, degassing of the coolant).

The boric acid quantity control in the coolant allows to increase the operational reactivity margin of the reactor, required for the continuous control of the fission chain reaction.

- *RAW processing system*

The system performs the processing of the radioactive wastes in gas, liquid or solid form.

Gaseous RAW occur mainly as a result of the continuous degassing of the coolant from gases generated by the radiolysis of the water in the reactor or as fission gas products. The gaseous RAW pass through dust filters, where the dust particles (aerosols) and moisture are retained, then the radioactive aerosols are retained by the adsorption filters. Thus the whole radioactivity is converted into solid or liquid form, and the purified air is evacuated via the vent pipe.

The liquid RAW are generated during the purification of the primary coolant, decontamination of the equipment, regeneration of filters, etc. The radioactive liquid is evaporated in special evaporation installations, then the condensed steam is filtered consecutively in mechanical and ion-exchange filters. After achieving the criteria for purified water, it is discharged under control into the water tanks. The exhaust ion-exchange resins and the concentrated residue from the evaporators are converted into solid form by fixation into another material (most often, cement, bitumen or glass).

The solid wastes are divided, fragmentized if necessary and stored in steel barrels**.**

The solidified and solid wastes in the steel barrels are placed in concrete containers which are then disposed of in a specialized storage facility.

- *Fuel pond cooling and cleaning system*

  The fuel pond cooling system provides for heat removal from the spent fuel during its long-term storage in the spent fuel pond, during refuelling and in case of removal of the whole core of the reactor. The system also maintains a sufficient level of protection for the servicing personnel against the radioactive radiation of the fuel. The cleanup system maintains the required quality of the cooling water. It consists of ion-exchange filters.

- *Ventilation systems*

  The ventilation systems ensure that the parameters of the environment meet the requirements for safe working conditions of the servicing personnel and for the proper functioning of the technological equipment during normal operation and in emergency conditions.

→ **Safety systems**

- *Emergency core cooling system*

  The Emergency core cooling system protects the core from thermal damages. It acts as the main emergency system in cases of LOCA[6], incidents, which are accidents involving loss of coolant in the primary circuit. In the case of such accidents, cooling borated water is supplied to the reactor. A basin located in the containment is used as a cooling water tank with a sufficient capacity for this purpose.

- *Residual heat removal system*

  The residual heat removal system removes the residual heat occurring during reactor shut down as a result of the radioactive decay of the fission products in the fuel and additionally cools the reactor under normal operating conditions, abnormal conditions and in case of design basis emergency conditions, retaining the leak-tightness of the primary circuit.

- *Pressure relief system*

  The pressure relief system is used for controllable pressure relief in the primary circuit, required for the proper functioning of the emergency core cooling system, as well as for its protection from overpressure.

- *Component cooling system (intermediate loops)*

  This is a closed cooling system providing for the heat removal from the primary circuit systems to the service water system. They provide a

[6] LOCA (Loss of Coolant Accident) – emergency in which there is loss of primary coolant.

protection barrier against radioactivity penetration into the service water system under abnormal modes.

- *System for service water of important consumers*

  This system provides for the residual heat removal from all the important systems of the unit which cannot operate under long-term lack of cooling. In case of an emergency, it removes the heat from the intermediate component cooling loops of the emergency core cooling system or the residual heat removal system.

  The heat from the system is transferred to the ultimate heat sink, in most cases the cooling towers or spray ponds are used for the purpose.

- *Steam Generators Emergency Feedwater System*

  This system serves for supplying demineralized water to the steam generators in case of failure of the normal operation systems. Thus it provides for heat transfer from the primary to the secondary circuit in emergency situations without loss of coolant in the primary circuit.

→ **System of the Containment**

The system of the containment consists of an internal leak-tight shell and an external protective shell. The leak-tight shell consists of the structure itself and leak-tight units (penetrations, air locks) and inside it are situated the temperature and pressure control systems (e.g. passive heat removal, spray system, hydrogen ignition system, etc.).

The containment system is designed so that during normal operation and in emergency conditions related to radionuclides emission, including severe accidents, the emissions to the environment to be reduced to admissible radiation effects. The structure and the systems of the containment are designed with a view to protecting the reactor, the primary circuit and all related facilities that are important from the point of view of nuclear and radiation safety that are located inside the containment, against external events whose probability of occurrence cannot be excluded to a satisfactory degree. The system of the containment also functions as a biological shielding.

→ **The secondary** circuit is non-radioactive. Its purpose is to absorb the thermal energy from the primary circuit and to transform it into kinetic energy of rotation of the steam turbine. The steam generated in the steam generators is collected in a common steam header and is routed to the turbine. The exhaust steam condenses in the condensers of the turbine and flows back to the steam generators. The secondary circuit consists of:

- *Main steam supply system (steam lines)* – the function of the system is to transport the steam from the steam generators to the turbine in the range of the discharge rates and pressures which cover all operating modes from heating up the system to the full load operation. The steam supply system includes the main steam lines, fast acting steam isolation valves, safety devices and the connecting steam pipelines.

- *Turbine generator* – the function of the turbine generator is to transform the thermal energy of the steam into electric power. The turbine generator does not perform any functions related to the nuclear safety of the unit. It is coupled directly to the turbine shaft.
- *The lubrication facility of the turbine and the generator* is installed in the turbine hall. A tank, coolers, pumps, pipelines, valves and other equipment are installed there. The equipment is protected against oil losses in the system.
- *Main feed water system for the steam generators* – the function of this system is to feed the steam generators with water that has the required parameters. The feedwater station includes main feedwater pumps and auxiliary feedwater pumps (for start-up and stopping, as well as for the transients of the unit) and the connecting pipeline systems and valves. Thermal degassing takes place in the feedwater tank (deaerator). The control valves, together with the feedwater pump, ensure the required level of feed water in the respective steam generator.
- *Secondary circuit support systems* – these are the cooling systems in the turbine hall, the service water systems for consumers that are not responsible for safety, drainage system, heat-exchangers, etc. Some of the support systems provide services to the whole unit, e.g. the chemical treatment of the water and a reserve of demineralized water.
- *Circulation system* – it includes a coolant pumping station, channels, pipeline connections to the turbine hall, cooling of the condenser, piping connections to the cold and hot channels, etc. For cooling the condensers water from the Danube river will be used, which will flow along a third circulation circuit and will have no contact with the water from the secondary circuit. The water from the bank pumping station of the NPP is routed through channels to the nuclear power plant, from where the pumps of the circulation pumping stations feed water to the condensers of the turbines of the new unit.

→ **Instrumentation and Control System –** The instrumentation and control systems, together with the other systems of the electric power plant, provide for the production of electric power, maintaining a high level of safety. When implementing the instrumentation and control systems of the newly delivered facilities, priority will be given to using commercially available digital technologies. Depending on the specific supplier and the control philosophy, for some of the selected safety functions facilities, using combined digital and analogue technology may be used. With a view to minimizing the human factor effects and to restrict the consequences of human induced errors, a high degree of automation will be used. Only proven equipment will be used, taking into consideration the experience accumulated.

The information and control systems will be equipped with instruments so as to provide for the monitoring, measuring, recording and control of all operational parameters important for the nuclear safety during normal operation and in emergencies.

The alarms and the control will be designed and located in a manner that will allow the servicing personnel to receive information on the operation of the nuclear facility continuously and to respond if necessary.

The instrumentation and control systems will produce visual and sound alarms warning of the occurrence of operational states and processes that are deviating from the normal operation limits and may threaten the nuclear safety.

The instrumentation and control systems will record the current values of the nuclear safety related parameters at certain intervals depending on the need.

Upon occurrence of emergency conditions, the instrumentation will provide:

- information on the current state of the nuclear facility, based on which protective actions could be carried out;
- basic information concerning the occurrence of the emergency, which will be recorded;
- information that allows to forecast and characterize the emissions of radionuclides and radiation in the vicinity of the nuclear facility so that timely measures for the protection of the population could be undertaken.

According to the requirements currently in force, the NNU will also be equipped with instruments for monitoring the parameters for accidents with exceptionally low probability of occurrence related to fuel meltdown.

→ **Protective systems**

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

- capable of recognizing emergency states and automatically activating the respective systems, which ensure that the design limits will not be exceeded;
- designed for „manual” activation of the protection when needed.

The protective and the control systems will be separated in such a manner as to ensure that a failure in the control systems would not affect the ability of the protective system to perform its required safety function.

The protective system solution will have a high functional reliability ensured by redundancy and independence of each channel, so that no simple fault could cause a failure of the protective functions of the system.

→ **Human-machine interface**

A modern human-machine interface will be used for the management and operation of the new facilities to allow the servicing personnel of the power plant to respond timely and adequately to all states of the nuclear facility and the power plant systems.

Suitably arranged information will be available to the servicing personnel so they will have current information on the state of the nuclear facility when decisions are to be made thus ensuring safe and efficient control.

The information on the operation and the alarms concerning situations arising during operation or abnormal situations will be arranged in such a way as to minimize the load on the servicing personnel.

The reactors of the type WWER (PWR) are the most commonly used worldwide. The process of design, construction, commissioning and decommissioning of the new nuclear unit will be carried out in compliance with the legislative requirements, specified mainly in the Act on Safe Use of Nuclear Energy (ASUNE) and the relative regulations.

The design for the nuclear facility shall comply with the European requirements, specified in the European Utility Requirements for LWR Nuclear Power Plants.

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

1.7.2.1 NON-RADIOACTIVE

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 operation of the diesel generators (standby power supply sources for the power units) for the needs of the road vehicles and the various shops and units of Kozloduy NPP EAD. As certain quantities of diesel fuel will be needed, as well as petrol, etc., the EIA report will specify provisional quantitative and qualitative characteristics of the fuels and the possibilities for their safe storage will be analysed.

→ Fuels and lubricants- during the operation of the new nuclear unit various types and quantities of oils and greases will be used – machine and compressor oil, turbine oils, motor oils, various types of lubricants. They will be accompanied by the respective certificates and other documents, such as Safety Data Sheets, indicating the proper way for their storage, use and treatment.

→ ***Chemical substances and mixtures*** **–** for the support of the main technological process, various types of chemical reagents certified for use in the nuclear industry will need to be delivered. The main and most important hazardous substances and mixtures are: ammonium, sulphuric acid, hydrochloric acid, nitric acid, sodium hydroxide, etc. The chemical substances and mixtures will be delivered accompanied by their respective Safety Data Sheets, which is a prerequisite for their environmentally friendly storage and use. During the storage and use of hydrazine hydrate, ammonium and other substances and mixtures, in case of an emergency, there is a potential danger for the occurrence of bursts of emissions of dangerous toxic substances into the working environment and the natural environment.

In order to properly control the water-chemistry of the power reactors at the Kozloduy NPP EAD and for the needs of other production and auxiliary activities, large quantities of chemical reagents are delivered and used, some of which are: boric acid, nitric acid, sulphuric acid, hydrochloric acid, potassium hydroxide, sodium hydroxide – technical, ferrous chloride, ammonium, hydrazine hydrate; hydrated lime, etc. The information concerning the chemical substances and mixtures used on the territory of the Kozloduy NPP is specified in **Table 1.7-1**: *Description of the used chemical substances*.

TABLE 1.7-1: ***DESCRIPTION OF THE USED CHEMICAL SUBSTANCES***

No	Name	CAS No	EU No
Chemical reagents for production of demineralised water, decontamination, etc.			
1.	Hydrochloric acid	-	231-595-7
2.	Calcium hydroxide (hydrated lime)	1305-62-0	215-137-3
3.	Sodium hydroxide	1310-73-2	215-185-5
4.	Ferrous trichloride	7705-08-0	231-729-4
5.	Boric acid	10043-35-3	233-139-2
6.	Nitric acid	7697-37-2	231-714-2
7.	Ammonium hydroxide	1336-21-6	215-647-6
8.	Sulphuric acid	7664-93-9	231-639-5
9.	Hydrazine hydrate	302-01-2	206-114-9
10.	Potassium hydroxide	1310-58-3	215-181-3
11.	Oxalic acid	144-62-7	205-634-3
12.	Citric acid	77-92-9	201-069-1
13.	Potassium permanganate	7722-64-7	231-760-3
14.	Detergents	-	-
Ion-exchange resins			
15.	Ion-exchange resin LEWATIT	-	-
16.	Ion-exchange resin type AMBERLITE	-	-
17.	Ion-exchange resin type Wofatit	-	-
Liquid fuels and maintenance of MV			
18.	Diesel fuel Euro-diesel	68334-30-5	269-822-7
19.	Car petrol unleaded	68334-30-5	269-822-7
20.	Antifreeze[7]	107-21-1	203-473-3
21.	Gas for lighting (kerosene)	106-97-8	203-448-7
22.	Extraction benzene	-	-
Oils			
23.	Turbine oils	-	-
24.	Motor oils	-	-

[7] Hazard Category R and S – the phrases are about the substance ethylene glycol whose contents in antifreeze is > 90 %.

No	Name	CAS No	EU No
25.	Transformer oils	-	-
26.	Hydraulic oils	-	-
27.	General purpose mechanical oils	-	-
28.	Compressor oils	-	-
29.	Transmission oils	-	-
Greases and lubricants			
30.	Lubricants (К2, graphite, with MoS2, etc.)	74869-21-9	278-011-7
31.	Greases (Litol, Ciatim, graphite, with MoS2 high-temperature, etc.)	74869-21-9	278-011-7
Adhesives and sealants			
32.	Sealants, pastes, adhesives (loctite, Univer, Proma), silicon, liquid metal, etc.[8]	-	-
Paints, primers, varnishes, thinners и diluters			
33.	Paints non-water based (alkyd, oil, etc.)[9]	-	-
34.	Paints water based (facade paint, emulsion paint)[10]	-	-
35.	Thinners, diluters, rust converters, etc.	-	-
36.	Coresiline	-	-
37.	Primers	-	-
38.	Varnishes	-	-
39.	Alcohol/ethyl alcohol	64-17-5	200-578-6
Gases and gas mixtures			
40.	Gaseous nitrogen	7727-37-9	2317839
41.	Liquid nitrogen	7727-37-9	2317839
42.	Oxygen	7782-44-7	231-956-9
43.	Hydrogen	215-605-7	1333-74-0
44.	Propane butane	74-98-6 106-97-8	200-827-9 203-448-7
45.	Argon	7440-37-1	2311470
46.	Argon gaseous mixture (82 % Ar and 18 % CO_2)	7440-37-1 124-38-9	7440-37-1 2046969
47.	Crysal gaseous mixture (80 % Ar and 20% CO2)	7440-37-1 124-38-9	2311470 2046969
48.	Freon 22 (chlordifluormethane)	LD	LD
49.	Reference gaseous mixture Ar –CH4 (90% - 10%)	7440-37-1 74-82-8	2311470 200-812-7
50.	Carbon dioxide	124-38-9	2046969

The EIA report will examine the proposed possibilities for separation of the air and the capacity of the currently existing nitrogen-oxygen stations, and the extent to which they are capable of satisfying the needs of the NNU.

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[8] Due to the absence of information on the contents of the adhesives, sealants and silicons, their hazard phrase is quoted in the list as R 20/22 (Hazardous for breathing and swallowing).

[9] Hazard category, R and S – phrases are about the substance turpentine, the contents of which in the non-water based paints, varnishes and thinners varies within the range of 15 and 40%.

[10] Hazard category, R and S – phrases are about the substance ethyl glycol, the contents of which in the water based paints are < 1.5%.

The good practice of delivering chemical substances and mixtures accompanied by Safety Data Sheets, which specify the way for their environmentally friendly storage and use, will continue to be applied.

1.7.2.2 NUCLEAR FUEL (NF)

There are different types of nuclear fuel, one of the most widely used types is with uranium in the form of UO_2 enriched by the isotope U^{235}. This type of fuel is used in water-water reactors (WWER) or PWR reactors according to the western European abbreviation norms.

The initial raw material for all types of nuclear fuel is natural uranium mined by varying methods.

Taking into consideration the fact that the fuel cycle is an important element of the operation of a new nuclear unit, the fuel will be examined through all the stages of the process from the point of view of the environmental impact assessment – supply of fresh NF, transport of fresh NF, utilization of NF, temporary storage and transport of the spent nuclear fuel and transportation of the spent nuclear fuel.

The assessment relative to the transport of the fuel will consider the potential environmental impacts both under normal conditions and under emergencies.

The NF that will be used must comply with the design bases for the maximum discharge burnup of the fuel, stipulated by the EUR. As regards the requirements for the nuclear fuel of the NNU, the minimum to be considered in the EIA report is:

- → During normal operation:
  - emissions of fission products in gaseous form from the fuel pellets;
  - interaction of the fuel pellets with the fuel cladding;
  - compaction and expansion of the fuel pellets;
  - behavior of the spring inside the fuel rod.
- → During emergency situations:
  - fuel rod cladding embrittlement;
  - hydrogen generation;
  - fragmentation and melt-down of the FR.

Storage conditions for the fresh nuclear fuel

The following conditions for the handling and storage of the fresh nuclear fuel should be considered and analysed in the design of the NNU as a part of the EIA report:

- → provision for incoming fuel control, technical servicing and performance of periodical inspections and testing of the components important for the safety ;
- → ensuring control over the storage conditions;
- → minimizing the possibilities to inflict damage;

- prevention of unauthorized access to the nuclear fuel;
- prevention of falling of the fuel assemblies when transported;
- prevention of falling of heavy objects onto the fuel assemblies.

1.7.2.3 SPENT NUCLEAR FUEL (SNF)

The spent nuclear fuel is an inevitable technological product in the nuclear electricity generation. It is irradiated nuclear fuel. The average composition of the SNF relative to the initial quantity of heavy metal (HM) includes 94-95% of uranium, approximately 1% of plutonium and approximately 4-5% fission products, the radioactivity of which accounts for 99% of the radioactivity of all the materials used in the nuclear power sector and industry. The presence of radionuclides of uranium and plutonium in the SNF makes it fundamentally different from the radioactive waste. According to the commercial contracts between Kozloduy NPP and FSUC "FCNRF" – Moscow, Russian federation, our country possesses a large quantity of fission material which is stored on the territory of the Russian federation. According to the EURATOM Treaty, the ownership of the fission material (Pu and U) resulting from the processing of SNF is preserved for the owner.

Contemporary scientific research shows that SNF can be reprocessed and successfully used as nuclear fuel for the reactors on fast neutrons. This possibility will turn SNF into a considerable energy resource. The use of SNF as raw material instead of its processing as radioactive waste will lead to significant financial economy for the country. This policy regarding SNF is followed by other small countries developing nuclear energetics, such as Chech Republic, Hungary, Finland, Slovakia, etc. The alternative possibility for SNF management is its intermediate storage in the country with a view to its future utilization as a resource.

The practices of SNF management in the R. of The practice of SNF management in R Bulgaria is to store the SNF at the Kozloduy NPP site in the spent fuel ponds at the reactors and in SNFSF under water followed by transfering SNF for technological storage and processing. The processing of SNF decreases the bulk of the stored waste and there is a possible to use its energy resource in the future. The SNF high level waste (HLW) obtained after the processing are prepared for longterm storage and final disposal.

For the period 1974- 2009 the total quantity of SNF generated during the operation of units 1 to 6 is about 1880 tons heavy metal (HM). For the period 1980- 2009 about 52% of this quantity was transferred for processing and technological storage. SNF coming from the operation of units of WWER-440 and part of SNF of WWER-1000 (the spent fuel assemblies from WWER-1000 in the first three years are stored in the ponds at the reactors) was transferred in the pond for storage under water at the Kozloduy NPP site. With the existing schemes of refuelling units 5 and 6 of the plant, about 38.7 tons HM are generated annually. The dry SNF storage built at the Kozloduy NPP site, stages 1 and 1a is designed to hold respectively 2800 and 2456 casks from reactors WWER-440. The design rate for filling the storage is 420 casks annually. The second stage of the dry storage facility for storing 2508 fuel assemblies from the reactors WWER-1000 is in the phase of developing the technical project. In case the practice of returning certain quantities of SNF for reprocessing continues, this phase should not be implemented in the next 10 years as SNFSF can provide for accepting and safe storage of fuel from units 5 and 6 to 2030 at the current regime of refuelling. It has to be borne in mind that the transporting of SNF from the units of Kozloduy NPP for technological storage and processing is done on the basis of longterm commercial contracts with FSUC "FCNRF" №08843672/70046-09D, notified and approved by The Agency for supply of EURATOM with № AGW/6221 and № /6222 in 2007, whose termination will occur after the last spent fuel assembly is returned. The quantities of SNF that are transported for technological storage and reprocessing from 1998 to the end of 2009 are about 255 tons HM from the reactors WWER-440 and about 415.2 tons HM from reactors WWER-1000.

Pursuant to the contracts in force, HLW of the processed SNF shall be returned to Bulgaria 10 years after the particular volume is determined applying a Methodology agreed upon between the parties in accordance with the international practices in this field. HLW from SNF transferred for processing up to 1989 is not subject to returning to the R of Bulgaria. According to the international practice, the processing of 1 ton of SNF produces about 70 liters of HLW or about 200 kg vitrified HLW or HLW is about 3-4% of the processed SNF. The vitrified HLW is encapsulate in 170-liters canisters in a matrix of 11-18% sodium-alluminum-phosphate glass weighing about 450 kg. The HLW are transported in containers holding from 21 to 28 such canisters.

The expected quantities of HLW of the SNF shipped in the period from 1998 to 2009 to be returned to Bulgaria after 2020 are about 128 tons. The exact volume and the respective quality and quantity characteristics will be determined with the signing of the respective contracts.

By 31.05.2010 there were about 925 tons heavy metal SNF (about 630 tons HM from the WWER-440 reactors and about 295 tons HM from WWER-1000 reactors) stored in SFP and SNFSF on the Kozloduy NPP. From 2010 to the end of the design term of units 5 and 6 of Kozloduy NPP, respectively 2017 and 2021 it is expected about 495 tons heavy metal SNF (1136 assemblies from WWER-1000reactors) to be generated additionally. In case of extending the term of operation with 15 years, respectively to 2032 and 2036, it is expected that Kozloduy NPP will generate an additional 595 tons of heavy metal SNF (1364 assemblies from WWER-1000reactors) in the period 2017/21 – 2032/36.

The processing of SNF is seen as a necessary process providing for separation of FP and at the same time storage and possibility for using the energy resource of the fission materials which are property of Kozloduy NPP. The main advantage of this alternative is the clearing of the Kozloduy NPP site from SNF using finances allocated in eaqual portions for a long period of time. Thus the principle of not burdening the future generations is observed. The dry storages provide for SNF storage for a period of 50 years. The longterm storage has some advantages, the most important of which is that it provides for the possibility the best choice to be made in the future and the results from the current studies and elaborations to be effectively used. A shortcoming of this alternative is that a large quantity of spent nuclear fuel will be accumulated at the Kozloduy NPP site. Despite all the measures taken, the presence of such a large quantity of SNF at the site will become a serious problem in the long term and this is a deferred decision laying the responsibility on the future generations. In order to satisfy the condition of not encumbering the next generations with expenditure on processing or disposal of SNF after the expiration of the term for their longterm storage in dry repositories, the operator is obliged simultaneously with the building and filling of the containers with SNF to make contributions for SNF and nuclear material management including the activities related to SNF processing and disposal of HLW resulting from its processing to the account of the Decommissioning of Nuclear Facilities Fund (DNF). These funds are recognized expenses and are included in the production cost of energy.

The National Strategy for Spent Nuclear Fuel and Radioactive Waste Management by 2030, approved with a decision by the CM on 5 January 2011г includes a schedule for solving the problems with the high level radioactive waste (HLW) at national level

Without refuting the possible alternative solutions to the management of HLW and RAW category 2b, for the purposes of protection of the economic and political sovereignty of the country, at this stage the decision for building an on ground longterm repository with a period of administrative control not shorter than 100 years for HLW and intermediate level RAW (ILRAW) category 2b is considered an optimal option. This period for controlled storage of HLW and RAW category 2b will make it possible to obtain new data and technical solutions which will substantially change the methods of management of this type of waste. Thus potential gross mistakes will be avoided concerning the final disposal in stable geological formations.

To achieve this goal the following measures have to be implemented by Kozloduy NPP and SE RAW:

- *Transferring of SNF for processing should continue on the basis of economically efficient decisions and commercial contracts;*
- *Removal of SNF from the wet SNFSF and its transfer to DSNFSF;*
- *Commissioning of stage 2 of DSNFSF for SNF from WWER-1000 after 2015 taking into account the possibility for packaged SNF transportation from WWER-1000 as of 2011;*
- *extending the term of operation of the wet SNFSF by 10 years after 2014;*
- *Investigation of the possibilities for building a repository for long-term storage of casks with HLW from the processing of SNF at Kozloduy NPP to 2022. The final decision on the problem with the HLW from the processing of SNF is to be taken by means of a contract entered between the operator and SE RAW.*
- *Development of a National Programme for Geologic Disposal of HLW and ILRAW category 2b until 2013, which is to be approved by the Council of Ministers.*
- *Continuing the investigation of the possibilities for disposal of HLW from the processing of SNF in the country and/or international repositories. Including for the term of validity of the present strategy, a site should be selected for building a facility for long-term isolation of HLW from the environment and its building is to be*

implemented under the condition that it is not economically reasonable and possible to ship the HLW to other countries pursuant to the EC requirements."

1.8 DETERMINATION OF THE TYPE AND QUANTITY OF THE EXPECTED WASTE AND EMISSIONS DURING THE OPERATION

1.8.1 WASTE

1.8.1.1 NON-RADIOACTIVE

During the operation of the new nuclear unit, it is expected that domestic, industrial, construction and dangerous wastes will be generated, since throughout the year various operational activities, repairs, reconstruction of buildings and premises at the site release as by-product more than one non-radioactive waste of different type and quantity. According to Article 7 of the Waste Management Act[11], the persons whose activity produces wastes and the owners of wastes either treat them as part of their work or offer them for collection, transportation and treatment to persons who are licensed to perform these activities in accordance with the said Act.

Construction waste – they are generated during repair work. They would be collected separately and delivered to a specialised company conforming to the provisions of the Regulation for Management of Building Wastes and Re-use of Recycled Building Materials[12].

Domestic waste – the wastes of the protected zone would be transported and deposited at a regulated depot – Non-radioactive Household and Industrial Wastes Depot of the Kozloduy Nuclear Power Plant, upon mandatory radiation control. The wastes of the facilities outside this zone would be transported to a Regional depot in the Town of Oryahovo. In relation to biodegradable wastes information would be requested from the Kozloduy municipality concerning the manner of their separate collection, as they would be given for composting or anaerobic degradation

Industrial waste, which includes:

- → Metal wastes, which are not result of the electrical generation, but are generated by repair work and will be stored at certain places in the nuclear power plant and at a well organised open temporary warehouse;
- → Sediments from the treatment plant of domestic water waste from the production of chemical and demineralised water;
- → Sediments from neutralisation pits – facilities for neutralisation of waste water from the production of chemical demineralised water.

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[11] Waste Management Act, State Gazette No. 53/12.07.2013.

[12] Regulation for Management of Construction Waste and Re-use of Recycled Building Materials, State Gazette No. 89 of 13.11.2012.

Hazardous waste – they are generated by burnt down luminescent and mercury lamps, sediments of sludge and oil retainers, laboratory and industrial chemical substances and mixtures with expired shelf life, packing of fuels and oils, oiled rags, threads and sawdust. They will be stored separately, in specially organised temporary storage facilities at the Kozloduy NPP site. Upon piling certain quantities they will be dispatched for further treatment to specialised companies licensed in the way of the Waste Management Act.

In ***Table 1.8-1:*** *Characteristics of non-radioactive waste during the operation of the New Nuclear Unit*.

TABLE 1.8-1: CHARACTERISTICS OF NON-RADIOACTIVE WASTE DURING THE OPERATION OF THE NEW NUCLEAR UNIT

No.	Name	Code pursuant to Regulation No. 3 (publ. State Gazette, No. 44/25.05.2004, amend. No. 23/20.03.2012)
Domestic wastes		
1.	Paper and cardboard	20 01 01
2.	Electric piles and batteries, other than the ones mentioned in 20 01 33	20 01 34
3.	Electric and electronic equipment used no more, other than the ones mentioned in 20 01 21, 20 01 23 и 20 01 35	20 01 36
4.	Wood materials, other than the ones mentioned in 20 01 37	20 01 38
5.	Plastic materials	20 01 39
6.	Other fractions, not mentioned elsewhere (sediments from the cold channel and the avant-chambers of the Central Pump Station)	20 01 99
7.	Biodegradable waste	20 02 01
8.	Soil and stones	20 02 02
9.	Mixed domestic waste	20 03 01
10.	Waste from cleaning of sewerage systems	20 03 06
11.	Voluminous waste	20 03 07
Building waste		
12.	Concrete	17 01 01
13.	Excavated earth other than the one mentioned in 17 05 05	17 05 06
14.	Insulation materials other than the ones mentioned in 17 06 01 and 17 06 03	17 06 04
15.	Mixed waste from building and demolition other than the ones mentioned in 17 09 01, 17 09 02 and 17 09 03	17 09 04

No.	Name	Code pursuant to Regulation No. 3 (publ. State Gazette, No. 44/25.05.2004, amend. No. 23/20.03.2012)
Industrial waste		
16.	Bran, shavings, clippings, pieces wood materials, chipboards and veneers, other than the ones mentioned in 03 01 04	03 01 05
17.	Filings, shavings and clippings of ferrous metals	12 01 01
18.	Filings, shavings and clippings of non-ferrous metals	12 01 03
19.	Paper and cardboard packing	15 01 01
20.	Plastic packing	15 01 02
21.	Metal packing	15 01 04
22.	Absorbents, filter materials, wiping cloths and protection clothes other than the ones mentioned in 15 02 02	15 02 03
23.	Old out of use tyres	16 01 03
24.	Components, removed from discarded equipment other than the one mentioned in code 16 02 15	16 02 16
25.	Non-organic waste other than the ones mentioned in 16 03 03	16 03 04
26.	Organic waste other than the ones mentioned in 16 03 05	16 03 06
27.	Sharp instruments	18 01 01
28.	Waste the collection and disposal of which is not object of special requirements with view to prevention of infections	18 01 04
29.	Sediments of physical and chemical treatment other than the ones mentioned in 19 02 05	19 02 06
30.	Infiltrate from wastes depots other than the ones mentioned in 19 07 02	19 07 03
31.	Waste from sieves and grills	19 08 01
32.	Sediments from treatment of waste waters from inhabited areas	19 08 05
33.	Ferrous metals	19 12 02
34.	Non-ferrous metals	19 12 03
Hazardous waste		
35.	Spent greases	07 06 99*
36.	Solutions of developer and activator on water base	09 01 01*
37.	Fixing solutions	09 01 04*

No.	Name	Code pursuant to Regulation No. 3 (publ. State Gazette, No. 44/25.05.2004, amend. No. 23/20.03.2012)
38.	Non-chlorinated hydraulic oils on mineral base	13 01 10*
39.	Non-chlorinated motor, greases and oils for gears on mineral base	13 02 05*
40.	Non-chlorinated insulation and heat-transmission oils on mineral base	13 03 07*
41.	Sediments from sump shafts (collectors)	13 05 03*
42.	Oil and diesel fuel	13 07 01*
43.	Other emulsions	13 08 02*
44.	Packing containing residuals of hazardous substances or polluted with hazardous substances	15 01 10*
45.	Absorbents, filter materials, wiping cloths and protection clothes, polluted with hazardous substances	15 02 02*
46.	Non-organic waste, containing hazardous substances	16 03 03*
47.	Organic waste, containing hazardous substances	16 03 05*
48.	Sediments from physical and chemical treatment, containing dangerous hazardous	19 02 05*
49.	Solvents	20 01 13*
50.	Fluorescent tubes and other wastes, containing mercury	20 01 21*
51.	Piles and batteries, included in 16 06 01, 16 06 02 or 16 06 03, and unsorted piles and batteries, containing such cells	20 01 33*

(*) Waste, containing hazardous substances (igniting, teasing, harmful, toxic, cancerous, corrosive, mutation etc.) is classified as hazardous and is marked by an asterisk

According to Article 8 of the WMA[13], the transmission and reception of industrial, construction and hazardous wastes will be carried out only on the basis of a written contract with persons, holders of license, complex license or registration document pursuant to Article 35 of the Waste Management Act for the respective activity and having at their disposal site for waste with the appropriate code according to Regulation 3 (2004) pursuant to Article 3 concerning classification of wastes.

In the Report on the Environmental Impact Assessment a quantitative characteristics will be displayed, including description and analysis of the ways of collection, temporary

[13] Waste Management Act

storage and treatment of the waste, and identification concrete measures to guarantee their ecological management.[14,15,16]

1.8.1.2 RADIOACTIVE WASTE

The source of radioactive waste is the radionuclides generated in the operation process of the nuclear reactors. According to their origin the radionuclides divide mainly into two groups:

- → Products of fission
- → Products of neutron activation.

The accumulation of products of fission and activation of heat-transmitters of the first contour in the containment of the reactor and the structures inside the containment conditionally may be called primary pollutions.

All other pollutions of equipment, instruments, premises, special clothes etc. are generated as a result of the migration and re-distribution of the radionuclides, which follow various mechanisms – solution and crystallisation, evaporation and condensation, sorption, diffusion and chemical interactions. These pollutions are marked as secondary pollutions. Items polluted radioactively, which can no longer be used according to their purpose and at the same time are polluted with radionuclides above the adopted norms (levels of release) are classified as radioactive waste.

The new nuclear unit foresees use of sources of ionizing radiation for the needs of the metal control, calibration of dosimetric and radiometric devices, in the fire-fighting installations, technological measurements and control. Upon their discarding they are also treated as radioactive waste.

The "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" adopted by IAEA and the Regulation on the Safety of Radioactive Waste Management passed by the Nuclear Regulation Agency define the international criteria and the national statutory requirements on all aspects of the activities related to radioactive waste. The Regulation of the Nuclear Regulation Agency of 2004 determines 3 (three) categories of solid radioactive waste depending on their activity – I, II and III category, named low-, medium- and high-radioactive waste. The liquid radioactive waste are classified depending on the characteristics of the solid radioactive waste, which is expected to be produced after their conditioning.

In connection with the processing of radioactive waste and in accordance with Article 5 of the Regulation on the Safety of Radioactive Waste Management the following three categories of solid radioactive waste are defined:

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[14] Letter of the Kozloduy Nuclear Power Plant EAD, Safety and Quality Directorate, No. 190/8.02.13.

[15] Recommendation of the Ministry of Environment and Forests (Republic of Romania), letter No. 3672 RP of 18.10.2012.

[16] On the recommendation of the Regional Inspectorate of Environment and Waters – Vratsa, letter No. B2975/10.01.2013

→ Category 1: transitional radioactive waste, which may be exempted from control upon appropriate processing and/or temporary storage for a period of time not greater than 5 years whereat their specific activity decreases under the level marking exemption of control,

→ Category 2: low and medium active waste, containing radionuclides in concentrations, which do not require special measures for clearing of the heat-emission at storage and burial; the radioactive waste of this category is sub-categorised additionally into:

  ✓ Category 2a – short-lived low and medium active waste, containing mainly short-lived radionuclides (with period of half decay shorter or equal to the period of half decay of ^{137}Cs), and long-lived alpha-active radionuclides with specific activity, lower or equal to 4.106 Bq/kg for a single packing and lower or equal to 4.105 Bq/kg in the whole volume of the radioactive waste;

  ✓ Category 2б – long-lived low and medium active waste, containing long-lived alpha –active radionuclides (with period of half decay, longer than the period of half decay of ^{137}Cs) with specific activity, exceeding the limits set for category 2a;

→ Category 3: highly active waste in which the concentration of the radionuclides s such that the heat-emission has to be accounted for at storage and burial.

The radioactive waste management in the Kozloduy Nuclear Power Plant is subject to approved complex program for radioactive waste management. The program comprises the entire technological cycle from the origination of radioactive waste to its transfer to the Radioactive Waste State Enterprise (Radioactive Waste-Kozloduy Economic Enterprise), and the implementation of activities of exempting from regulating control.

In connection with the peculiarities of the methods applied for the processing of radioactive waste and in accordance with the contractual relations with Radioactive Waste State Enterprise, pursuant to Article 7 of the Regulation on the Safety of Radioactive Waste Management, additional radioactive waste categories were introduced by the Kozloduy Nuclear Power Plant EAD. The additional categories specify in detail the requirement of Article 5, item 2 of the Regulation and are connected with the operationally measurable parameters within limits, which are proposed by the Radioactive Waste State Enterprise, Radioactive Waste-Kozloduy Economic Enterprise and are in conformity with the "Procedure for reception of radioactive waste in the radioactive waste facility of the Kozloduy Nuclear Power Plant". The following two main groups are represented:

→ Additional categories of solid radioactive waste (category 2a);

→ Additional categories of liquid radioactive waste.

Additional categories of **solid radioactive waste (category 2a)** by the Kozloduy Nuclear Power Plant EAD are determined as follows:

- **2-I** – category – capacity of the equivalent dose of gamma-radiation at a distance of 0.1 m from the surface of the waste from 1 μSv/h to 300 μSv/h;
- **2-II** – category – capacity of the equivalent dose of gamma-radiation at a distance of 0.1 m from the surface of the waste from 0.3 mSv/h to 10 mSv/h;
- **2-III** – category – capacity of the equivalent dose of gamma-radiation at a distance of 0.1 m from the surface of the waste above 10 mSv/h.

The solid radioactive waste of each of the above additional categories are characterised as allowing pressing (fabric, cotton and waste on the basis of polyvinyl chloride, polyethylene and other plastics) and not allowing pressing (metals, wood, building materials etc.).

Additional categories of **liquid radioactive wastes are defined by the** Kozloduy Nuclear Power Plant EAD as follows:

- **2 – H** – category – with activity to 3.7E+5 Bq/l;
- **2 – C** – category – with activity from 3.7E+5 Bq/l to 7.2E+7 Bq/l;
- **2 – B** – category – with activity over 7.2E+7 Bq/l.

The liquid radioactive waste of each additional category, depending on its origin, may be characterised as:

- Liquid radioactive concentrate;
- Ion-exchanging resins
- Sludge and sediments
- Oils.

1.8.1.2.1 Solid radioactive waste

The solid radioactive wastes of the new energy unit will form from the radioactive waste generated during the everyday operation of the unit expecting them to be of Category 2a. The same category of radioactive waste is expected to be generated during the decommissioning of the new nuclear unit. The technology for the treatment of radioactive waste will include pressing, immobilising in cement matrix and packing in steel-concrete containers (net volume of 5 m^3).

In accordance with the technology for treatment the generated waste is divided into allowing pressing and not allowing pressing.

The activities in radioactive waste management are running on the basis of built administrative structures with a certain status between the operating organisation and the Radioactive Waste State Enterprise with defined functions and tasks and a clear distribution of rights, responsibilities and duties of both operators at the site.

The solid radioactive wastes, which will be generated, are predominantly of categories 1 and 2a.

According to the requirements of EUR during the operation of such type of reactor, the generated solid radioactive waste on an yearly basis, including the conditioned liquid radioactive waste, must not exceed 50 m^3 for 1000 MW installed power. These quantities are specified at a limit of the dose capacity of the packed conditioned radioactive waste of 10mSv/h. They do not include the quantities of radioactive wastes generated during the repair and maintenance, which are expected not to be more than 100 m^3 for one campaign (24-36 months). Where the contemporary technologies of radioactive waste management are abided by, these limiting quantities can be strongly reduced.

1.8.1.2.2 Liquid radioactive waste

In the process of operation of the new nuclear unit there will be generation of industrial radioactive waste waters of the first contour as a result of leakage from the equipment, from the depots for the spent nuclear fuel, from the equipment deactivation facilities and from regeneration and washing of the ion-exchanging filters, the washing machines for special clothes and the sanitary filters, radio chemical laboratories etc.

In accordance with the requirements of the Regulation for safe management of radioactive waste, the liquid radioactive waste is categorised in accordance with the requirements of Article 5 of the Regulation depending on the characteristics of the solid radioactive waste, which are expected to be produced upon their conditioning.

According to the requirements of EUR, during the operation of such type of reactors, the maximum activity displayed by the generated liquid radioactive waste on a yearly basis must not be more than 10 GBq (without Tritium).

1.8.2 EMISSIONS IN THE ATMOSPHERIC AIR

1.8.2.1 NON-RADIOACTIVE EMISSIONS

During normal operation gas emissions are expected over the national road network by transport activities, connected with the project. The transport plan of supplies (equipment) and removal of wastes affects the servitude territories of the road sections used by the project. They present a linear source of pollutants.

The assessment of the emission levels for the different pollutants by the motor vehicle transport on the roads of the national road network will be made according to Level 2[17] (Tier 2) of the European Guideline for inventory of emissions EMEP/EEA CORINAIR'2009 for the principal pollutants by: (a) passenger motor vehicles (NFRкод1.A.3.b.i), (b) lightweight motor vehicles under 3.5 t (1.A.3.b.ii), (c) trucks over 3.5 t and (d) buses (1.A.3.b.iii) in section **Transport.**

The emissions of the following pollutants will be evaluated:

- Ozone precursors – CO, NO_X, NMVOC (non-methane volatile compounds);
- Greenhouse gases (CO_2, CH_4, N_2O);

[17] When defining the levels of the greenhouse gases emissions according to the methodology of IPCC methods are used with different complexity. The level of complexity of the method is designated as Level (Tier) X, i.e. the greater the number X, the more complex and more precise is the used method.

→ Oxidising substances (NH_3, NO_X, SO_2);

→ Fine particulate matter – only the fraction 2.5, as the higher fraction 2.5÷10 is negligible small in the soot of the burnt gases.

→ Cancerous compounds:

- ✓ PAH – polycyclic aromatic hydrocarbons (Benzo (α) pyrene, Benzo (b) fluoranthene + Benzo (k) fluoranthene, indeno (1,2,3-cd) pyrene – for unleaded petrol));
- ✓ POP – the stable organic pollutants;
- ✓ Toxic substances (DIOX – dioxins and furans (for unleaded petrol)

→ Heavy metals.

In the Report on the Environmental Impact Assessment the emissions by diesel generators for emergency powering of the safety systems will also be evaluated on the basis of spent fuel.

1.8.2.2 EMISSIONS OF RADIOACTIVE PRODUCTS

Sources of organised gas aerosol radioactive emissions into atmosphere will be the ventilation pipes of the new nuclear unit.

Radioactive substances originate at normal operational regime as a result of organised and unorganised emissions of the coolant contour and at the ventilation of the technological premises. Radionuclides are also found in the air of the premises of the Special shell. The special ventilations are organised to take out the gases from the premises upon passing through respective gas-purifying systems.

The radioactive gases and aerosols are treated by means of gas-purifying systems equipped with facilities for extraction of the radioactive gases and the Tritium and reduction of their activity before emission into the atmosphere and by means of devices for purifying the gases of iodine isotopes and of radioactive aerosols.

The radioactive emissions into the atmosphere are made of a mixture of tens of radionuclides, which are represented by over 50 types with different period of half decay from several seconds to tens of years. The basic radioactive emissions into the atmosphere can be presented in three groups – radioactive inert gases, long-lived aerosols and Iodine-131 (^{131}J).

The limits for the radioactive emissions into the atmosphere, according to EUR for the regimes of normal operation and emergency state are:

- For radioactive inert gases – 50 TBq;
- For long-lived aerosols and halogen elements– 1 GBq.

These reference values are determined on the basis of 150 MWe. They may be accepted conservatively at the examination of the impact on the environment by the new nuclear unit as the real emissions from different reactor models are expected to be lower.

At all operational states of the new nuclear unit the yearly effective dose of internal and external radiation of the population caused by the impact of the liquid and gaseous emissions into the environment of all units and facilities (units 1 – 6, the depot for storage of the spent fuel under water and the National Depot for burial of radioactive waste), which are located and will be located at the Kozloduy NPP site must not be higher than 0.25mSv (directives of the Nuclear Regulation Agency by letter No. 47-00-171/12.02.2013, pursuant to the final provisions of § 3, par. 2, item 2 of the Regulation on Ensuring the Safety of Nuclear Power Plants (2004) for the existing nuclear power plants at the moment of enforcement of the Regulation.

1.8.3 EMISSIONS INTO THE WATERS

The basic receiver of all types of waste waters for the new nuclear unit will be the Danube River.

The Danube River is the second largest river in Europe around which live over 80 million people. It passes through 13 states, and ensures river connection between them as a water transport corridor and provides fresh water for the economies of the states. A number of hydro-technical facilities have been built by the river, which make use of its hydro-energy potential, including nuclear power plant, and the river is receiver of the waste water and heat. The quality of the river's water is of enormous significance and because of that the International Commission for Protection of the Danube River was set up, seated in Vienna, where the Republic of Bulgaria is an active member.

According to the Bulgarian legislation – the Waters Act and the Water Frame Directive of the EC 2000/60, the developed River Basin Management Plan for the Danube region defines the Bulgarian section of the river as Category River named DanubeRWB01 and code BG1DU000R001. This water body is of the type "heavily modified water body" with moderate ecological potential and bad chemical state. The aims and the measures in the River Basin Management Plan require that these indicators be corrected in the following plan years until better state and better potential is reached. The Danube River and the entire Danube region for basin management of the waters in this country are defined as a sensitive zone with regard to the anthropogenic pollution pursuant to Order No. RD-970/28.07.2003 of the Minister of the Environment and Waters, therefore the requirements towards the users of the water facilities are stricter. For the nuclear power plant these requirements are incorporated in the permits for discharge waste water from their industrial activities into the water receiving Danube River, issued by the Ministry of Environment and Waters/Danube River Waters Management Basin Directorate.

The waste waters of the new nuclear unit will be analogous to the existing nuclear power plant. (Letter of the Ministry of Environment and Waters, Regional Inspectorate of the Environment and Waters – Vratsa No. 2975/10.01.2013г.)

The sewerage network of the new nuclear unit will be divided for the various types of waste waters. According to Regulation No. 2/08.06.2011 for Issue of Permits for Discharge of Waste Waters into Water Bodies and Determination of Emission Limitation for Point

Sources of Pollution, Article 6, par. 1, item 3 and item 4, new connections of waste water are banned and no permits are issued for discharge of waste waters into drainage and irrigation systems and of industrial waste waters into drainage systems. The main receiver of waste water will be only the Danube River, abiding by all strict requirements of the ecological legislation.

1.8.3.1 Non-radioactive polluted waste waters

Domestic waste waters

These waters originate from all administrative, main and auxiliary building outside the "controlled zone". They will pass through the waste water treatment facility, which will be supplied with contemporary technological scheme of treatment guaranteeing at the exit-station the parameters allowed in the permit for receiving water the Danube River – III category, according to Order No. RD-2728/03.05.2001 of the Ministry of Environment and Waters and the permit to discharge these waste waters issued in the way of the Water Act. The expected water amount will be estimated according to the existing norms, which determine the necessary amount of drinking water according to the number of consumers. The waste water treatment facility for domestic waters will be according to the layout of the building at the site and to the vertical planning, ensuring maximum short path of the treated waste water to the main channel taking all waste waters to the water receiver.

Industrial waste waters

These are drainage waters from the turbine room, the diesel generator station, the transformer beds, the oil section and other auxiliary activities, which will be built on the territory of the new unit. They will be fed to the treatment plant for oil products, while for the coarse separation of the oils, local facilities are foreseen like separating wells, oil-collection pits etc. The waste waters from the water preparing installation will be treated in neutralisation facilities before being fed to the industrial waters site sewerage. These waste waters vary in quality and quantity. The location of the local treatment facilities will be determined by the composition of the main buildings and structures and the general layout of the underground sewerage system, which ensures the flow of the treated industrial waste waters to the receiver.

Rain waters

The expected amount of precipitation will be determined by the method of the density for a 5 minutes of rain and the drainage norm and will depend on the composition of the buildings and structures, the vertical planning, the grass areas, the areas covered with permanent pavement etc.

Spent cooling waters (to be carried off to the Danube River through Hot Channel 1 and Hot Channel 2).

Waste domestic waters from the "controlled zone" upon passing through the specialised treatment plant followed by radiation control within the strictly defined parameters, will be taken to the next treatment with the other domestic waters before joining the sewerage network to be taken to the receiver.

1.8.3.2 INDUSTRIAL WASTE WATERS WITH RADIOACTIVE POLLUTION

The radioactively polluted waste waters, which will originate from the new nuclear unit, will be analogous to the ones generated by the existing capacities.

In the process of operation of the energy units industrial radioactive waste waters will originate from:

- leakage of the Ist contour of the nuclear reactors;
- the pools and the storage facilities for spent fuel;
- equipment deactivation;
- regeneration and washing of ion-exchange filters;
- the special clothes washing facilities and the sanitary filters;
- Radio-chemical laboratories etc.

These waters will be treated (purified) consecutively in steam installations and filter complexes (special Special Water Treatment SWT-3) in the Special building of the new energy unit. The treated waters, called "debalanced" will be collected in intermediate tanks and following radioactivity control, will flow to Hot Channel 1, -2 if they satisfy the norms. Otherwise they will be taken back for second treatment.

The designation of the systems for special water cleaning is:

- SWT-3 – intended for treatment of floor drain from the Controlled zone. Sources for such waters are unorganised leakage from the Ist contour, structures and systems deactivation, washing and regeneration of filters, the SVO-3 itself – where the cleaned waters do not satisfy the norms of the water chemical regime at the nuclear power plant or for debalanced waters etc.;
- SWT-5 – its purpose is cleaning the water from the blowdown of the steam generators – permanent and periodic;
- SWT-7 – intended for cleaning of radioactive waters from special washing facilities and showers.

Debalanced are also the waters of the deaerator reamers and the blowdown of the steam generators. These waters will be cleaned by ion-exchange filters and in case that they cannot be used again in the technological cycle, they will be discarded (having passed dosimetric control) into the hot channel.

The radioactive sludge will be discarded into special tanks for bottom residue. It is subject of processing (cementing) in the Radioactive Waste Kozloduy Economic Enterprise, division of the Radioactive waste State Enterprise.

1.8.4 SOIL POLLUTION

The wind is one of the elements, which have direct impact over the spreading of emissions and deposition of radioactive elements on the soil. The sites under consideration for the new nuclear unit are located in an area, characterised by year-round predominance of winds from the west and the north-west. The regime of the wind for a given place strongly depends on the local conditions. The hilly relief leads to re-distribution and deformation of the air flow and as a result changes occur both to the velocity of the wind and the frequency of the prevailing directions. Not less important is the role of a large water basin like the Danube River, which may be considered in this case as a large aeration channel.

In order to evaluate the distribution of the emitted radionuclides from the new nuclear unit and their surface concentrations, it would be necessary to solve a series of tasks, including the development of models for description of the respective processes.

The main radioactive emissions into the atmosphere by the nuclear power plant are presented in three groups – radioactive inert gases, long-lived aerosols and Iodine 131 (^{131}I). The greatest significance for the evaluation of the soil pollution, probability as a result of aerosol emissions, may be attributed to the long-lived radioactive aerosols (mainly the isotopes of: ^{134}Cs, ^{137}Cs, ^{89}Sn, ^{90}Sn,^{95}Zr, ^{59}Fe, ^{58,60}Co, ^{54}Mn, ^{51}Cr, ^{110m}Ag). The period of their half decay in comparison with the other two groups of radionuclides, present in the radioactive emissions is greater; therefore they are particularly interesting for the assessment of the impact on the soils, irrespective of their lesser participation in the emitted activity by the nuclear power plant. The monitoring for a number of years of the Kozloduy Nuclear Power Plant (Report on the Environmental Impact Assessment, 1999) indicates that the maximum values of the surface concentrations of the long-lived aerosols (3.2 μBq/m^3 in 1994 and 1996 to 1.06 μBq/m^3 in 1998) are reached around the boundary of the Preventive Protection Measures Zone of 2 km, mainly to the west of the nuclear power plant. These values are in good correspondence with the yearly emitted activity of the long-lived aerosols. With the increase of the distance from the nuclear power plant they strongly decrease.

The comparison between the obtained model-based values of long-lived aerosols deposits, emitted by the ventilation pipes of the Kozloduy Nuclear Power Plant and the experimentally obtained results by the Environmental Radiation Control Department of the Kozloduy Nuclear Power Plant and also the experimental data of the National Centre of Radiobiology and Radiation Protection on the general beta activity of the samples by the permanent control points at the monitoring zones is not justified, because the deposits of radioactive products existing in the form of aerosols in the atmosphere are result both of emissions by the operation of the nuclear power plant and caused by distant transfer. As orientation for the ratio between the two components the example may be given of the registered mean joint beta activity of the atmospheric sediments in the City of Pleven and the Town of Lom in 1998, which is around 0.35 Bq/m^2, similar, even higher than the one at the control point in the Town of Berkovitsa. These values are many times higher than the defined depositions of the long-lived aerosol emissions by the nuclear power plant, which indicates its insignificant influence on the atmospheric radioactivity in this region.

For the full coverage of the studies, the Report on the Environmental Impact Assessment will provide assessment of the distribution of the emissions of long-lived aerosols from the Storage depot of spent fuel under water, irrespective of the fact that its share in the total flow of emitted radionuclides in the atmosphere by the Kozloduy Nuclear Power Plant is insignificant.

1.8.5 NOISE AND VIBRATIONS

The source of noise in the environment, related to the project of the building and commissioning of new nuclear unit at the Kozloduy NPP site, will be the main and auxiliary technological equipment and the transport in service to the industrial activities. The noise emissions in the environment will be determined on the basis of the passport data on the noise characteristics of the involved equipment. Where such data is lacking, the Bulgarian legislation (Regulation No. 6 on the Noise Indicators in the Environment, Taking Account of the Degree of Discomfort during the Different Hours of the Day and Night, the Limitation Values of the Indicators For Noise in the Environment, the Evaluation Methods of the Indicators Values for Noise and Harmful Effect of Noise on the Health of the Population, Ministry of Health, Ministry of Environment and Waters, State Gazette No. 58/2006, which is in accordance with the European Directive 2002/49/EC) allows use of data from an analogous facility (with technology and equipment similar to the ones in the Investment Proposal in question). The transport servicing the operation of the facility will also be considered as source of noise, defining the expected equivalent level of noise created by the vehicles on the basis of data for the expected intensity of movement.

According to the project, the future technological equipment would not be source of vibrations in the environment. The vibrations are characteristic for large-scale machine parts at high speed of turning. In the generation of electric energy these are mainly the turbines, situated in the turbine room. The limiting of vibration distribution outside their source concerning machines and devices is achieved by special technical requirements during their installation: anti-vibration treatment of the foundations by means of rubber plugs, isolation inserts from vibration damping materials, elimination of the solid link between vibrating areas and construction elements of the premises etc. The vibration in the industrial facilities is a factor only of the working environment.

It is not expected that transport vehicles supporting the activities of the new nuclear unit would be source of vibrations in the environment. They will use the IInd class national road network, which corresponds design-wise to the respective category of road movement whereby the vibrations originating from the heavy-duty trucks will subside at short distances around the road.

Upon these considerations in the Report on the Environmental Impact assessment – stage: Operation of the new nuclear unit, technological and transport vibrations will not be considered as a factor of the environment.

1.8.6 RADIATION

1.8.6.1 IONIZING RADIATION

The ionizing radiation is result to a great extent of nuclear interactions and decay of the nucleus of natural or artificial radionuclides. This radiation impacts live organisms through its ionisation component.

Radioactive materials are present almost throughout the chain of technological process in the nuclear power plant. The principal part of them are working (technologically necessary), such as the nuclear fuel and the radioisotopes, used in the control and diagnostic devices. The specific radioactive material – the spent nuclear fuel, product of the basic technological process in the nuclear power plant is stored, re-loaded and transported in compliance with the statutory requirements for nuclear and radiation safety in the nuclear power plant.

1.8.6.2 NON-IONIZING RADIATION

The principal sources of extremely low frequency electric and magnetic fields (with industrial frequency of 50 Hz) in the working environment are the outdoor switchgear of the transformer facilities, the bus systems, the breakers and the electric lines. Sources of extremely low frequency fields (mainly magnetic) may be also turbine generators, alternators, systems of electric powering with low currency.

Sources of radiofrequency and microwave electromagnetic radiation in the Kozloduy Nuclear Power Plant may be found in the:

- → Security systems;
- → Mobile communication systems;
- → Emergency information systems.

2 ALTERNATIVES FOR IMPLEMENTATION OF THE INVESTMENT PROPOSAL

2.1 ALTERNATIVES BY LOCATION

According to the Technical assignment, object of assessment there are four alternatives by location – ***Figure 2.1-1****: View of the layout of the four alternatives sited for accommodation of the New Nuclear Unit.*

Site 1 – it is situated to the northeast of units 1 and 2 of the Kozloduy Nuclear Power Plant, between the outdoor switches and the Valyata area, in the vicinity of the existing cold and hot channel (to the north of them). The area of the terrain is around 55 ha. The terrain is even with a slight slope from the southwest to northeast. The adaptation of the site is foreseen by building of a fill to raise the elevation. Open drainage channels exist at the site, which will need to be reconstructed. Part of the site is used to cultivate agricultural crops.

Site 2 – It is situated to the east of units 1 and 2 of the Kozloduy Nuclear Power Plant in the direction to the Village of Harlets, south of the existing cold and hot channels. The area of the terrain is about 55 ha. The terrain is hilly and with considerable slope from the south to the north, more evident in the south-eastern part of the site. The adaptation of the site will need excavation work. The area of the site incorporates a former collective farm household. The rest of the area is used for cultivating agricultural crops.

Site 3 – It is situated to the north of units 5 and 6 of the Kozloduy Nuclear Power Plant, in the vicinity of the bypass road of the nuclear power plant. The area of the terrain is around 53 ha. The terrain is plainly with a slight slope from the south to the north. The adaptation of the site necessitates a fill to raise the elevation. The area of the site encompasses open drainage channels, which will need to be reconstructed. The area is used to cultivate agricultural crops.

Site 4 – It is situated to the west of units 3 and 4 of the Kozloduy Nuclear Power Plant and the Depot for spent fuel of the Nuclear Power Plant, south of the cold and hot channels. The disposable area is about 21 ha within the boundaries of the alienated terrains of the Kozloduy Nuclear Power Plant. The terrain covers the existing servicing centres – Equipment Bureau, Auto Vehicle Repair Centre and Structures Mounting Centre. The site will need adaptation by reconstruction and displacement of basic underground communications of the Kozloduy Nuclear Power Plant and the auxiliary buildings.

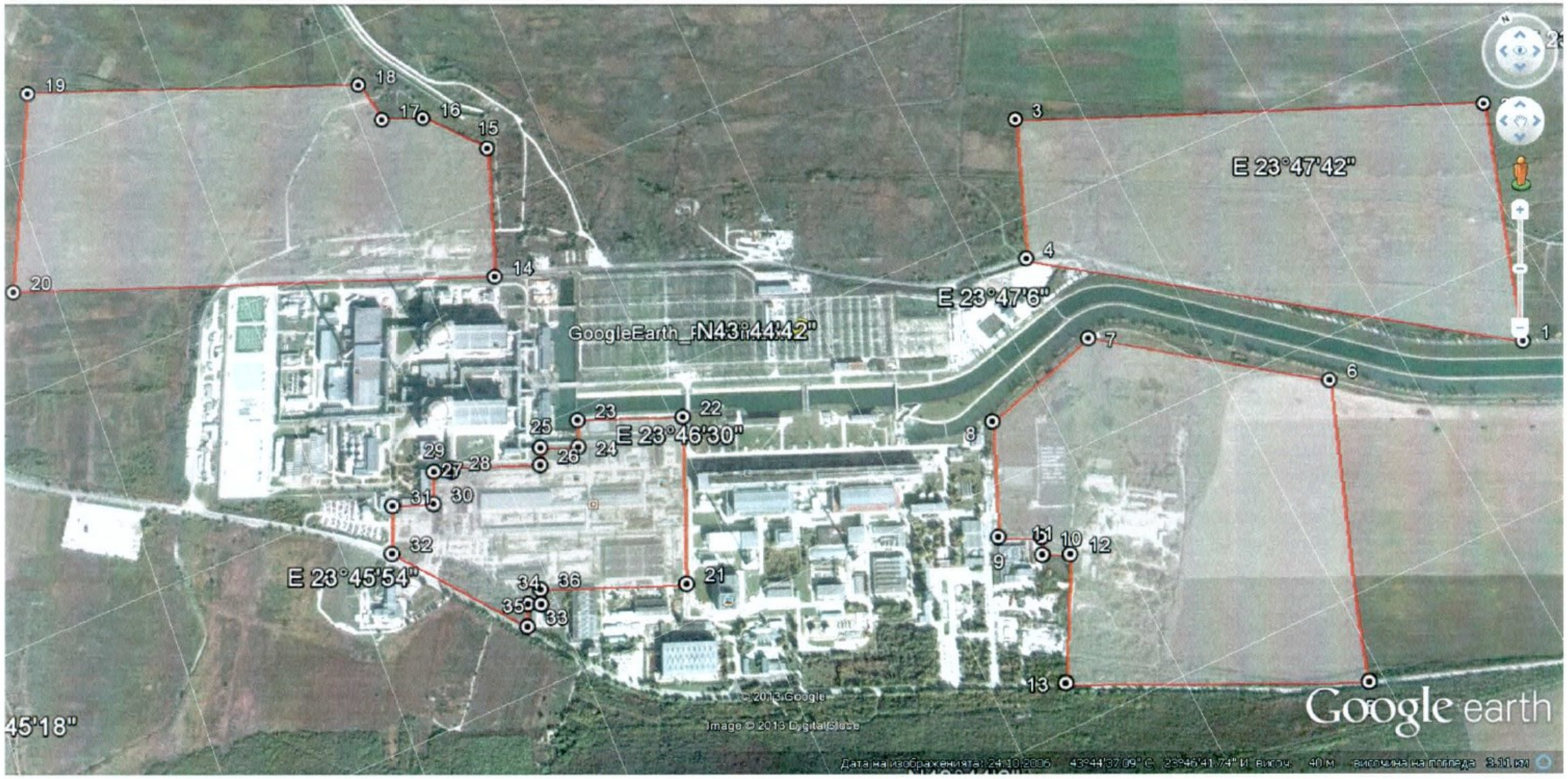


FIGURE 2.1-1: VIEW OF THE LAYOUT OF THE FOUR ALTERNATIVES SITED FOR ACCOMMODATION OF THE NEW NUCLEAR UNIT

2.2 ALTERNATIVES FOR ACCOMPANYING INFRASTRUCTURE DURING THE IFNSTRUCTION WORKS AND OPERATION

Before the main construction works at the proposed concrete site, it will be necessary to apply methods for improvement of the earth foundation, so that its carrying capacity corresponds to the load and the subsidence is within the admissible limits.

For the specific proposed site it will be necessary to organise temporary facilities related to storage of bulk materials, ready-made steel, concrete and steel-concrete, metal construction elements and the like and oils and fuel, temporary offices, temporary premises for accommodation of the manpower from other regions, temporary social-household and sanitary points, feeding water pipe network and removing household waste water for treatment and structures for piping precipitations and a dewatering system for the underwater. This organisation of the construction site will be possible at sites 1, 2 and 3. Site 4 will need additional terrains.

The vertical planning of the proposed site will conform to the working elevation of the existing site of the nuclear power plant, which is +35 m according to the Bulgarian Standard. This is ruled by the fact that it will be necessary to join the existing cold channel and hot channel. For instance if site 1 or 3 are selected, it will be necessary in the stage of construction work preparation to displace or reconstruct the draining channels passing through, while the selection of site 4 will require destruction of existing servicing buildings and their removal to a new terrain. Where site 3 is selected, it will be necessary also to remove the web of electric line 400 kW.

All sites possess technical possibility to feed drinking water from the existing water network of the nuclear power plant.

All sites possess possibility to ensure access of the necessary motor vehicle transport by diversion of the existing road infrastructure.

The liquid radioactive waste, which will form during the operation of the energy unit – the first contour as a result of leakage of the equipment, of the equipment deactivation facilities and of the regeneration and washing the ion-exchange filters, the washing facilities of special clothes and the sanitary filters, the radio-chemical laboratories etc. will be treated on the territory of the respective site in accordance with Regulation on the Radioactive Waste Management Safety.

According to the requirements of EUR during the operation, the generated solid radioactive waste on an yearly basis, including the conditioned liquid Radioactive waste, must not exceed 50 m^3 at 1000 MW installed power.

The solid radioactive wastes generated are predominantly of the category 1 and 2a.

The activities of radioactive waste management will be performed on the basis of built administrative structures with a set status between the operator of the new nuclear unit and Radioactive Waste State Enterprise through defined functions and tasks and clear distribution of the rights, responsibilities and obligations.

2.2.1 ELECTRICAL PART – LAYOUT SOLUTIONS

In the Report on the Environmental Impact Assessment there will be evaluation of the whole layout of the new nuclear unit at the site, including the link with the National Energy System, pursuant to Regulation No. 4 of 21.05.2001 on the Scope and Contents of the Investment Projects and Article 2, par. 1, item 4 of Regulation No. 6 of 09.06.2004 on the Joining of Producers and Consumers of Electrical Energy to the Transmission and Distribution Electrical Networks, which complies with the Regulation for electric energy system management, issued on the basis of Article 21, par. 1, item 7 of the Energy Act by the Chairman of the State Commission for Energy and Water Regulation, Annex to item 1 of Decision No. P-5 of 18.06.2007, published in State Gazette No. 68 of 21.08.2007:

- *Joining the electric energy system of the Republic of Bulgaria* – the joining to the electric energy system of the country shall be done by means of one self-contained overhead line 400 kW to Outdoor Switchgear-400 kV of the Kozloduy Nuclear Power Plant, which at this moment is linked to the electric energy system by eight electric lines 400 kV (of which two are inter-system) and one is auto-transformer 400/200 kV. The reserve powering for own needs will be implemented by one overhead line 220 kV again from Outdoor Switchgear-400 kV of the Kozloduy Nuclear Power Plant. The so built reserve powering will ensure at eventual external or internal damages of the electric network less interference as much as possible in the normal operation of the reactor. The residual heat removal system and the consumers who are responsible and important for the operation of the nuclear power plant will be ensured electric power from two different sources (an on-site generator and the network of the electric energy system).
- *Working supply* – the working source of supply for on-site needs of any of the generating units will be working transformers for on-site needs. The joining of the working transformers will be carried out by diversion between the general breaker and the step-up transformer of the unit.
- *Reserve powering* – to reserve energy supply for on-site needs for each of the nuclear units groups of two reserve transformers will be envisaged. These transformers will be powered by Outdoor Switchgear-220 kV of the Kozloduy Nuclear Power Plant. The reserve sources will be used at normal and emergency regimes of work and additionally at emergency conditions in case of partial or full loss of working powering.
- *Emergency powering* – to power the systems, which are important for the nuclear safety, systems will be envisaged for reliable electric powering. The emergency systems will be switched on automatically by connection to emergency sources of electric powering and/or charged batteries.

2.2.2 SUPPLY OF TECHNICAL WATER

What concerns the ensuring of supply of technical water, the following alternatives are available:[18]

2.2.2.1 SITE 1

2.2.2.1.1 Structures ensuring technical water

The structures situated at the site and ensuring the technical water supply with fresh water from the Danube River and removing the hot spent water are:

- → Connections with the channels bringing the cold water and taking away the hot water,
- → Avant chamber,
- → Central pump station,
- → Electrical command building,
- → Pressurised pipelines,
- → Filter room,
- → Low pressure channels

The link of the new nuclear unit with Cold Channel 1 and Hot Channel 1 will be possible through feeding and by-pass channel for cold water and low-pressure and open channel for the hot water. The by-pass channel will be necessary because the connection will be built with working channels, which will necessitate reduction of the water amount in them at the time of cutting. During the adaptation of the site large filling works will be necessary in order to reach elevation “0” of the principal site of the nuclear power plant and reconstruction and/or relocating the existing open draining channels.

2.2.2.1.2 Auxiliary utilities

As a whole the auxiliary utilities will have the purpose to ensure and fill up the conventional reserves, necessary for implementation of the normal and design-based operating regimes and for protection of the environment from various waste products of the technological process and supply with the necessary amount of drinking water.

The following refer to the auxiliary utilities:

- → Water preparation installation;
- → Treatment plants for household waters from the “controlled” and the “lean” zones and for industrial water and various local treatment devices;
- → Supply of fuel and the diesel generator station;

[18] Technical and economic study for building of new nuclear capacity using the equipment delivered for the Belene Nuclear Poawer Plant, NIPPIES Energoproekt.1999.

- Other general and auxiliary utilities
- A link with the existing water supply network of drinking water at the principal site will be possible at a suitable place;
- New separate sewerage channel system, removing the waste water from the site to the water receiver – the Danube River upon guaranteed treatment and permit for discharge, issued in the way of the Water for Industrial Purposes Act.

2.2.2.2 SITE 2

2.2.2.2.1 Structures ensuring technical water

The structures situated at the site and ensuring the technical water supply with fresh water from the Danube River and removing the hot spent water are:

- Connections with the channels bringing the cold water and taking away the hot water,
- Avant chamber,
- Central pump station,
- Electrical command building,
- Pressurised pipelines,
- Filter room,
- Low pressure channels

Here the connection of the structures for technical supply with water of the new nuclear unit will not differ in principle from the one at Site 1 the difference being that an inverted syphon for the cold water from Cold water – 1 and a by-pass channel for the hot water from Hot water will be built. It will be possible to complete the connection at working double channel reducing the water amount in the channels during the cutting.

2.2.2.2.2 Auxiliary utilities

As a whole the auxiliary utilities will have the purpose to ensure and fill up the conventional reserves, necessary for implementation of the normal and design-based operating regimes and for protection of the environment from various waste products of the technological process.

The following refer to the auxiliary utilities:

- Water preparation installation;
- Treatment plants for household waters from the "controlled" and the "lean" zones and for industrial water and various local treatment devices;;
- Supply of fuel and the diesel generator station;
- Other general and auxiliary utilities;

- A link with the existing water supply network of drinking water at the principal site at a suitable place;
- New separate sewerage channel system, removing the waste water from the site to the water receiver – the Danube River upon guaranteed treatment and permit for discharge, issued in the way of the Water for Industrial Purposes Act.

2.2.2.3 SITE 3

2.2.2.3.1 Structures ensuring technical water

The structures situated at the site and ensuring the technical water supply with fresh water from the Danube River and removing the hot spent water are:

- Connections with the channels bringing the cold water and taking away the hot water,
- Avant chamber,
- Central pump station,
- Electrical command building,
- Pressurised pipelines,
- Filter room,
- Low pressure channels.

Here the connection may be completed without disturbing the week of the remaining units where there is built an additional Cold Channel 2. After terminating the work of units 1 – 4, there is a surplus of fresh technical water from the Danube River amounting to 100 m^3/s. This assured reserve does not warrant building of additional utilities for technical water supply, i.e. Cold Channel 2, therefore it will be necessary to find other technical solutions related to the existing Cold Channel 1.

2.2.2.3.2 Auxiliary facilities

As a whole the auxiliary utilities will have the purpose to ensure and fill up the conventional reserves, necessary for implementation of the normal and design-based operating regimes and for protection of the environment from various waste products of the technological process.

The following utilities refer to them:

- Water preparation installation;
- Treatment plants for household waters from the “controlled” and the “clean” zones and for industrial water and various local treatment devices;
- Supply of fuel and the diesel generator station;
- Other general and auxiliary utilities

- → A link with the existing water supply network of drinking water at the principal site at a suitable place;
- → New separate sewerage channel system, removing the waste water from the site to the water receiver – the Danube River upon guaranteed treatment and permit for discharge, issued in the way of the Water for Industrial Purposes Act.

In this case construction works will be necessary to carry out reconstruction and/or relocation of existing open draining channels of the irrigation-draining system of the Kozloduy lowland, which is important for the site of the nuclear power plant. Large-scale earth-filling will be necessary to reach elevation "0" of the existing site of the nuclear power plant and new technical solution for technical water supply, as well as relocation of the web of electric line 400 kV...

2.2.2.4 SITE 4

2.2.2.4.1 Facilities ensuring technical water and auxiliary utilities

The layout of the main and auxiliary utilities will necessitate destruction of all buildings, structures and their respective communications, which are at the site. Their restoration will need new terrains.

The technical water supply of the energy unit will be able to be made from the Avant chamber of units 5 and 6 through an inverted syphon. The inverted syphon will cross the main draining mixed sewerage collector and the low pressure channels of units 5 and 6. The drainage pipelines of the circulation water supply will be linked to the low pressure channels of units 5 and 6 or of unit 4:

- → A link with the existing water supply network of drinking water at the principal site will at a suitable place;
- → New separate sewerage channel system, removing the waste water from the site to the water receiver – the Danube River upon guaranteed treatment and permit for discharge, issued in the way of the Water for Industrial Purposes Act.

During the development of the Report on the environmental impact assessment on the basis of the Technical Economic Analysis for the New Nuclear Unit, which will be provided by the Investor, the technical solutions for the link of the existing utilities, ensuring technical water and draining the spent cooling water for the New Nuclear Unit for each of the alternative site will be concretised and assessed.

2.3 VARIANTS OF THE BUILDING OF NEW NUCLEAR UNIT ALTERNATIVES

In the field of nuclear energy units of III, respectively III+ generation represent the present day level of lest technology. These are the newest designs of nuclear power plants, which in comparison with the old generations display better technological and economic quality and safety quality.

The steady development of nuclear energy is illustrated in the next ***Figure 2.3-1:*** *Development of nuclear energy according to reactor generation.*

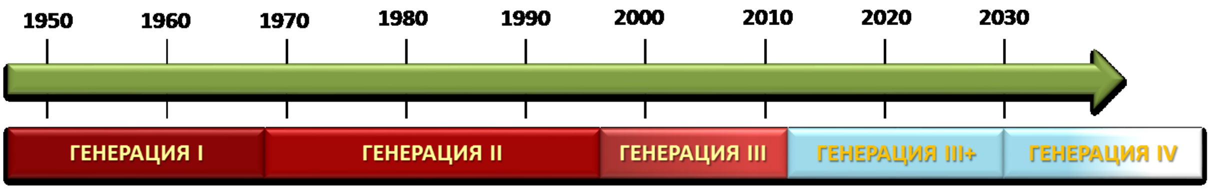


FIGURE 2.3-1: DEVELOPMENT OF NUCLEAR ENERGY ACCORDING TO REACTOR GENERATION

The nuclear power plants of the IIIrd generation at this moment use the best accessible technologies based on the proven types of the IInd generation. The main differences with the IInd generation are:

- → Standardised design, reducing the time necessary for licensing the separate nuclear power plants, the necessary investment costs and the time of building;
- → Simplified and at the same time solid design, permitting more simple servicing and increase of operational reserves;
- → Higher available resource (90 % and more) higher net effectiveness (up to 37%) and longer life (minimum 60 y);
- → Lower risk of emergency with considerable damage to the active zone (considerably lower than 10^{-5}/year);
- → Higher resistance to external impacts;
- → Possibility for higher fuel burning (higher use of the fuel to 70 GWd/tU) and reduction of the quantity of waste produced;
- → Extension of the term of stay of the fuel in the active zone by using burnable absorbers (to 24 months).

The generation III+ comes as an immediate development of the IIIrd generation. It concerns reactors with improved operational economy. Of the reactors of the PWR type the units EPR belong to generation III+, they are being built at the Finnish Olkiluoto and the French Flamanville or the new Russian reactor AES-2006, the Japanese EU-APWR or the reactor with units AP-1000 of the company Westinghouse. The reactor (respectively the nuclear power plant), which is object of this investment intent will belong to this generation.

According to the Technical assignment of the Investor, the implementation of the investment intent is possible with the following two alternatives of building the New Nuclear Unit with reactor of the newest generation, covering modern requirements for safe operation:

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

Both alternatives foresee use of energy reactors of the PWR of the newest generation (Generation III or III+) with installed electrical power of about 1200 MW. Variants of different reactor models are presented hereunder for the two alternatives.

2.3.1 DESCRIPTION OF A-1 (HYBRID)

The Belene Nuclear Power Plant (***Figure 2.3-2:*** *General layout of AES-92 (V-466B – Belene)*) is designed with pressurised water reactor of the type WWER-1000/V466B with four circulation circles on the basis of a standard project for a nuclear power plant WWER AES-92, which passed in 2006 all analyses stages for compliance with the European requirements for energy capacities, supported by the principal European companies for the next generation of nuclear power plants with light water under pressure.

The main difference between this design and previous designs of nuclear power plant with PWR of previous generation is the following:

- Quick suspension of the nuclear reaction in the active zone by two entirely independent reactivity control systems;
- Heat removal from the residual energy generation and maintaining the reactor in a state of safety by combination of active and passive systems, which do not need operator interference and energy supply from outside;

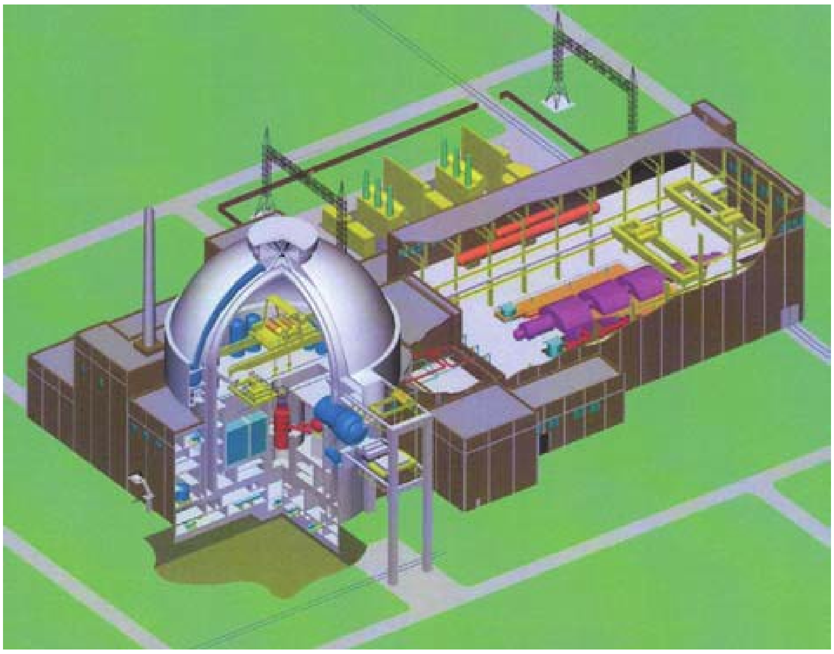


FIGURE 2.3-2: *GENERAL LAYOUT OF AES-92 (V-466B – BELENE)*

→ Double hermetic containment foreseen for a wide spectre of inner or outer events: the inner containment with hermetic shall is constructed by pre-stressed reinforced concrete with steel insert, while the outer is of steel-concrete.

Substantial improvement has been done of the hermetism ensuring maximum barrier to the emission of radioactive products in the environment. It has been designed as a construction with double containment where the inner containment is made of pre-stressed reinforced concrete with hermetic metal shell, while the outer is made of reinforced steel concrete. The outer containment is designed to withstand outer forces, like for instance the impact of a big passenger of military plane, outer explosion waves, hurricane winds, snow, extreme temperatures and earthquakes. The construction of the inner shell has been designed to withstand seismic impacts, all other safety systems covering the requirements for seismic safety. The Belene Nuclear Power Plant has been designed to withstand maximum design-based earthquake a^{max} = 0.24 g and probability of event 1 in 10,000 years.

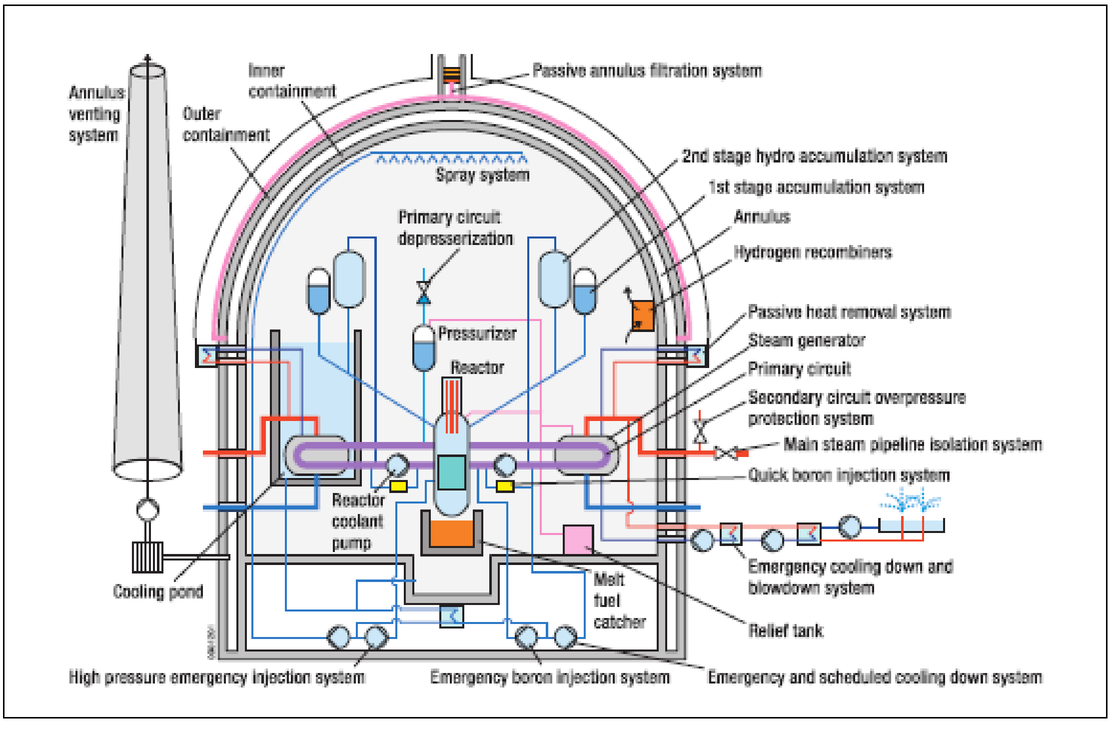


FIGURE 2.3-3: ***SCHEME OF AES-92 (V-466B – BELENE)***

The design of the Belene Nuclear Power Plant (***Figure 2.3-3:*** *Scheme of AES-92 (V-466B – Belene)*) is notable for its unique combination of active and passive safety systems, which guarantees higher safety level of the nuclear power plant , including use of nuclear meltdown catcher.

The transformation of the steam and energy of the Hybrid model of reactor two alternatives of the conventional island – turbine installation have been foreseen. The designed operational parameters of the nuclear island of WWER-1000 AES-92 have been coordinated with the end absorber at the Kozloduy NPP site. The suppliers are Toshiba and Alstom.

They propose the following variations of the turbine generator:

- ✓ Turbine generator ARABELLE 1000 of ***Alstom***
- ✓ Turbine generator TC6F of ***Toshiba***

The main characteristics of the two turbine generators will be described in the Report on the Environmental Impact Assessment.

The main technical parameters of the design for the Belene Nuclear Power Plant V-466B (AES–92) are as follows:

GENERAL DATA

Electric Power, gross [MWe]	1068
Electric Power, net [MWe]	1000
Thermal Power [MW]	3000
Effectiveness [%]	33.1
Operation regime	Basic and following the load
Designed term of operation [years]	60
Availability [%]	85 or > 90 (aim)
Construction time [month]	60
Damage frequency of the active zone , 1/year	$<6.1 \times 10^{-7}$
Frequency of early large emissions 1/year	$<1.77 \times 10^{-8}$
Removal systems of residual energy	4 channels – active and passive
Feeding systems	4 channels – active and passive
Meltdown catcher	Yes
MP3 [g]	0.24
First contour	
Number of main circulation cycles	4
Debit of First Contour [m³/s]	23.9
Operational (nominal) pressure [MPa]	15.7
Second contour	
Steam debit at nominal conditions [kg/s]	1633
Steam temperature/pressure [°C/MPa]	278.5 / 6.27
Active zone of the reactor	
Active zone [m]	3.53
Active zone equivalent diameter [m]	3.16
Number of fuel cassettes	163
Fuel cassette	Hexagonal
Maximum enrichment of the fuel [%]	4.28
Number of bundles with absorption elements	121
Average depth of burning [MWd/kg]	54.6
Fuel	UO_2
Duration of of fuel campaign [month]	12÷18
Amount of fuel [t UO_2]	79.8
Containment of the reactor	

GENERAL DATA

Diameter of cylinder body [mm]	4195
Wall thickness of cylinder body [mm]	195
Total height [mm]	11185
Main circulation pumps	
Number	4
Nominal debit [m^3/h]	21500
Volume compensator	
Total volume [m^3]	79
Design-based pressure [MPa]	17.3
Steam generators	
Number	4
Type	Horizontal with tubes in U form
Maximum outer diameter [mm]	4490
Total length [mm]	13820
Inner hermetic containment	
Design	pre-stressed reinforced concrete with steel shell
Volume [m^3]	63000
Outer protection containment	
Design	reinforced steel concrete

In addition to the big water tanks in the second contour, this type of reactor is equipped with 8 additional two-step hydroaccumulators with water volume of 120 m^3 each, and an extended pond for spent fuel, which ensures much more additional time reserve to cool fuel in case of emergency. It is characteristic for the WWER design that the location of the pond for spent bundles is inside the hermetic shell.

The safety systems include: protection, localising, supplying and management systems. The protection systems fulfil functions connected with the emergency cooling and removal of the residual energy emission from the active zone of the reactor. They have active and passive parts. Each safety system has four independent channels. The effectiveness of the channels has been selected on the principle “single refusal”, the channels of the safety systems being physically separated.

2.3.2 DESCRIPTION OF A-2

As second alternative of building the New Nuclear Unit an entirely new design of OWR is contemplated, Generation III or III+ with electrical power about 1200 MW. The generation III and III+ are 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 basic Safety Fundamentals a Safety Requirements of the International Atomic Energy Agency (IAEA).

The reactors under consideration must cover the safety criteria, specified in the Bulgarian statutory documents, the documents of IAEA and the European Utility

Requirements (EUR) for LWR Nuclear Power Plants. The choice of reactor of the type WWER/PWR is dependent on the following factors:

- → In Bulgaria reactors of the said type (WWER) are in operation since 1974;
- → They will be operated by highly qualified personnel from the site of the Kozloduy Nuclear Power Plant with many years of knowledge of the respective technology;
- → The technology proposed is used most widely worldwide for generation of electric energy from a nuclear source, approximately 80% of the reactors being of this type.

At present more than 430 nuclear energy reactors in the world are in operation with total installed power of 370 GW_e. Several tens of units of nuclear power plants are in different stages of building – ***Figure 2.3-4:*** *Share of built or under construction of PWR-type new nuclear capacities according to states in the period 2004-2010*

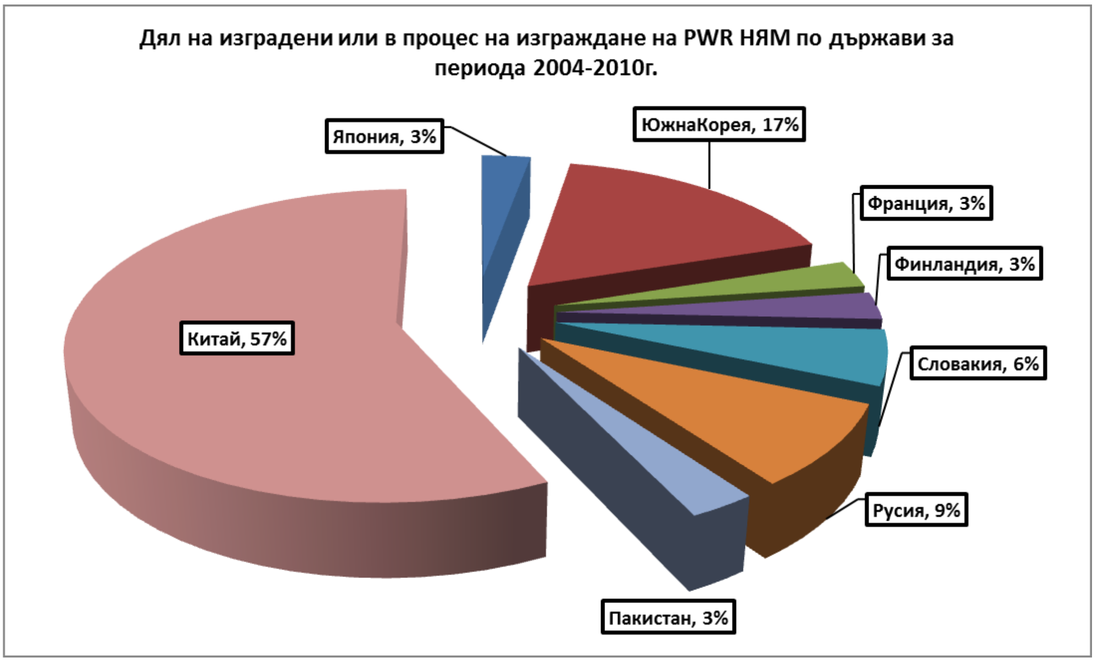


FIGURE 2.3-4: *SHARE OF BUILT OR UNDER CONSTRUCTION OF PWR-TYPE* NEW NUCLEAR CAPACITIES ACCORDING TO STATES IN THE PERIOD *2004-2010*

Together with the project of the Environmental Impact Assessment another project is underway – Technical Economic Analysis to support the building of a New Nuclear Unit on the site of the Kozloduy Nuclear Power Plant. With reference to the alternative A-2 (entirely new design) the Technical Assignment for the Technical Economic Analysis stipulates that the installed single electrical power needs to be about 1200 MW. The requirement is conditioned on the fact that a number of statutory documents recommend that the single electrical installed power should not exceed 10% of the total installed capacity in the country. At this moment the total installed power in the country is about 12200 MW. An emergency switching off of a single capacity more than 1200 MW would endanger the integrity of the electric energy system of the country.

Having in mind that in recent years almost no new nuclear power plant of generation III or III+ have been built, the construction of this type of reactor at this moment would be an advantage.

According to intermediate results of the Technical Economic Analysis to support the building of a New Nuclear Unit at the Kozloduy NPP site, a summary of the reactor models of the PWR type, generation III or III+, available at this moment on the market is presented on ***Table 2.3-1***: *Reactors of IIIrd or III+ generation*

TABLE 2.3-1: *REACTORS OF IIIRD OR III+ GENERATION*

Model	EPR	EU-APWR	APR1400	AES-2006	ATMEA1	AP-1000
Producer	Areva France	Mitsubishi Japan	Kepko Korea	Atomstroy export Russia	Areva + Mitsubishi	Westinghouse USA
Electric power (*gross*)	1770 MW	1700 MW	1455 MW	1170 MW	1200 MW	1200 MW
Electric power (*net*)	1650 MW	1620 MW	1400 MW	1082 MW	1150 MW	1117÷1154 MW
Certificate	EUR; URD-pending	EUR-pending; URD-pending	URD-pending	Designed to cover requirements of EUR	Designed to cover requirements of EUR	URD; EUR
License	France; iDAC; NRC-pending	NRC- pending	KINS; NRC-forthcoming	Rostechnadzor	Pending	NRC; iDAC
Construction	France Finland China	No	Korea OAE	Russia	No	China USA

legend: EUR-European Utility Requirements; URD-Utility Requirements Document (US); iDAC – Interim Design Acceptance Confirmation (UK); NRC – Nuclear Regulatory Commission (US); KINS – Korean Institute for Nuclear Safety

The review of the requirements set in the Technical Assignment for the Technical Economic Analysis and the models available on the market show that several models of reactor cover the necessary requirements...

In the "Assignment of scope and contents of a Report on Environmental Impact Assessment" of the Investment Intent "Building of New Nuclear Unit of the newest generation at the Kozloduy NPP site" as an example the following two models of reactor will be considered:

- ✓ AES-2006;
- ✓ AP-1000.

The model AES-2006 of Atomstroyexport is an evolutionary design of the design AES-91/92, which was developed also for the Belene Nuclear Power Plant. The design of AES-92 has passed compliance with the requirements of EUR assessment. At the moment the model of AES-2006 is being built in Leningrad, Novovoronezh and Kaliningrad.

The model of Westinghouse AP-1000 passed compliance with the requirements of EUR assessment and is licensed by NRC. At this moment the construction is underway in China (four units are expected to be commissioned up to 2015) and the USA (combined license for construction and operation By NRC is received for 14 units).

These different technical solutions represent alternatives of the investment intent, which will be object of environmental impact assessment. The requirements for the environment and the safety for all types of reactor are similar and the impacts will be evaluated at their potential maximum values.

For the purposes of the Report on the Environmental Impact Assessment the so-called **conservative** approach has been selected and the assessment would always evaluate the values, which have less favourable impact on the environment.

2.3.2.1 REACTOR AP-1000

Westinghouse AP-1000 (***Figure 2.3-5:*** *Layout of AP-1000**)*** has been designed following the conventional configuration of the primary system with 2 contours and 2 steam generators and some improvements on a few components (***Figure 2.3-6:*** *First contour OF AP-1000*).

AP-1000 has been designed for 3400 MW_t thermal power and depending on the concrete conditions, nominal power of 1117 MW. It has been licensed in China and the USA. In Europe the nuclear control of Great Britain is in the process of licensing it. At this moment construction of the first four units is underway in Sanmen and Hauyang in China.

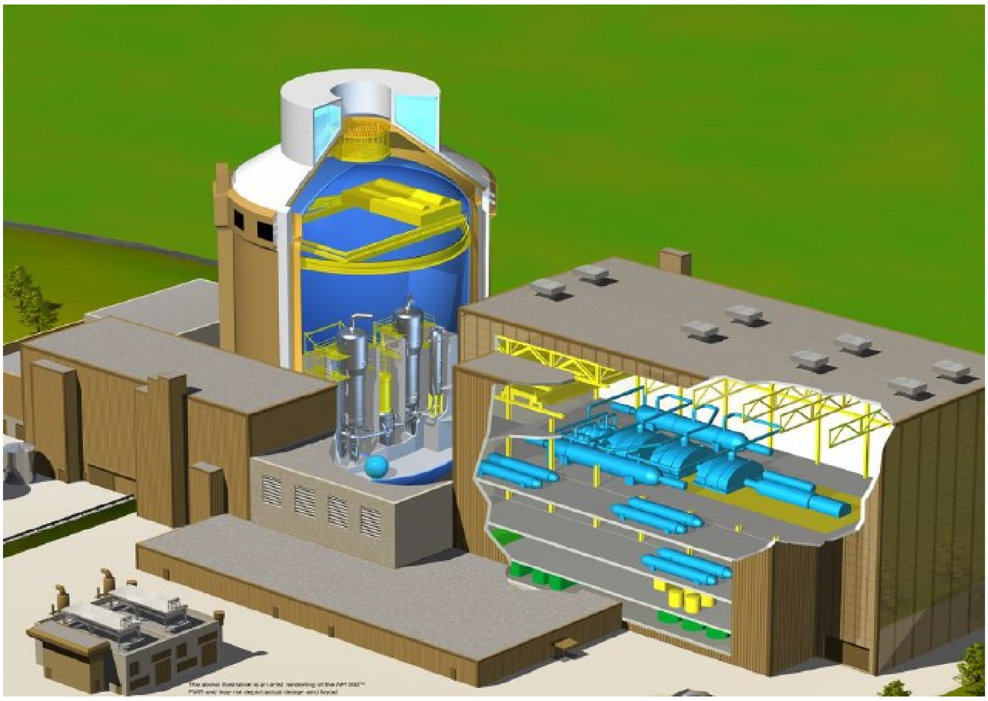


FIGURE 2.3-5*: LAYOUT OF AP-1000*

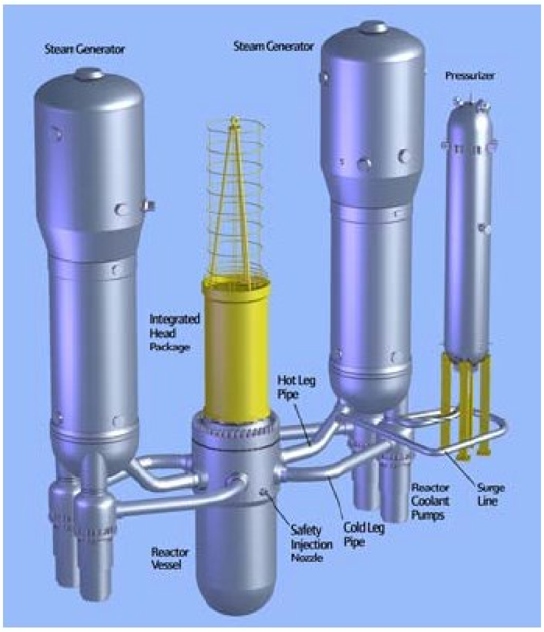


FIGURE 2.3-6*: FIRST CONTOUR OF AP-1000*

The active zone contains 157 fuel bundles, as at the nuclear power plants in Dul-4 and Tiange-3 in Belgium. AP-1000 has systems for passive emergency cooling of the active zone and for cooling of the hermetic construction. This means that the active systems in AP-1000, necessary only for elimination of design-based emergency conditions are replaced by more simplified passive systems, whose motion is activated by gravity, with condensed gases or directly by means of natural circulation instead of pumps. Besides AP-1000 has no need of sources of alternate current with high safety class. The needs of electricity during the hardly probable events when the passive emergency system must be activated are ensured by battery class 1E.

In comparison with a standard nuclear power plant with similar generation capacity, AP-1000 has 35% less number of pumps, 80% less pipelines with high class of safety and 50% less valves with class of safety ASME. There are no pumps with high class of safety. This allows the nuclear power plant AP-1000 to be much more compact than the old designs. Since the equipment and the pipelines are less than the standard, the greater part of the safety equipment is mounted in the hermetic construction. Therefore AP-1000 has approximately 55% less pipe joints to the hermetic construction in comparison with the nuclear power plants of today's generation. The volume of construction works at earthquake category 1 is about 45% less in comparison with older designs of comparable capacities. AP-1000 has relatively large pressure compensator therefore it adapts easily to various regimes.

The passive cooling system of the active zone of AP-1000 (***Figure 2.3-7:*** *AP-1000 System for passive cooling of the active zone)* uses stepped tanks with boron water, which are designed to spill out into the shell of the reactor and to various points of the first contour.

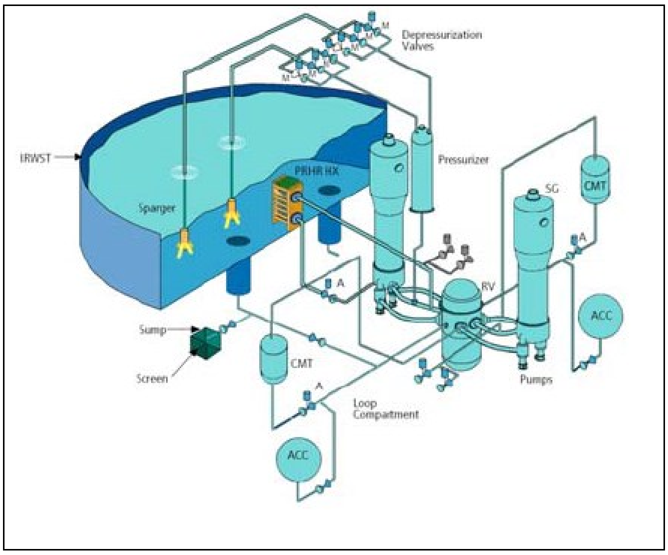


FIGURE 2.3-7*: AP-1000 SYSTEM FOR PASSIVE COOLING OF THE ACTIVE ZONE*

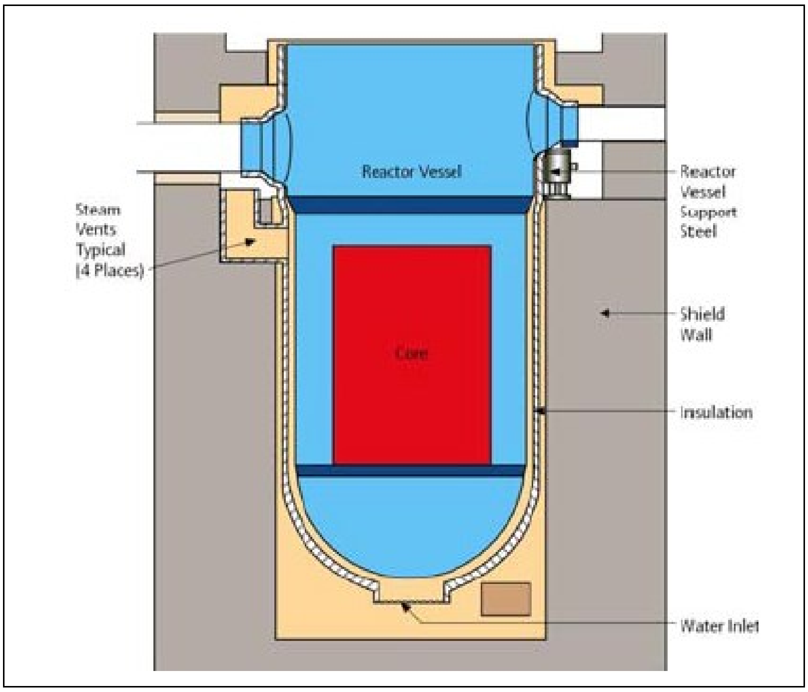


FIGURE 2.3-8*: AP-1000 DESIGN FOR INNER COOLING OF THE VESSEL*

AP-1000 is designed in such a way that it retains pieces of the melted active zone in the reactor vessel, so that there is no penetration of meltdown to the bottom of the containment of the reactor. In case of heavy emergency cooling water may be used from the big tank with reserve water, used at re-charging with fuel, to pour over the reactor pit and to cool the shell of the reactor from the outside. The structure is shown on ***Figure 2.3-8****: AP-1000 Design for inner cooling of the vessel*. The specially designed insulation of the shell of the reactor forms a ring, which allows the coolant to enter into direct contact with the vessel. There are ventilation vents allowing the steam to get out of the ring.

The ventilated steam condenses on the walls of the hermetic construction and takes back to the cavity (***Figure 2.3-9:*** *AP-1000 Passive cooling of the hermetic construction*).

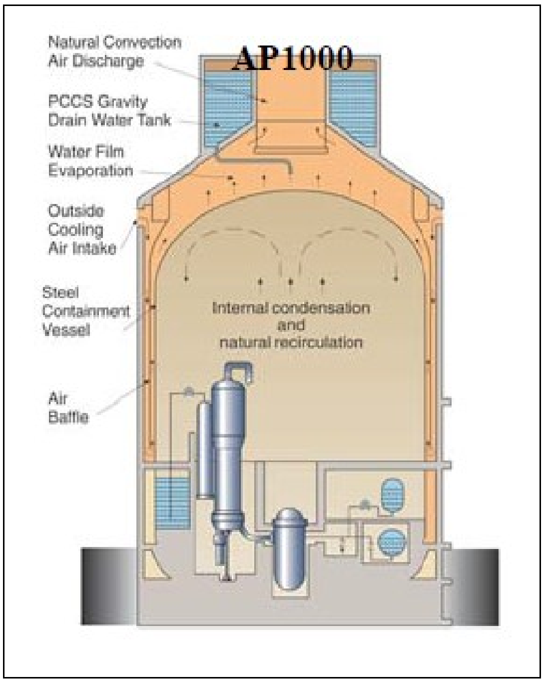


FIGURE 2.3-9: *AP-1000 PASSIVE COOLING OF THE HERMETIC CONSTRUCTION*

The main technical parameters of the design *AP*-1000 are as follows:

General data	
Electric Power, gross [MWe]	1200
Electric Power, net [MWe]	1117÷1154
Thermal Power [MW]	3400
Effectiveness [%]	33÷34
Operation regime	Basic and following load
Design-based term of operation [years]	60
Availability [%]	> 93
Time to build [months]	54
Active zone damage frequency [1/year]	5.11×10^{-7}
Early large emission frequency [1/year]	5.94×10^{-8}
System of removal of residual energy	Passive
Feeding systems	Passive
Meltdown catcher	Yes – in the shell
MP3 [g]	0.3
First contour	
Number of main circulation circles	2 hot / 4 cold
Debit through first contour [m^3/s]	19.87
Operational (nominal) pressure [MPa]	15.5
Second contour	

General data	
Steam debit at nominal conditions [kg/s]	1886
Steam temperature/pressure [°C/MPa]	272.78 / 5.76
Reactor active zone	
Height of the active zone [m]	4.267
Equivalent diameter of the active zone [m]	3.04
Number fuel bundles	157
Fuel bundle	Square
Maximum enrichment of the fuel [%]	4.8
Number of bundles with absorption elements	69
Average depth of burning [MWd/kg]	60
Fuel	UO_2 or MOX
Duration of the fuel campaign [month]	18÷24
Amount of fuel [t UO_2]	95.97
Reactor containment	
Inner diameter of the cylinder body [mm]	4038.6
Depth of wall of cylinder body [mm]	203
Total height [mm]	13944
Main circulation pumps	
Number	4
Nominal debit [m^3/h]	17886
Volume compensator	
Total volume [m^3]	59.5
Design-based pressure [MPa]	17.1
Steam generators	
Number	2
Type	Vertical with pipes in the U form
Maximum outer diameter [mm]	6096
Total height [mm]	22460
Inner hermetic shell	
Make	Steel
Volume [m^3]	58333
Outer protective shell	
Make	Steel concrete

2.3.2.2 REACTOR AES-2006

AES-2006 is water pressurised reactor with power 1200 MW. This is the newest design of the Russian company Atomstroyproekt, by the Russian State company Rosatom. This design is based on the design and the experience of the operation of reactors WWER-1000 and further develops the design AES-92. The design AES-2006 is licensed in Russia. At this moment the design AES-2006 is in the process of construction in Leningrad – model V-491 and in Novosibirsk albeit a different model – V-392M.

The safety functions of AES-2006 have been improved in comparison with the nuclear power plants AES-92. In the AES-2006 both the passive and the active systems are used to fulfil safety functions. In addition, AES-2006 has systems for management of sever accidents. The nominal operational life of the nuclear power plant is 60 years. With AES-2006 the construction protection against impact by large airborne vessel is concentrated in the inner hermetic construction and storage of fresh fuel.

A nuclear power plant with reactor of the AES-2006 type includes the following main equipment and systems:

- → Pressurised water reactor with thermal power 3200 MW, with pressure of the coolant in the first contour 16.2 MPa, whereby the water with boron acid is coolant and moderator in the reactor. During operation the concentration of the boron acid varies. The fuel used is low enriched uranium dioxide;
- → For horizontal steam generators of the type PGV-1000MKP with pipe matrixes, fixed at great distance in corridor layout. Each steam generator produces (1602+112) t/h dry saturate steam with pressure of 7.0 MPa;
- → Four sets of main circulation pumps of the GTsNA-1391 type;
- → Main circulation pipelines with nominal diameter Dn 850;
- → System of pressure compensation;
- → Equipment of the concrete containment of the reactor;
- → Safety systems.

The safety systems of the AES-2006 (B 491) consist of four entirely independent channels. The capacity, the quick action and the other characteristics of the lines are chosen on the basis of the condition for ensuring nuclear and radiation safety at any initial events foreseen in the design. Thanks to the fact that the channels of the safety systems are situated in separate shells, a high level of physical separation is achieved. Each channel of the safety systems is separated from any other by fireproof physical barriers along their whole length, including the joints from on premise into another (***Figure 2.3-10:*** *AES-2006 (B 491) Physical separation of the safety channels*). The direct connections between the different channels are not allowed. A physical protection of the safety systems is foreseen against unauthorised access of the staff.

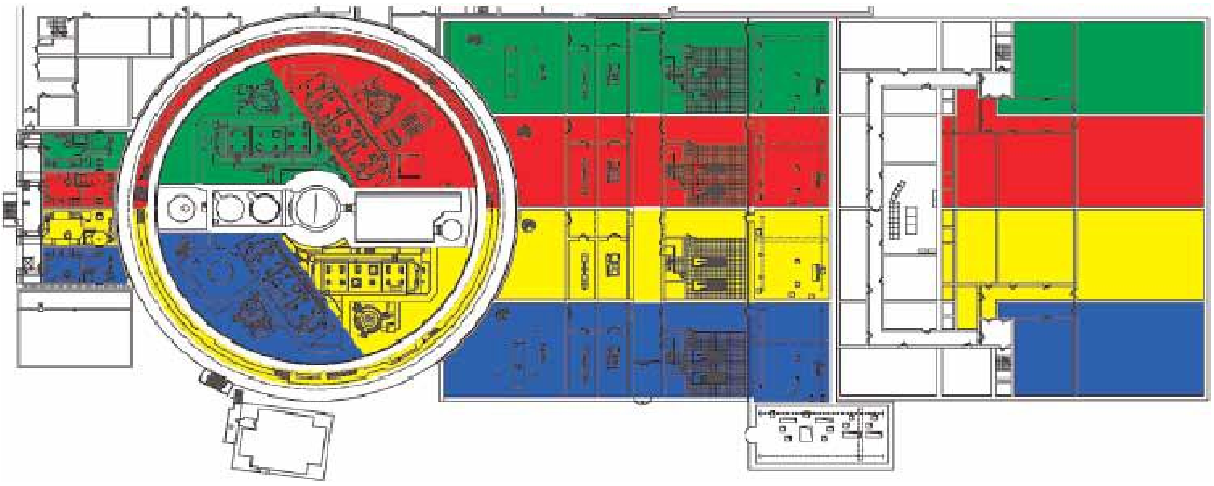


FIGURE 2.3-10: AES-2006 (B 491) *PHYSICAL SEPARATION OF THE SAFETY CHANNELS*

(Shown in different colours)

Thanks to the engineering solutions in the design of AES-2006 with WWER-1200, no heavy accidents above the design-based may occur at overlay of several single and consecutive failures of components of the safety systems. Such accidents may occur only in case of failure of several channels of the safety systems, which is a rare event.

The localisation systems are aimed at prevention of or curbing the spreading of radioactive substances (as a result of accidents) within the boundaries of the nuclear power plant and their emission into the environment. In principle, the inner hermetic construction (the containment) is a cylinder of pre-stressed reinforced steel concrete with semi-spherical upper part and a steel-concrete plate as foundation. Inner side is metal-clad with welded sheets of carbon steel to ensure hermetism. The outer hermetic construction represents a cylinder of steel-concrete with semi-spherical upper part. The inlets of all pipelines are firmly fixed to the walls of the inner shell and are welded to the steel casing. All inlet pipes are equipped with localisation valves (***Figure 2.3-11****: Hermetic casings AES-2006*).

FIGURE 2.3-11: HERMETIC CASINGS AES-2006

The main details of AES-2006 are as follows:

General data

Electric Power, gross [MWe]	1170
Electric Power, net [MWe]	1082
Thermal Power [MW]	3200
Effectiveness [%]	34
Operation regime	Basic and following load
Design-based term of operation [year]	60
Availability [%]	> 90
Construction time [month]	54
Damage frequency of the active zone [1/г]	$< 1 \times 10^{-6}$
Frequency of early large emissions [1/г]	$< 1 \times 10^{-7}$
Systems of removal of residual energy	4 channels – active and passive
Feeding systems	4 channels – active and passive
Meltdown catcher	Yes
MP3 [g]	0.25

General data

First contour	
Number of main circulation circles	4
Debit of first contour [m³/s]	23.9
Operational (nominal) pressure [MPa]	16.2
Second contour	
Steam debit under nominal conditions [kg/s]	1780
Steam temperature/pressure [°C/MPa]	286 / 7
Reactor active zone	
Height of active zone [m]	3.73
Equivalent diameter of active zone [m]	3.16
Number of fuel bundles	163
Fuel bundle	Hexagonal
Maximum fuel enrichment [%]	5
Number of bundles with absorption elements	121
Average depth of burning [MWd/kg]	60
Fuel	UO_2
Duration of fuel campaign [month]	12÷24
Fuel amount [t UO_2]	87
Reactor containment	
Inner diameter of cylinder body [mm]	4250
Wall thickness of cylinder body [mm]	200
Total height [mm]	11185
Main circulation pumps	
Number	4
Nominal debit [m3/h]	21500
Volume compensator	
Total volume [m³]	79
Design-based pressure [MPa]	17.6
Steam generator	
Number	4
Type	Horizontal with pipes in the U form
Maximum outer diameter [mm]	5100
Total length [mm]	13820
Inner hermetic shell	
Make	pre-stressed reinforced concrete with steel casing
Volume [m³]	74169
Outer protection shell	
Make	Steel-concrete

2.3.3 SPENT NUCLEAR FUEL

Each of the considered alternatives for nuclear unit envisages in its design spent fuel Pool. In this type of pool the fuel lies from 3 to 5 years, and then it can be transported out of the facility. The Spent fuel pool provides space for placement of the fuel bundles during repair of the unit and for storage of activated components under water. The requirements to the spent fuel pool in relation of safety are to ensure subcriticality of 5% in the regime of normal operation and during design-based accidents... this requirement is ensured by:

- → Limitation of the nest steps for storage of the spent fuel pool;
- → Control over the layout of the bundles with spent fuel pool and limitation of the possible displacement during transportation at the site, manipulation and storage of the spent fuel pool in conditions of normal operation and under external impacts;
- → Control of the parameters of the systems (elements), which influence the nuclear safety in the spent fuel pool management.

Data on the pools foreseen in the design of the New Nuclear Unit are presented in ***Table 2.3-2:*** *Spent fuel pool*.

TABLE 2.3-2: *SPENT FUEL POOL*

MODEL	Location of the spent fuel pool	Number of fuel bundles in the active zone	Capacity of spent fuel pool (number fuel bundles)	Duration of the fuel campaign and part of active zone for re-charging	Approximate total capacity	Cooling system of the spent fuel pool	Additional cooling system	Cooling system for state above design-based
AP-1000	**Special casing outside the containment**	157	889	18 months 1/3 of the active zone	17 x 1/3 of the active zone	Passive	Active system of cooling and filtration	Yes
AES-92 Hybrid	**In the containment**	163	580	12 months 1/3 of the active zone	10,7 x 1/3 of the active zone	Passive	Sprinkler system in the cointainment	See previous
AES-2006	**In the containment**	163	(*)	18 months 1/3 of the active zone	Approximately 10 years	Passive	(*)	(*)

(*) No data at this moment

The management strategy of the spent fuel and radioactive waste in the Republic of Bulgaria envisages open fuel cycle. Actually this decision is no cycle. Once the fuel is used, it is deposited in a facility for storage without further processing; it is only packed in order to ensure better isolation of the radioactive substances from the biosphere. This method has been preferred by six states: the United States, Canada, Sweden, Finland, Spain and South Africa. In some states, notably Sweden and Canada, such depot have been designed in order to make possible future use of the nuclear material where need arises, while other states plan permanent burial in a geological depot. In the Republic of Bulgaria the spent fuel is considered usable resource, which can be processed and bring benefits for the country. The strategy envisages storage of the spent fuel in intermediate depots, the preferred technology been dry storage.

The existence of depot for dry storage of the spent nuclear fuel concerning the proposed models is important, particularly until depot is provided or if decision is taken in favour of the strategy “Let us wait and see”.

The considered alternatives for the New Nuclear Unit propose different solutions for dry storage of the spent fuel:

With **AES–92** the dry storage depot is a separate building with capacity covering the work of a unit for 20 years (72 containers). With the existing designs of WWER-1000/V466B the facility is shared by the two units and it is presumed that it could be extended and makes its capacity sufficient for the entire operational life.

In the pools at the reactor the fuel is placed in containers CASTOR1000, which are transported to depot for dry storage.

AP-1000 has at its disposal conceptual designs for depots for dry storage, covering the entire operational life of the nuclear unit. Especially for the UK generic design assessment, Westinghouse proposes underground depot with storage of the fuel in containers HI-STORM 100U developed by Holtec international. In one or another case there are various dry storage systems available on the market.

2.4 ZERO ALTERNATIVE

In view of the government decision to withdraw from “Belene” Project and from building a NNU at the Kozloduy NPP site using the nuclear equipment manufactured for “Belene” Project, and in compliance with the CoM decision with Protocol No. 14 of 11.04.2012 on principle concent for undertaking the actions necessary for the building of the NNU in Kozloduy NPP, the zero alternative is not really a possible option.

In this sense, the following two opportunities are available:

1. To look for another site in the country where the necessary NNU can be built;
2. To put an end to all investigations and actions associated with the building of NNU in the country.

The first option can be discussed theoretically. Kozloduy NPP is the only operating and licensed site where the greater part of additional infrastructure needed for building a NNU is built.

In fact "Zero" alternative, or the decision to give up any actions for the realization of this investment intention at the Kozloduy NPP site means withdrawal from building a NNU in the country in the near future. Such a decision is in contradiction with the set objectives in the National Energy Strategy of the country for the introduction of new nuclear power capacities and increasing the share of the electrical power produced in NPP by 2020.

From the above mentioned two options, the second one is really possible only if considered separately from the energy needs of the country. For the energy power sector giving up the building of a NNU means building of another electric power facility 1000 – 2000 MW. Taking into consideration the energy resources of the country, the necessary new energy power will most probably be produced by TEPPs which are located elsewhere. This will require investigation of another site, new design, technical works, preparation of the site and construction according to the accelerated time-schedule in view of constructing a new 2000 MW TEPP.

"Zero" alternative impact on environment

Building of a new facility to replace the "Kozloduy" NPP in case of giving up nuclear power can theoretically be realized in different ways. The most probable one is building a new TEPP having in mind the energy resources and energy consumption-energy production balance of the country.

Building a new 1000 – 2000 MW TEPP will cause problems in the energy sector in two directions at least:

- New TEPP of the indicated power means a new big fuel installation (BFI) meeting the requirements of Directive 2001/80/EC on limiting the BFI emissions of certain pollutants in the atmosphere. Building of a TEPP using lignite coal is more realistic and profitable but investigations show that with using such coal the released emissions exceed the admissible level. Therefore, it is unrealistic and impossible to build a new TEPP with such power using lignite coal provided that the directive's requirements cannot be met. A TEPP of such power, using imported high quality coal or imported natural gas is not probable to be economically preferred;
- Building a new BBI-TEPP of 1000 – 2000 MW using lignite coal will mean increase of gas emissions causing greenhouse effect and reduction of Bulgaria's possibility of meeting its obligations under the UNFCCC and IPCC, as well as other international agreements and programmes for environment protection.

To analyze the impact on environment in these two directions, some data from global and national aspect have to be presented.

On one side it is necessary to emphasize that in the present century the energy needs and the installed energy power plants worldwide are expected to increase. This will lead to abrupt increase in burning up conventional fuels which will increase still more the global negative impact related to greenhouse gases and change of climate.

In this situation, reducing the impact on environment to the minimum, and also saving of greenhouse gases with every new power plant acquire specific significance especially in continental/regional and national aspect. We emphasize the latter taking into account the obligations under the UNFCCC and Kyoto Protocol, etc.

Within this context, a comparison will be made between power production by TEPP and NPP.

The controlled nuclear reaction of fission of small quantities of uranium fuel produces enormous power and comparatively small volume of radioactive waste. Compared to the plants using coal, the volume of waste in a NPP is over 30 000 times smaller than this in the TEPP.

By comparing the produced domestic product per unit of CO2 release, the effect on reducing emissions with widely used nuclear energy is especially obvious. The data obtained from 6 countries in the world that account for over 60% of the world economy and are populated by almost half of the world population show that the quantities of CO_2 emissions are in inverse proportion to the relative share of the nuclear power engineering in the respective national power branch. All the more that the experience of the USA – the greatest CO_2 emitter in the world – shows that over 75% of the whole quantity of the "saved" emissions in power production are due to nuclear power production and less that 1% – to the solar and wind energy.

These examples of the nuclear power production role in the "power production – environment" system, as well as the many publications in this field of a series of international organizations such as MAAE, Euroatom, World Nuclear Association and other, demonstrate the proportion of impacts on environment and the conclusions from them are applicable to a great extent to any country.

At present, under the current conditions in our country, we have to emphasize the Bulgarian government's commitment in the field of power production and environment in view of closing "Environment" Chapter at the preparation for the negotiations on Bulgaria's accession to the EU, more specifically, for the accomodating in the Bulgarian legislation of Directive 2001/80/EC on limiting the emissions of some pollutants of the air from big fuel installations (BFI). On the other side, building of a new 2000 MW facility is related to fixed terms under the Plan for development with minimum expenses of the energy sector of the Republic of Bulgaria in the period 2004-2020.

In order to compare the impact on environment of a new TEPP using lignite coal with comparable power to that proposed by the Investment proposal for the construction of "Kozloduy" NPP, the real parameters will be used of the impact of the biggest operating

TEPP in the country – "Maritsa – Iztok" 2 TEPP, though its installed power 1587 MW is by 24.4 % higher than the envisaged 1 200 MW at theKozloduy NPP site.

The conducted investigation in the country with regard to the opportunity of applying Directive 2001/80/EC shows that "Maritsa – Iztok" 2 TEPP is the greatest power source of SO_2 ranking fourth by NO_X emissions, accounting for 44% and 11% of these emissions respectively. From this point of view the building in the country of another great source of emissions is not acceptable, especially having in mind the obligations of the country for reducing the SO_2 emissions.

To evaluate the impact of saving "greenhouse gases emission" from "Kozloduy" NPP versus equal power TEPP using lignite coal, one only example of "Maritsa – Iztok" 2 TEPP is sufficient:

The installed electric power of "Maritsa – Iztok" 2 TEPP after the rehabilitation of units 1 – 6 got increased and reached 1600 MW[19]. For the period 1996 – 2000 the station uses averagely 6.995 million tons of coal per year from Maritsa-Iztok coal mine. At average calorific capacity of coal 6.12kJ/g and C=18.4%, the calculated average annual CO_2 emissions amount to about 4.724 million tons. These emissions are 38% of the reduction of greenhouse gasses emission required by Kyoto Protocol – 12.4 million tons CO_2-eqiv. It is evident that from this point of view, the building of another powerful source of emissions in the country is not acceptable either. It will increase the annual CO_2 emissions from Bulgaria by about 4.7 million tons.

We can summarize that as far as emissions of greenhouse gasses, of SO_2, $NO_{X,}$ dust, etc. are concerned, the "zero" alternative, namely to replace the NNU at the Kozloduy NPP site not releasing such hazardous substances to the atmosphere by a TEPP of equal or even less power is not expedient.

[19] http://www.tpp2.com/page/equipment-and-installations.html

3 CHARACTERISTICS OF THE ENVIRONMENT IN WHICH THE INVESTMENT PROPOSAL WILL BE IMPLEMENTED, AND AN ESTIMATE OF THE IMPACT

3.1 CLIMATE AND ATMOSPHERIC AIR

3.1.1 CLIMATE

The region under consideration around the Kozloduy NPP is situated in the western parts of two climatic regions according to the climatic zoning of Bulgaria – the Northern and Middle climatic region of the Danube Hilly Plain in the Moderate-Continental climatic sub-region.

The climate in this region is characterized as markedly continental due to the abrupt contrast between the winter and summer thermal conditions. The average annual air temperature amplitude is between 24.5°C and 26°C – the highest for the country. The continental nature of the climate is also confirmed by the precipitation regime in the region. The annual precipitation is between 540 mm and 580 mm, where the maximum is in June and the minimum – in February. The difference between the precipitation total for the three summer months and the three winter months is between 70 mm and 120 mm, i.e. 15% – 20% of their annual total. The absolute maximum 24-hour precipitation in the summer is approximately 100 mm – 130 mm. However, summer rains are grouped in certain days and particularly in the second half of the summer there are dry spells. In both summer and autumn there are 4-5 periods without precipitation, with a duration of over 10 days and an average duration of 16-20 days. In some years, even longer draught periods are observed.

In the parts of the region to the west of the Ogosta River, the influence of the Balkan Mountains can be felt. It is reflected in the annual precipitation distribution, where the seasonal precipitation totals are almost identical, without abrupt extremities, which results from the relative increase of winter precipitations and decrease of summer precipitations.

The dynamics of air transfer in the ground layer is characterized by the wind rose. The indented relief and proximity of the Danube River, which is considered as a big aeration channel, have a significant effect on local climate. This results in the appearance of material inhomogeneities in the fields of the meteorological elements and especially of those which exhibit pronounced sensitivity to the shape and location of the terrain, such as the minimum temperatures and the ground wind. The establishment of these inhomogeneities is of great significance for many meteorological tasks and, in particular, for the spread of pollutants in atmospheric air.

Till 1997 the climatic profile of the region was based on data determined using statistics from the regular climatic observations of the Kozloduy station, conducted during the period 1970–1982, as well as those of the Lom station. After 1997, real meteorological data has been used, obtained from three meteorological stations, corresponding to class III, united in an Automated Meteorological Monitoring System (AMMS). The first of them was installed at an external radiation control site, representative of the observed region (Automatic Measurement Station – External Radiation Control [AMS–ERC]), and the other two were positioned within the "Blatoto" (The Swamp) area and in the village of Harlets.

The assessment of the local climate of the region is mostly based on reports on tasks assigned by the Central Office of the "Meteorological Systems and Equipment" consortium, as well as official online publications.

3.1.1.1 CLIMATIC PARAMETERS

3.1.1.1.1 Air Temperature

The average annual air temperature in the examined region for 2009, 2010 and 2011 [20] was about 13°C.

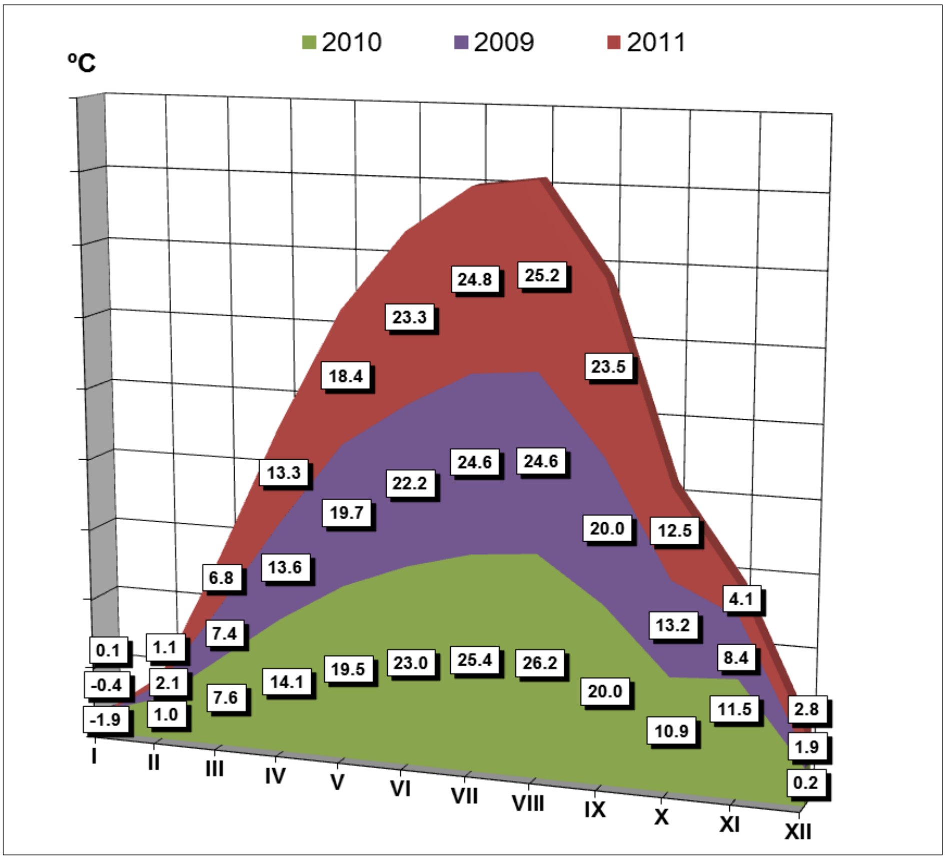


FIGURE 3.1-1*: AVERAGE MONTHLY TEMPERATURE FOR THE PERIOD 2009÷2011*

A maximum in the annual course of the average monthly temperatures is observed in August (from 25.2°C to 26.2°C) and a minimum – in January (from 0.1°C to minus 1.9°C). The average temperatures for the three years during the winter season is about 0.8°C,

[20] Reports on the Local Meteorological Conditions in the area of the Kozloduy NPP, 2009, 2010 and 2011.

and for the summer season – from 24.4°C. In autumn and spring the temperature average is 13°C (***Figure 3.1-1***: Average monthly temperature for the period 2009÷*2011)*. ***Figure 3.1-2***: Temperature gradation roses for 2009*,* ***Figure 3.1-3***: Temperature gradation roses for 2010 and ***Figure 3.1-4***: Temperature gradation roses for 2011*,* present the frequency of temperature gradations across 10 degrees in the 16 sectors of the wind direction for the period 2009÷2011, the so-called "temperature gradation roses".

The greatest percentage is held by the temperatures within the range from +5°C to +15°C with north-northeast and south winds (above 3% individually). The positive temperatures (above 0°C) exceed 80%, and the average monthly temperature during the warmest month (August) for 2009 was the lowest out of the three years – 24.6°C (see ***Figure 3.1-1***: Average monthly temperature for the period 2009÷*2011*).

In 2010, the greatest percent belongs to temperatures in the range +15°C to +25°C with west-southwest winds (3.7 %). The positive temperatures (above 0°C) exceed 86 %, which shows that 2010 was much warmer than 2009. The average monthly temperature during the warmest month (August) was the highest – 26.2°C (***Figure 3.1-1***: Average monthly temperature for the period 2009÷*2011*).

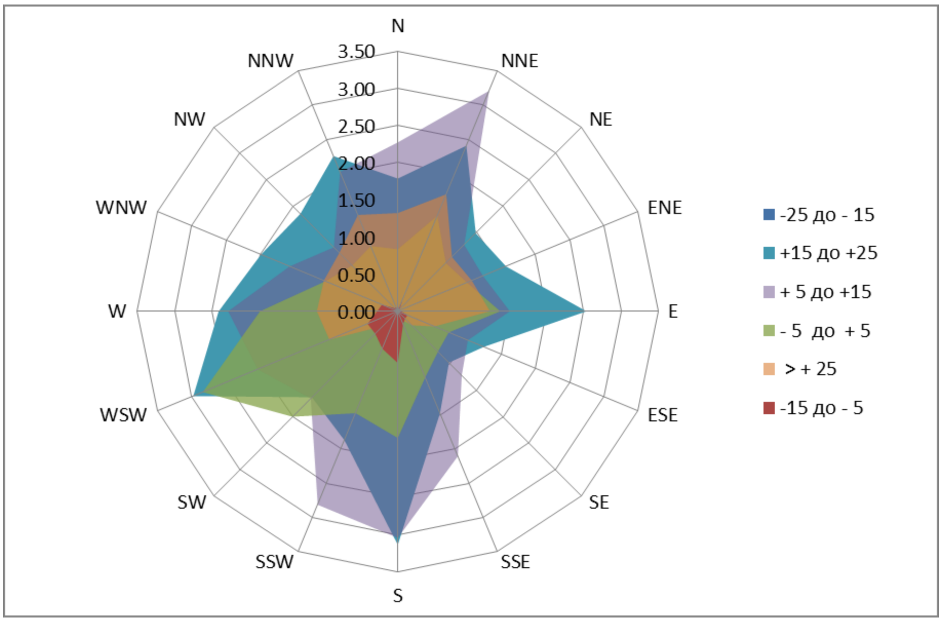


FIGURE 3.1-2*: TEMPERATURE GRADATION ROSES FOR 2009*

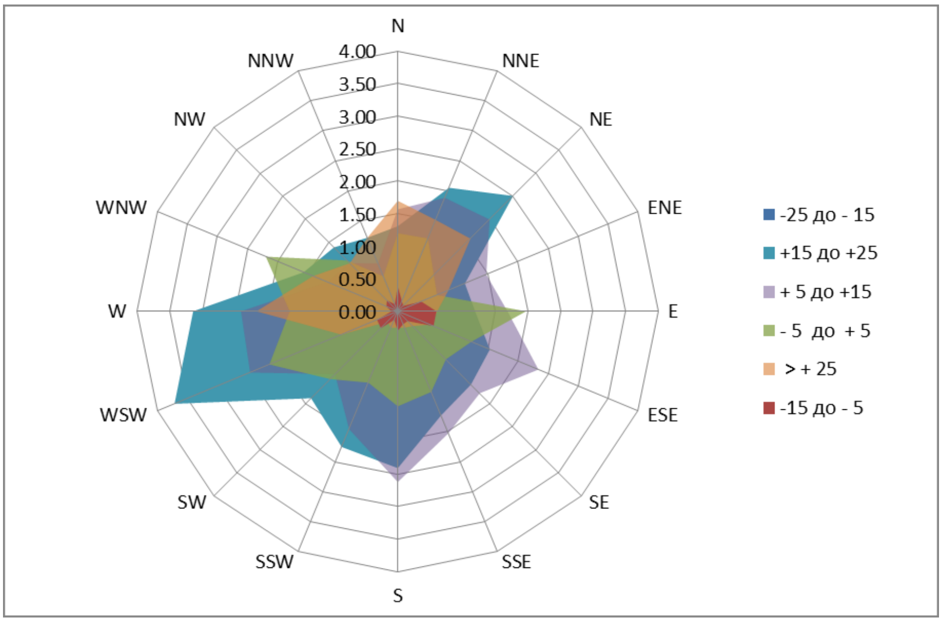


FIGURE 3.1-3: ***TEMPERATURE GRADATION ROSES FOR 2010***

In 2011 we observe many cases of temperatures within the range from +15°C to +25°C under purely south winds (4.7%), and despite that fact, the positive temperatures (above 0°C) were just 75 %.

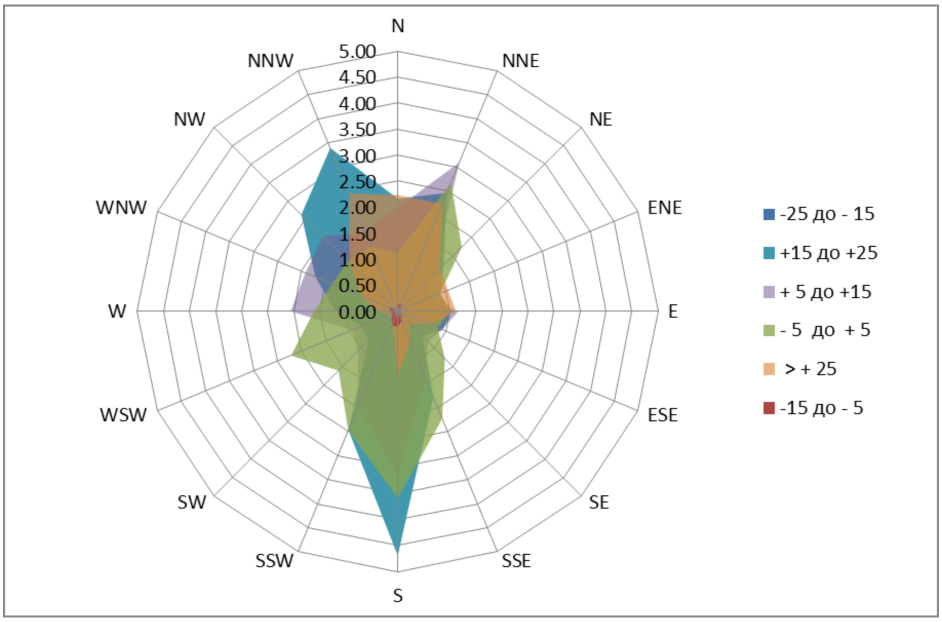


FIGURE 3.1-4: ***TEMPERATURE GRADATION ROSES FOR 2011***

Table 3.1-1: Extreme temperatures for 2009, 2010 and 2011**,** presents the extreme temperature values for the Kozloduy NPP area for 2009, 2010 and 2011. The column "Date [hour:min]", shows the date and the exact time of their recording.

TABLE 3.1-1: *EXTREME TEMPERATURES FOR 2009, 2010 AND 2011*

T [°C]	Minimum °C	Date [hour:min]	Maximum °C	Date [hour:min]
2009	-16.3	05.01.2009 [08:24]	38.8	24.07.2009 [17:50]
2010	-19.3	26.01.2010 [00:41]	39.8	28.08.2010 [16:50]
2011	-11.7	26.01.2011 [07:28]	38.9	16.07.2011 [15:23]

3.1.1.1.2 Precipitation

Table 3.1-2*:* Annual precipitation (mm) for a period of 8 *yearsyears* presents the total annual precipitation for a period of 8 years – 2004÷2011 based on the reports on the **Local Meteorological Conditions for the Kozloduy NPP area** for these years.

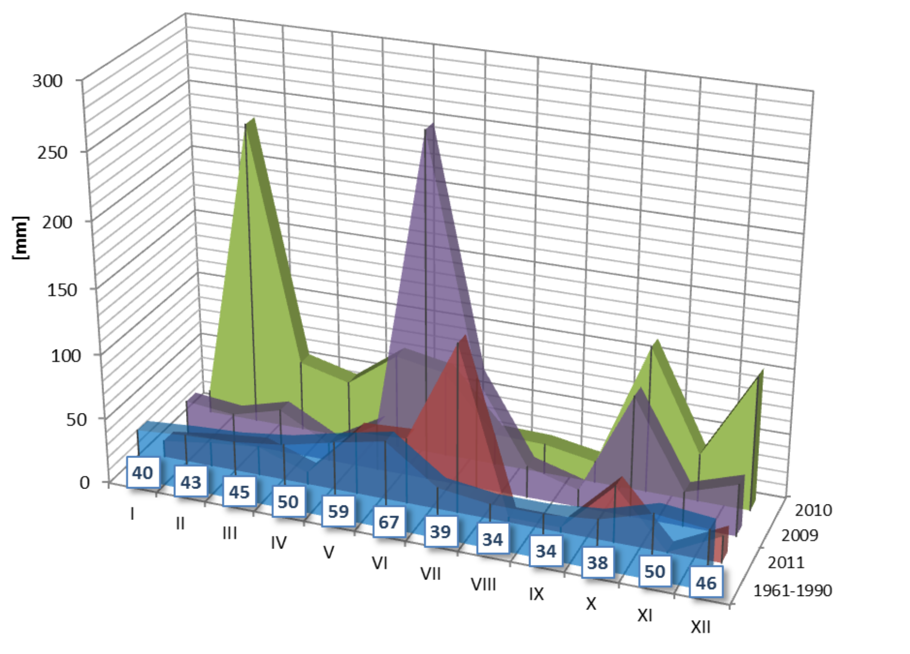
TABLE 3.1-2: *ANNUAL PRECIPITATION (MM) FOR A PERIOD OF 8 YEARS*

Year	Amount in mm	Year	Amount in mm
2004	**305.5**	**2008**	**422.2**
2005	**532.8**	**2009**	**676.7**
2006	**234.0**	**2010**	**801.8**
2007	**518.8**	**2011**	**363.2**

The averaged annual precipitation total for the period of 8 years is 481.9 mm, which is below the climatic norm (1961–1990)[21] for the precipitations in the region – 545 mm.

Figure 3.1-6: *Deviations of the monthly precipitation totals (mm) for the period 2009÷2011 from the climatic* norm – *climatic anomalies* shows the deviation of the monthly precipitation total from the climatic norm.

[21] The World Meteorological Organisation has defined the climatic norm as the average value of a given climatic element for a fixed baseline period of 30 years. The baseline periods adopted so far are 1901-1930, 1931-1960, 1961-1990.



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1961-1990	40	43	45	50	59	67	39	34	34	38	50	46
2011	12.9	18.4	22.3	9.3	48.4	50.5	129.6	3.8	3.8	43.2	0.5	20.5
2009	26.7	22.9	33.3	13.3	35.4	263	85.4	24.1	13.3	92.7	26.7	39.9
2010	17.6	233.4	54.1	44.5	72.4	65.6	23.8	22.8	16.2	112.2	36.4	102.8

FIGURE 3.1-5: PRECIPITATION FOR THE PERIOD 2009÷2011 AND CLIMATIC NORM FOR 1961-1990

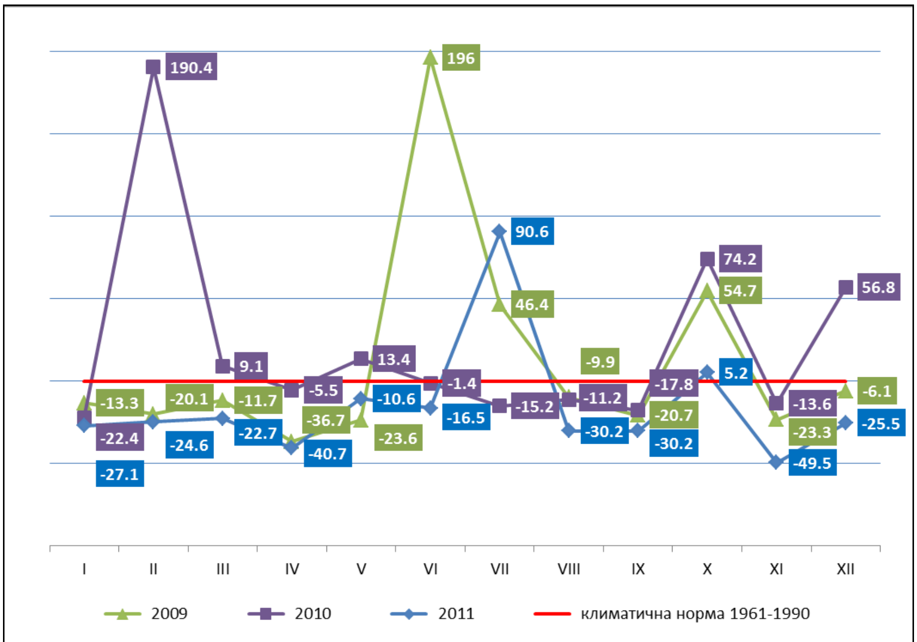
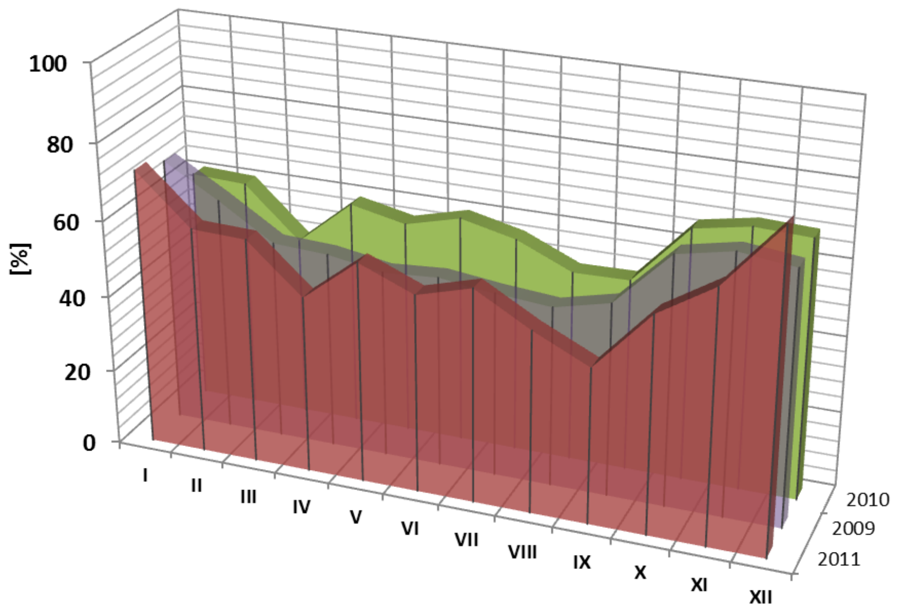


FIGURE 3.1-6: DEVIATIONS OF THE MONTHLY PRECIPITATION TOTALS (MM) FOR THE PERIOD 2009÷2011 FROM THE CLIMATIC NORM – CLIMATIC ANOMALIES



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2011	72.7	59.7	59.2	46.5	57.9	52.0	56.1	47.9	41.0	56.9	66.0	82.8
2009	69.7	61.4	52.4	51.7	49.3	50.3	48.6	47.4	50.9	65.5	68.5	66.8
2010	60.9	60.3	47.2	59.1	56.1	59.8	56.5	50.2	50.5	66.0	68.7	68.1

FIGURE 3.1-7*: RELATIVE HUMIDITY FOR THE PERIOD 2009÷2011*

3.1.1.1.3 Relative humidity

A relative humidity above 60 % is observed during the winter months and in the last 2 autumn months. The maximum of the relative humidity was observed in December of 2011 (above 82 %), despite the fact that for this year the average relative humidity was lower than that for 2009 (**Figure 3.1-7***: Relative humidity for the period 2009÷2011*).

In August, the frequency of the incursions of fresh and moist Atlantic air is relatively low, and that is why this is the time when the lowest values of relative humidity are observed.

3.1.1.1.4 Wind

The dynamics of air movements in the surface layer is characterized by the wind rose – the wind speed and wind direction, 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. The hilly relief leads to the redistribution and deformation of the air flow, resulting in changes to both wind speed and the frequency of the dominant directions. For a region like the reviewed one, the proximity of a large water basin, such as the Danube River (an aeration channel), also exerts some impact.

***Figure 3.1-8*: Wind** rose for 2009*,* ***Figure 3.1-9*:** Wind rose for 2010 and ***Figure 3.1-10*:** Wind rose for 2011, show the wind rose for the gradation of the wind velocity in 2009, 2010 and 2011. The area of the coloured fields for the different ranges of wind velocity indicates the percentage of the share of the velocities in this range for all cases of wind during the year.

The percentage of "calm conditions" (the cases of wind velocity below 1 m/s) is 8.8%, 5.2% and 7.7%, accordingly.

In 2009, the greatest component was the southern one at low wind speeds between 2 and 2.9 m/s (their share in all speeds being 29.6%), and in the range between 3 and 4.9 m/s, the greatest frequency was that of northeast winds (***Figure 3.1-8*: Wind** rose for 2009*)*. The share of the winds in the range 1÷7 m/s is 97.8% of the cases.

In 2010, the greatest component was the western one at wind speeds between 3 m/s and 4.9m/s (their share in all speeds being 30.4 %) and between 5 m/s and 6.9 m/s (***Figure 3.1-9***: Wind rose for 2010). The share of the winds in the range 1 m/s ÷7 m/s is 96.9 % of the cases.

In 2011, the greatest component was the southern one at wind speeds between 1 m/s and 1.9 m/s (their share in all speeds being 31 %) (***Figure 3.1-10***: Wind rose for 2011). The share of the winds in the range 1 m/s ÷7 m/s is 97.9 % of the cases.

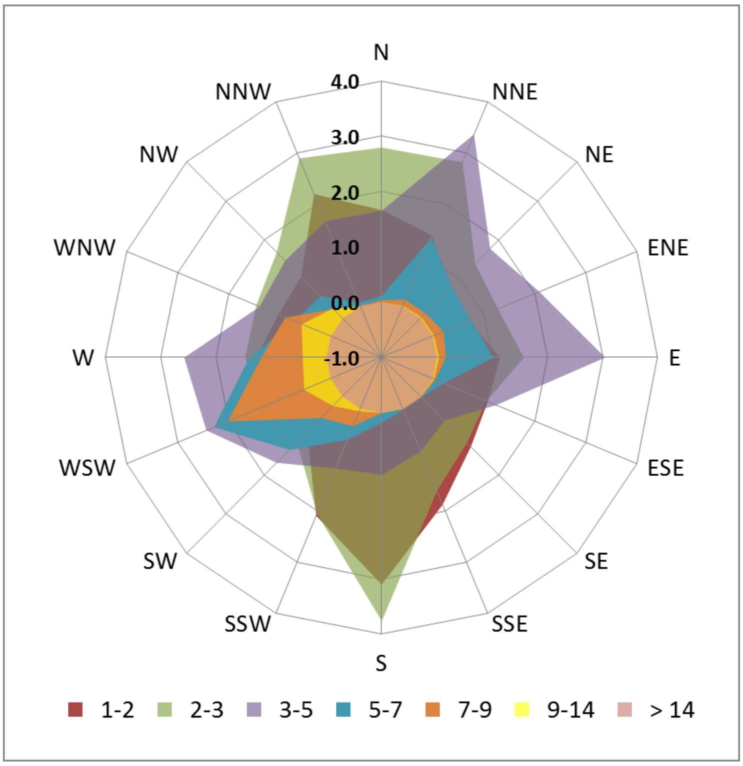


FIGURE 3.1-8*: WIND ROSE FOR 2009*

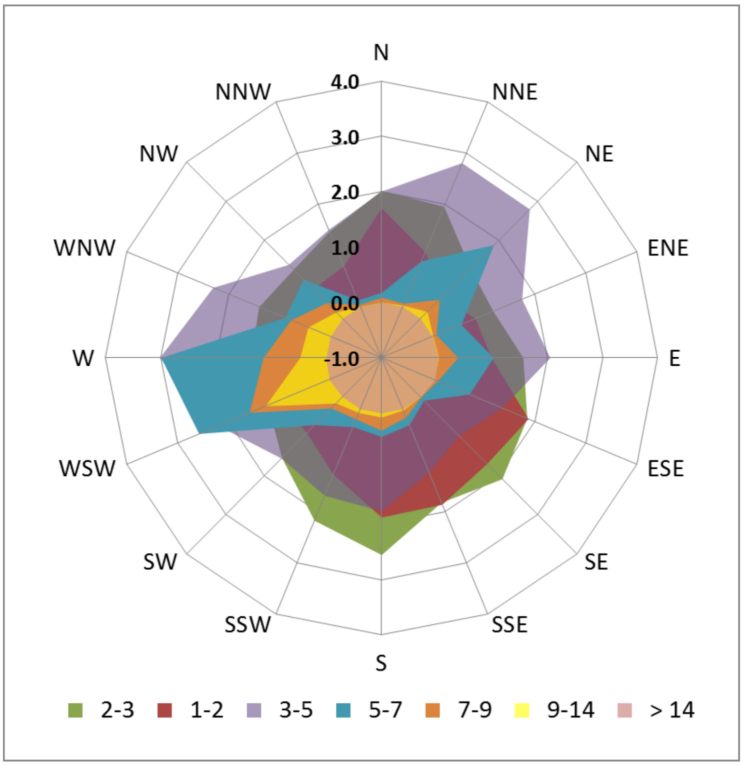


FIGURE 3.1-9: ***WIND ROSE FOR 2010***

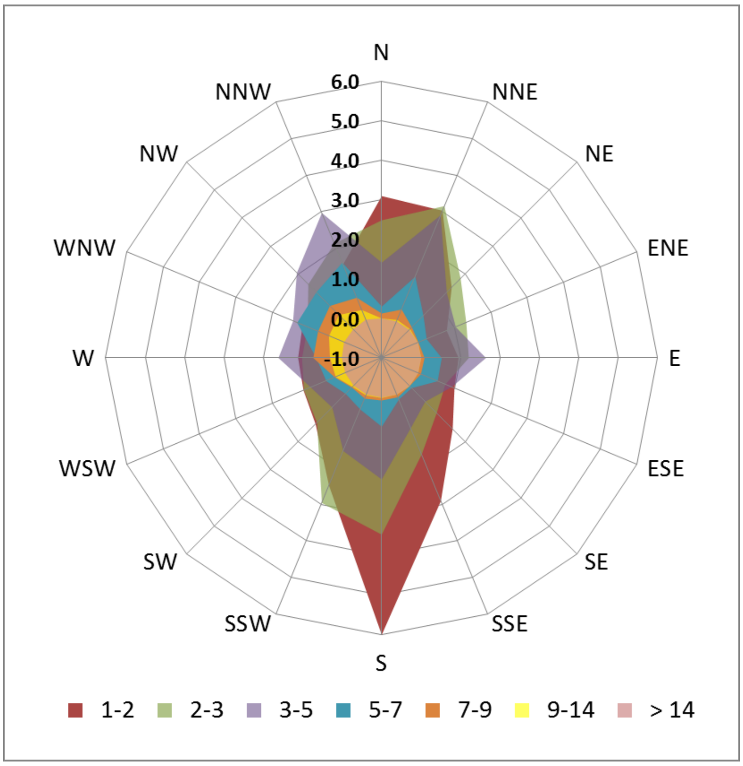


FIGURE 3.1-10: ***WIND ROSE FOR 2011***

Extreme wind speeds are presented in ***Table 3.1-3***: Extreme speeds for 2009, 2010 and 2011*.* It is worth noting that, apart from these three years, they always come only from the north[22].

TABLE 3.1-3: *EXTREME SPEEDS FOR 2009, 2010 AND 2011*

	Maximum	Date [hour:min]
2009	34.6 m/s from the direction 357º (north)	21.03.2009 [12:10]
2010	26.0 m/s from the direction 357º (north)	09.12.2010 [22:35]
2011	23.5 m/s from the direction 357º (north)	28.11.2011 [14:58]

3.1.1.1.5 Annual characteristics of Pasquill atmospheric stability classes for the area of the Kozloduy NPP

For the purpose of calculating the radiation exposures in the area of the Kozloduy NPP, we should have information about the state of atmospheric turbulence, which determines the possibility for the spreading of impurities in atmospheric air. The majority of the diffusion models usually use the Pasquill atmospheric stability classes. There are 6 atmospheric stability classes: ***A – very unstable***, ***B – unstable***, ***C – slightly unstable***, ***D – neutral stratification***, ***E – slightly stable*** and ***F – stable***.

Under unstable conditions (classes **A**, **B** or **C**) of the atmosphere, pollutant diffusion takes place very quickly because of the strong turbulence in the vertical direction, which results in the quick vertical mixing of the pollutants with the ambient air masses. Although these conditions are favourable for pollutant diffusion, single occurrences of large ground concentrations may be observed near the source at small wind speeds in the early hours of the day in sunny weather.

Under stable conditions of the atmosphere (classes **E** and **F**) the absence of turbulence or the presence of very week turbulence prevents the spreading of impurities in the vertical direction or transports them in the horizontal one, but when the wind is very week or absent altogether, the pollution may stay for a long time in the area around the source. Such conditions occur in the presence of inversions in the late evening hours or at night.

The neutral condition of the atmosphere (class **D**) is observed in cloudy weather or on sunny days in the hours between the break-down of the inversions formed at night (increase of temperature with height) and the development of the unstable daily conditions. That is when lower ground-level concentrations are observed.

Figure 3.1-11: *Rose of Pasquill atmospheric stability classes for 2009*, ***Figure 3.1-12:*** *Rose of Pasquill atmospheric stability classes for 2010* and ***Figure 3.1-13****: Rose of Pasquill*

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atmospheric stability classes for 2011, show the stability class roses for 2009, 2010 and 2011 respectively. The coloured area for each stability class indicates the percentage share of the specific class among all classes observed during the year.

In 2009 the greatest share was that of slight atmospheric stability (class **E**) – 54.15%, the frequency of south winds being the highest – 6.8% – ***Figure 3.1-11:*** *Rose of Pasquill atmospheric stability classes for 2009* The share of neutral conditions – class **D,** was 32.5%, where the frequency of west-southwest winds was 4.8 %. Unstable atmospheric conditions (class **A**, **B** and **C**) have a share of just 8.7% of the cases.

In 2010, the greatest share was that of slight atmospheric stability (class **C**) – 28.6%, the frequency of western winds being the highest at 3.4% – ***Figure 3.1-12:*** *Rose of Pasquill atmospheric stability classes for 2010,* followed by class **E** with a share of 27.8%. The share of neutral conditions – class **D,** is 22.1%, where west-southwest winds are most common, at 3.4 %. The unstable atmospheric conditions (class **A** and **B**) have a share of 11.3% of the cases.

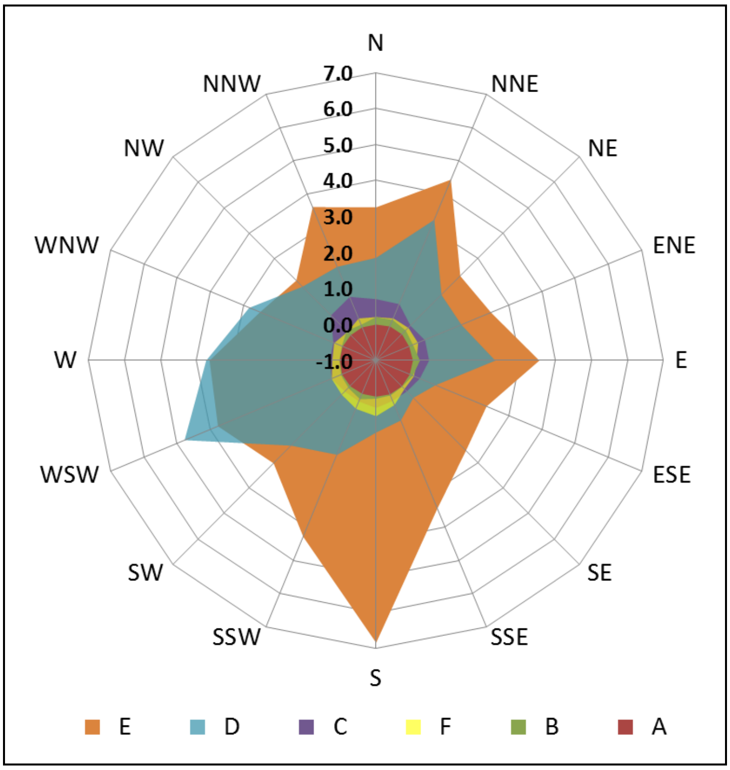

FIGURE 3.1-11: ROSE OF PASQUILL ATMOSPHERIC STABILITY CLASSES FOR 2009

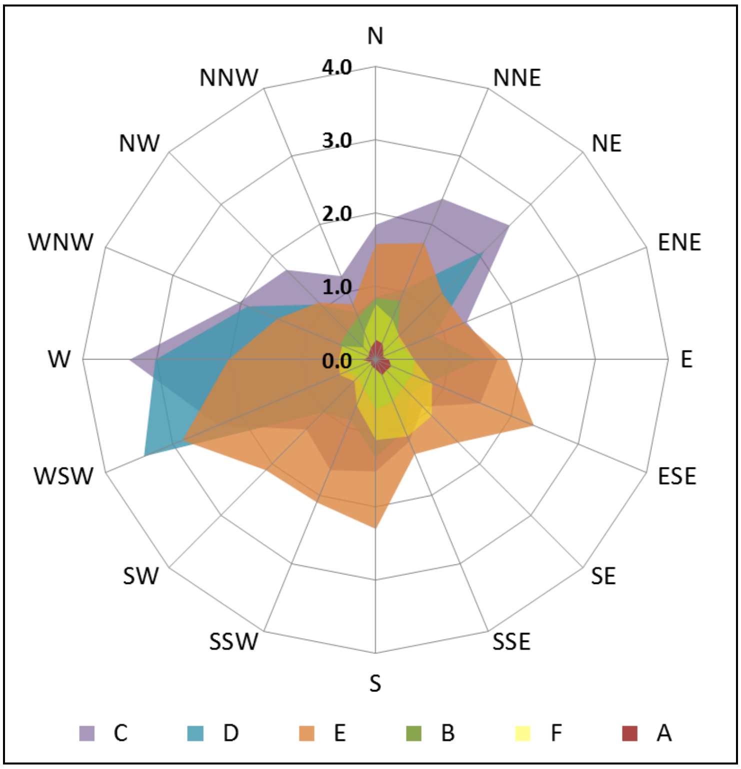

Figure 3.1-12: Rose of Pasquill atmospheric stability classes for 2010

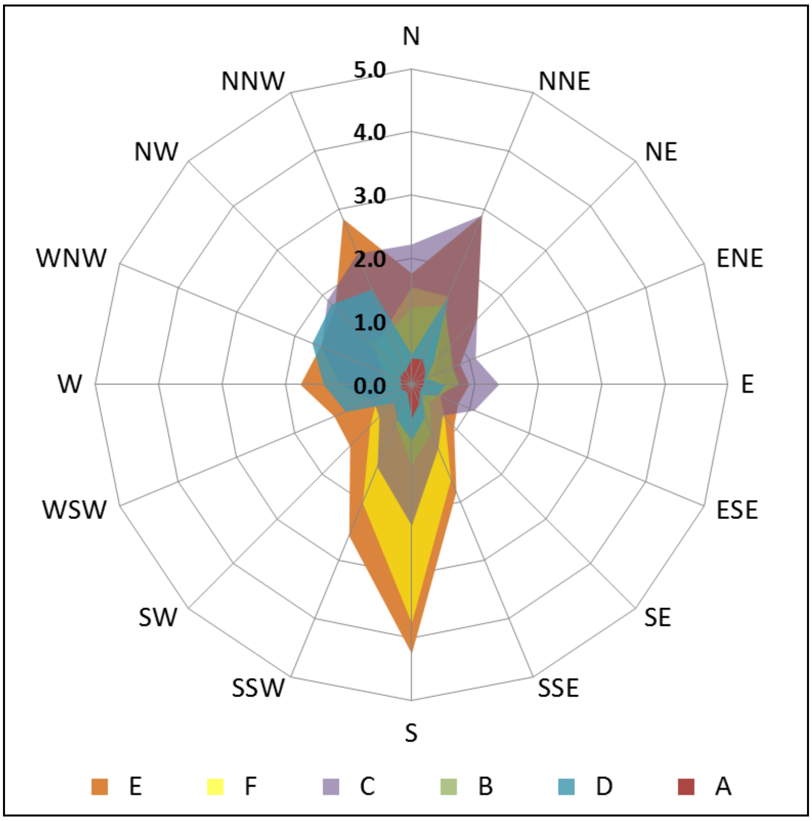

Figure 3.1-13: Rose of Pasquill atmospheric stability classes for 2011

In 2011, the greatest share was that of slight atmospheric stability (class **E**) – 28.6%, the frequency of southern winds being the highest at 4.2 % – ***Figure 3.1-13***: *Rose of Pasquill atmospheric stability classes for 2011,* followed by class **C** with a share of 23.7 %. The share of the class of the neutral conditions – class D, amounts to 14%, the frequency of the winds from the north-western quarter of the horizon being the highest. The unstable atmospheric conditions (class **A** and **B**) have a share of 15.9% in the cases.

3.1.1.1.6 Cloudiness

The amount and type of cloudiness is determined by the nature of the baric systems and their interaction with the relief. The annual course of cloudiness for the region is determined by the annual circulation course, the humidity course, and the air layer stratification. From the middle of autumn to the end of winter the amount of low and total cloudiness increases due to the increase of atmospheric stability and the decreased height of the condensation level. The maximum of the total cloudiness is observed in December – with a level of 7.4, and the number of "gloomy" days (with a cloudiness level of 8-10) – 17 days on average. During the cold half of the year the cloudiness is greatest in the morning hours and lowest in the evening ones.

The annual minimum of total cloudiness is in August when anticyclone weather prevails. Cloudiness is mostly convective. In the considered region the average total cloudiness level for August is 2.4-2.8. This is also the time when the maximum of the clear days is observed (cloudiness level of 0-2), which is about 50% of the days of the month. In August, the monthly number of cases with clear skies is the smallest (about 15) in the noon hours, and the greatest in the morning or evening hours (20-25).

3.1.1.1.7 Mists

The data from the Lom and Oryahovo stations regarding the number of misty days (***Table 3.1-4***: Number of foggy days by months and annually) is very close, which may be a good reason to assume that it is close to the actual characteristics of the region and specifically the Kozloduy NPP site.

TABLE 3.1-4*: NUMBER OF FOGGY DAYS BY MONTHS AND ANNUALLY*

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Lom	7.7	6.2	3.5	0.6	0.4	0.1	0.1	0.1	1.0	5.6	6.4	9.8	41.3
Oryahovo	7.8	7.0	3.4	1.2	0.7	0.7	0.5	0.3	0.7	4.7	7.3	10.1	44.5

It is characteristic for fog duration that throughout the year at Lom fogs usually last less than 24 hours. January is the only month during which 7 % of the fogs last 1-2 days, and only 1% of them last up to 2-3 days. In October only 4% of the fogs lasted 1- 2 days. The duration of fogs during the other winter months is within the same range. At Oryahovo, the percentage for January is somewhat different – 80% of the fogs lasting up to 1 day, 14% lasting 1-2 days, 5% lasting up to 2-3 days, and only 1% lasting more than 3 days.

The mentioned noticeable differences lead to the conclusion that there are no grounds to assume that the fog data from the adjacent stations are characteristic for areas of the Kozloduy NPP. Therefore, observations of the fog regime at the power plant site should be carried out. This is also valid for horizontal visibility.

3.1.1.1.8 Snow cover

Regarding the climatic characteristics of the *snow* cover in the area of the Kozloduy NPP, conclusions may be drawn from the data from the climatic stations of the NIMH-BAS, located in the region. The results from the climatic processing of this data are presented in their fullness in the "Climate Directory for the People's Republic of Bulgaria," volume 2 (1979) – ***Table 3.1-5****:* Climatic characteristics of snow cover***.***

Table 3.1-5: ***Climatic characteristics of snow cover***

Snow cover (SC) parameter	Lom	Oryahovo
Average SC height in cm	XII – 5÷9; I – 9÷12; II – 8÷12; III – 3÷6;	XII – 2÷6; I – 6÷7; II – 10
Average number of days with SC	XII–5; I–20; II–16; III–3	XII–7; I–16; II–14; III–4
Average monthly SC height in cm	XII–13; I–25; II–25; III–11	Not available
Maximum monthly SC height (cm)	XI-27; XII–70; I–111; II–104; III–81; IV-8	Not available
Monthly number of days with SC height in cm: **а) 10÷20** **б) 20÷50** **в) ≥ 50 cm**	 XII–4; I–11; II–9 I–6; II–6 none	Not available

3.1.1.2 Meteorological phenomena

3.1.1.2.1 Hail phenomena

The greatest hail frequency with inflicted damage on the studied region is observed in July (about 36%), followed by June (32%) and May (17%) – "Climate of Bulgaria," 1991. Their frequency is negligible in April, September and October. The 24-hour course of the beginning of hail precipitation reaches a maximum in the interval 14:00-18:00 o'clock local time. Night hails between 22:00-24:00 and 00:00-04:00 are also possible, falling along cold atmospheric fronts. Overall we can say that statistically speaking hails are a strongly expressed random phenomenon due to their great spatial and temporal variations. This makes the occurrence of the aforesaid climatic characteristics unlikely.

3.1.1.2.2 Ice formation on grounded objects and structures

The geographical location and the climatic specifics of the country provide relatively favourable conditions for icing and frosting of ground-based objects or for wet snowfall in the winter. Ice formation on ground-based objects – the accumulation of wet snow and ice depositions, characteristic of the non-mountainous parts of the country, has been poorly studied in our country as elements of climate. The most probable temperature-wind-humidity combinations during the process are: a temperature between 0°C and minus 2°C to minus 4°C, wind speed between 3 m/s and 5 m/s and relative humidity along the Danube river between 95% and 100%. During the period between November and March, and mostly during the months December and January, these meteorological conditions allow us to also make long-term weather forecasts on the icing process, accounting for the prevailing direction of the ice-carrying wind.

3.1.1.2.3 Dust storms

No data about observed dust or sand storms in the region of the Kozloduy NPP site are available. ***Table 3.1-6***: Number of cases with dust storms by *years* (Ivanov and Latinov, 1993), shows the number of the recorded dust storms by years for the entire country and the two meteorological stations closest to the region of the Kozloduy NPP – Lom and Oryahovo.

TABLE 3.1-6*: NUMBER OF CASES WITH DUST STORMS BY YEARS*

	1964	1970	1971	1972	1975	1976	1977	1978	1980	1983	Total
Lom	-	-	1	-	1	-	-	-	-	-	2
Oryahovo	-	-	1	1	3	2	-	-	-	-	7
the country	3	1	3	1	14	10	3	1	1	5	42

As shown in the study, these phenomena are determined by both the current synoptic conditions, and by the preceding climatic conditions – below-the-norm monthly total of precipitations for a given checkpoint. The probability for the occurrence of dust storms obviously depends on nature of the soil, as well as on the vegetation cover.

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 a 'general snowstorm' and encompasses the whole under-cloud layer) or when freshly fallen "dry" snow is blown away and carried away (it encompasses a layer of the ground air up to a few metres in height – "ground snow storm", or up to a few tens of centimetres – “low snow storm”). The phenomenon creates difficulties for land transport and other activities due to the snow-drifts formed by the snow carried by the wind. Snow storms in our country are observed mostly during the period December–February. They are manifested most intensely and most frequently in North-East Bulgaria, where the snow transfer is usually from the north and north-east (depending on wind direction) and is about 10m^3 per linear meter of the front. Snow storms are observed most often in synoptic circumstances related with a Mediterranean cyclone from the south and a Siberian winter anticyclone from the north-northeast.

3.1.1.2.5 Tornado

Although rarely, in circumstances characterized by meso-scale convective storms, tornadoes (or local tornadoes) may be formed in our country, most often above rugged mountainous terrains or above the sea aquatory[23]. Tornadoes are often mistaken for the so-called "falling" or squall-like wind.

The typical synoptic circumstances favouring the development of tornadoes over our country are a deep valley or a separate cyclonic whirlwind to the west of Bulgaria, where the flow in the middle troposphere in the frontal part of the cyclone or the valley is directed from the southwest to the northeast. Strong convective systems are formed, where the Coriolis force facilitates the development of a tornado within them.

These were the synoptic circumstances where the tornadoes described in cases 1, 3, 5A and 5B were formed ***Table 3.1-7***: Number of tornado cases during the period 2006-2009. 2 cases were recorded near the power plant during this period – at about 20 km to the south of the NPP, near the village of Hayredin (case 5A), and near the village of Tarnava, at about 35 km in the south-southeast direction, which occurred on the same day. These two are the only cases observed over a period of more than 100 years.

TABLE 3.1-7: *NUMBER OF TORNADO CASES DURING THE PERIOD 2006-2009*

No.	Affected region	Date	Beginning	Duration (min)	Movement direction of the tornado	Precipitation area (km^2)	Precipitation intensity (mm)	Daily precipitation total (mm)	Maximum size of hailstones (cm)	Damage inflicted by the tornado (USD)
1	**Bobeshino**	02.04.2006	05:20	31	W-E	200	64	3-11	1.5	80 000
2	**Kalekovets**	21.05.2007	13:20	10	NE-SW	232	45	6-40	6.0	110 000
3	**Kostandenets**	22.05.2008	13:55	80	SW-NE	320	237	2-14	6.0	640 000
4	**Kyustendil**	08.07.2008	16:02	12	NW-SE	500	100	2-24	3.0	68 000
5A	**Hayredin**	02.06.2009	15:58	75	SW-NE	600	225	14-32	9.0	134 000
5B	**Tarnava**	02.06.2009	13:35	75	SW-NE	600	225	14-32	7.5	225 000

On average for the whole country the probability for the occurrence of a tornado is estimated to be ~ 10^{-6} cases per year.

[23] Analysis of Strong Convective Storms Related to the Development of Tornadoes in Bulgaria during the period 2006–2009, Petar Simeonov, Ilian Gospodinov, Liliya Bocheva, Rangel Petrov.

3.1.1.3 UNFAVOURABLE METEOROLOGICAL CONDITIONS FOR THE DIFFUSION OF IMPURITIES INTO THE ATMOSPHERE

3.1.1.3.1 Temperature inversion

Temperature inversion in a specific region is observed when the lower atmospheric layer is in a strong stable equilibrium. A characteristic property of this layer is the suppression of air movements originating there, which results in the damping of dynamic turbulence and thermal convection, which determine the dispersion of air pollutants. In the cases with ground-level inversions (starting from the earth surface), the low-positioned pollutant sources play a major role. Conclusions regarding the presence of a phenomenon of this type may be drawn from the aerological samples from the period September 1967 – August 1968, taken in the region of the Kozloduy NPP[24].

Table 3.1-8: *Characteristics of the temperature inversions in the area of the Kozloduy NPP, based on aerological samples during the period* September 1967 – August 1968**,** presents the number, thickness ***d***, and average vertical temperature gradient γ from the one-year period of single (at 08:00) aerological sampling of the layer up to 2 km in height. The inversions have been observed in 30 % of the cases, this percentage being about 37 % during the cold half-year and about 22 % during the warm half-year. There have been ground-level inversions in 15 % of the cases, their frequency being much lower during the warm half-year – about 7 %, whereas in the cold season it is about 23 %.

TABLE 3.1-8: CHARACTERISTICS OF THE TEMPERATURE INVERSIONS IN THE AREA OF THE KOZLODUY NPP, BASED ON AEROLOGICAL SAMPLES DURING THE PERIOD SEPTEMBER 1967 – AUGUST 1968

	Ground inversions							High inversions									
Monitoring Period	**Number of cases with thickness, in m**				Total number of cases	Average temperature gradient, °C/100m	Average layer thickness	**Number of cases with thickness, in m**					Total number of cases	Average height H1, in m	Average temperature gradient γ	Number of the samples taken	Number of days with ar. .
	$200 \le d_1 \le 300$	$301 \le d_1 \le 500$	$501 \le d_1 \le 1000$	$d_1 > 1000$				$100 \le H_1 \le 150$	$151 \le H_1 \le 250$	$251 \le H_1 \le 500$	$501 \le H_1 \le 1000$	$H_1 > 1000$					
Warm half-year	-	2	5	1	8	-0.29	757	-	5	8	4	2	19	462	-0.29	121	27
Cold half-year	3	5	14	10	32	-0.62	801	1	3	6	9	6	25	720	-0.51	140	52
Total for the year	3	7	19	11	40	-0.46	779	1	8	14	13	8	44	591	-0.40	261	79

[24] Nikolova N., "Assessment of the meteorological conditions in the area of the Kozloduy NPP in connection with the design for the construction of an nuclear power plant", Institute of Hydrology and Meteorology, volume XIX, 1972.

Even though just for a one-year period and using single sampling, the study gives an idea about the degrees of stability of the boundary layer above the Kozloduy station, based on the Pasquill classification. The stability classes were determined based on ground-level data (radiation balance – not in the sense of nuclear radiation – and wind speed) and on the values for the vertical temperature gradient in the lower 200-metre air layer **-γ** [deg/100m]. The study mentioned above shows that in total for the year, the following classes occur with the greatest frequency:

- **D** (neutral conditions) – 0.5 deg / 100 m $\leq \gamma \leq$ 1 deg / 100 m – in about 40 % of the cases;
- **E** (slightly stable) – 0.5 deg / 100 m $< \gamma <$ 0,5 deg / 100 m – in about 30 % of the cases;
- **C** (slightly unstable) – 1 deg / 100 m $< \gamma \leq$ 1,5 deg / 100m – in about 25 % of the cases;
- **B** unstable($\gamma >$ 1.5 deg / 100 m) and F stable($\gamma \leq -$ 0.5 deg /100 m) have low frequency in the order of 5 % – 8 % of the cases.

Based on the data and the analyses made, we can draw the following conclusions regarding the processes and phenomena that are relevant to the Kozloduy NPP site in connection with the peculiarities of the site:

- Because of the prevalence of low wind velocities (within the range from 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 transboundary pollution over the territories of Romania;
- The precipitations are below the climatic norms, therefore the potential for the cleansing of pollutants (their wetting and grounding by rainfall) in the atmosphere is low;
- The icing of ground structures in this part of the Danube River may occur when the following meteorological parameters are combined: air temperature between 0°C and minus 2°C to minus 4°C, wind speed between 0 m/s and 3 to 5 m/s and relative humidity between 95 % and 100 %;
- Hails, causing damage in Northwest Bulgaria, occur in the period 5 May – 31 July, however specifically at the Kozloduy NPP site they are statistically a quite rare random event, because of their great spatial and temporal variations;
- The probability of snow storms is very low in comparison with the north-eastern part of the Danube Plain;
- The average nationwide probability for the occurrence of a tornado is approximately 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 QUALITY OF ATMOSPHERIC AIR (QAA)

3.1.2.1 NON-RADIOACTIVE POLLUTANTS

The Kozloduy region includes the Municipalities of Kozloduy, Oryahovo, and Mizia. With respect to these municipalities, it is not required to prepare a pollutant level reduction programme, since according to Articles 30 and 31 of Regulation No. 7 on the assessment and management of atmospheric air quality, the measured concentrations of harmful substances are not only lower than the admissible norm, but they are also lower than the upper and lower assessment thresholds.

As a rule, the quality of the ground layer of atmospheric air in the region is determined by the operation of the Kozloduy NPP, industrial activity, road transport, and household sources.

The more significant sources of atmospheric air emissions within the territory of the Municipality of Kozloduy are: the Concrete Batching Plant in the village of Butan belonging to "Patstroy Engineering" AD (Road Construction JSC), town of Vratsa, "Atomenergostroyprogress," "Zavodski Stroezhi" (Plant Construction), and "Mehanizatsia i Transport" (Machinery and Transportation).[25] These are dust sources with a local impact. Transport is the most significant source of carbon monoxide, hydrocarbons, nitrogen oxides, etc. The roads in the municipality are characterized by a relatively high traffic intensity. Rush hours create, even for a short while, conditions for an increase of road traffic emissions.

The Municipality of Valchedram falls within the Montana region, where the major emission sources are concentrated within the regional city and are outside the 30 km Urgent Protective Action Planning Zone (UPAPZ).

3.1.2.1.1 Emissions from industrial fuel and production processes sorted by municipalities.

According to data from the National Statistical Institute, **the districts, regions and municipalities in the Republic of Bulgaria for 2006, 2007, 2008**[26] have been analysed in terms of emissions of industrial and combustion and production processes for the municipalities Valchedram, Kozloduy, Mizia and Hayredin. ***Table 3.1-9:*** *Emissions of combustion and production processes (in thousands of tons) for the municipalities in the area of the Kozloduy NPP for the period* 2006÷2008

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[25] Annex 3 – Used literature and input data: Delivery Protocol 15 from 26.02.2013.

[26] Data up to 2008 is used, since as of 2009 the data on emissions in the different municipalities regarding combustion and production processes are confidential and not accessible pursuant to Article 22 of the Statistics Act.

TABLE 3.1-9: EMISSIONS OF COMBUSTION AND PRODUCTION PROCESSES (IN THOUSANDS OF TONS) FOR THE MUNICIPALITIES IN THE AREA OF THE KOZLODUY NPP FOR THE PERIOD 2006÷2008

EKATTE	Statistical districts, regions and municipalities	Sulphur oxides	Nitrogen oxides	NMVOC	CH_4	CO_2	CO	N_2O
		thousands of tons						
	2006							
VRC20	Kozloduy	4.894	2.971	62.066	59.719	0.537	2120.974	0.277
VRC28	Mizia	7.072	0.988	5.637	13.358	0.319	448.349	0.071
VRC35	Hayredin	9.979	1.277	0.753	0.253	0.547	406.426	0.046
	2007							
VRC20	Kozloduy	6.873	2.793	21.176	12.184	0.811	1619.163	0.029
VRC28	Mizia	0.238	0.075	4.386	6.594	0.004	112.149	-
VRC35	Hayredin	3.620	0.368	0.386	0.012	0.007	206.876	0.036
	2008							
VRC20	Kozloduy	4.434	32.336	21.325	8.194	2.985	12026.426	0.309
VRC28	Mizia	0.146	0.046	0.539	6.363	0.002	68.858	-
VRC35	Hayredin	0.736	0.045	0.256	0.002	0.001	37.038	0.007

Figure 3.1-14: Emissions from combustion and production processes visually illustrates the data from ***Table 3.1-9***: *Emissions of combustion and production processes (in thousands of tons) for the municipalities in the area of the Kozloduy NPP for the period 2006÷2008,* making it clear that the municipality of Kozloduy has the most developed production activity, which also gives it the greatest share of combustion emissions. They are not caused by the power plant itself, because with nuclear power generation there are no emissions of conventional pollutants. The emissions are related both to auxiliary production activities at the power plant and to the good business environment in the municipality, which encourages the development of small production companies using combustion processes, whose manufacturing products are mainly intended for the power plant – an asphalt facility, concrete production plants etc. Statistically, the fuel combustion for heating purposes is not included in the emission quantities presented above.

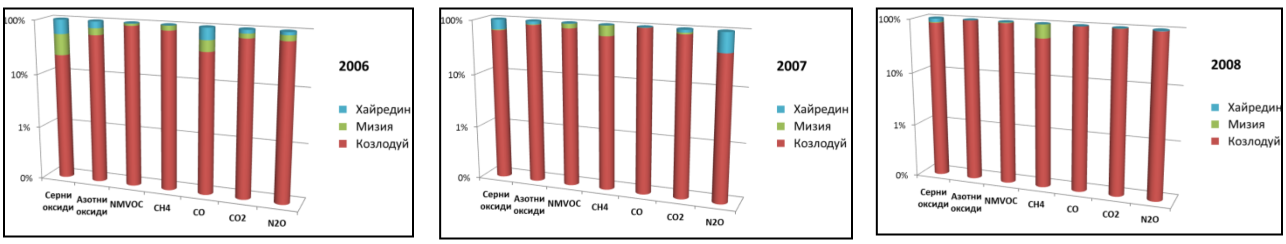

FIGURE 3.1-14*: EMISSIONS FROM COMBUSTION AND PRODUCTION PROCESSES*

3.1.2.1.2 Emissions related to the Danube River navigation

In the sections of the Danube River bordering on the power plant, the river traffic (both national and international) is a source of emissions caused by the ship engines. The emissions into the atmospheric air from the diesel engines (with compressor ignition) along inland waterways (IWW[27]) are regulated by MARPOL 73/78, Annex VI, where the limitations on the emissions of certain pollutants depend on the engine category (working volume of the cylinder).

The assessment of air emissions is based on information on the river traffic (number and type of passing ships) in the lower stream of the Danube River (the Bulgarian section of the river), published in EUROSTAT[28], where the total volume of goods (in tons) transported annually along the inland water ways, and the national, international or transit transportation, is presented in the ton-km format – ***Table 3.1-10*****: Goods** carried along inland waterways to the Lower Danube. This allows us to calculate the emissions using emission factors, in grams of harmful substances released per ton-kilometre (g/Tkm)[29].

TABLE 3.1-10*: GOODS CARRIED ALONG INLAND WATERWAYS TO THE LOWER DANUBE*

Year	Ton	Ton-km	km
2004	4 406 369	697 414 292	158
2005	5 270 366	756 837 254	144
2006	5 705 895	721 810 965	127
2007	6 622 307	1 010 837 176	153
2008	10 956 000	2 890 000 000	264
2009	17 104 000	5 436 000 000	318
2010	18 372 000	6 048 000 000	329
average	**9 776 705**	**2 508 699 955**	**213**

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[27] IWW – Inland Water Ways

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

[29] Van Essen et al. Emissions of pipeline transport compared with those of competing modes -Case I.Antwerp-Cologne, Delft Nov 2003.

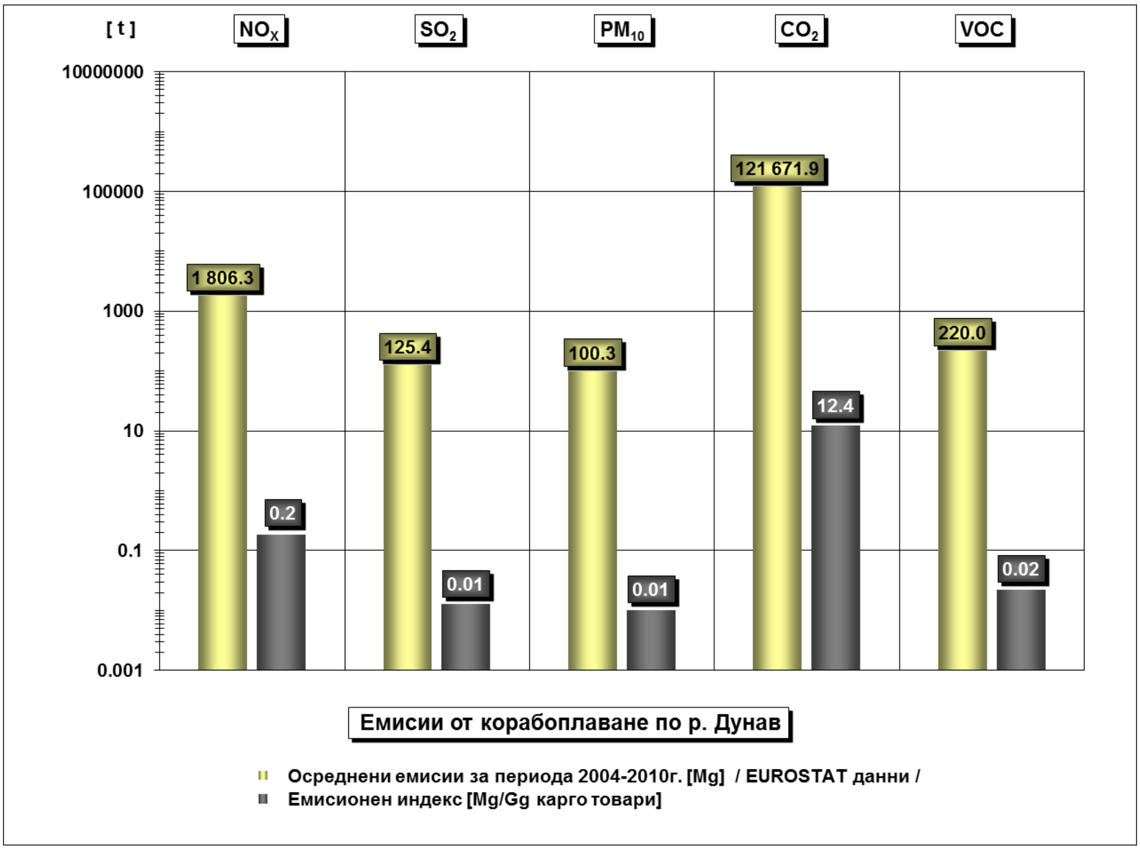

FIGURE 3.1-15: AVERAGED EMISSION LEVELS FOR THE PERIOD 2004-2010 AND EMISSION INDEX FOR A GIVEN POLLUTANT RESULTING FROM THE NAVIGATION ALONG THE LOWER DANUBE

Figure 3.1-15*: Averaged emission levels for the period 2004-2010 and emission index for a given pollutant resulting from the navigation along the Lower Danube* presents the annual emission levels caused by navigation, as well as the averaged emission index for the period for a given pollutant, calculated in compliance with the requirements envisaged by MARPOL 73/78, Appendix VI.

The resulting emission indexes (***Figure 3.1-15****: Averaged emission levels for the period 2004-2010 and emission index for a given pollutant resulting from the navigation along the Lower Danube*) for a given pollutant are below the typical values for the same indexes. For the port of Varna, for instance, they are higher by orders of magnitude. We should take into account the fact that the indexes for the port of Varna are for a small area (the actual area of the port), whereas for the Danube River the indexes encompass the whole length of the river, therefore for any defined section of the river (such as that adjacent to the power plant) they will be even lower.

3.1.2.1.3 Emissions from the Depot for Non-radioactive Household and Industrial Waste of the Kozloduy NPP

The Depot for Non-radioactive Household and Industrial Waste (DNHIW) accepts non-radioactive waste from the protected zone of the Kozloduy NPP. The depot is source of greenhouse gases – methane (**CH_4**) and carbon dioxide (**CO_2**) and smaller quantities of other volatile organic compounds.

The landfill[30] gas is formed by the body of a given depot at a temperature of about 10-20°C higher than that of the ambient air, and the formation speed and quantities of the gas depend on:

- → The morphological composition of the garbage – the greater the organic component in the garbage, the more landfill gas is released,
- → Waste age,
- → The presence of oxygen – the release of methane starts only after the depletion of oxygen in the body of the garbage,
- → Moisture content – moisture content accelerates the process of biological degradation. The optimal moisture content is 40 % – 50 %,
- → Temperature – in the summer we observe an increase in the quantities of released gas, and in the winter – a decrease.

Once the landfill gas has been formed in the body of the cell, it is emitted to the atmosphere via:

- → **diffusion** – gases are transferred from places with high concentration to ones with low concentration;
- → **convection** – places with higher pressure push the gas to the surface;
- → **solubility** – methane is soluble in water and is also released in small quantities via the resulting infiltrate.

During the period up to 2011, the quantities of waste received by the depot are presented in ***Table 3.1-11***: Waste quantities received by the *DNHIW.*

TABLE 3.1-11*: WASTE QUANTITIES RECEIVED BY THE DNHIW*[31]

Years	Volume of received waste [m³]	Volume of received waste cumulative [m³]	Time to fill up, [years]
by 31.XII 2001	7 298	-	**1**
by 31.XII 2002	5 397	12 695	2
by 31.XII 2003	4 690	17 385	3
by 31.XII 2004	4 267	21 652	4
by 31.XII 2005	4 690	26 342	5
by 31.XII 2006	5 153	31 495	6
by 31.XII 2007	4 421	35 916	7

[30] When the landfill gas is treated to remove some impurities (such as sulphur), it is converted into biogas, suitable for fuel purposes.
[31] Own non-radiation monitoring of the Depot for Non-radioactive Household and Industrial Waste, 2011

Years	Volume of received waste [m³]	Volume of received waste cumulative [m³]	Time to fill up, [years]
by 31.XII 2008	4 836	40 752	8
by 31.XII 2009	5 519	46 271	9
by 31.XII 2010	4 747	51 018	10
by 31.XII 2011	4 949	55 967	11

The emissions (general ones: from diffusion, convection and dissolved in the leakage) from the depot body are calculated using the model **LandGEM**[32] of the United States Environmental Protection Agency (EPA).

The model is based on the equation for the (bacteriological) decomposition of the organic component of household waste of the first order. The input parameters are the initial year of disposal, the capacity of the depot and the quantities of the disposed waste by years (Mg). The model can also calculate, based on the capacity of a given depot, by which year it will be able to receive waste. Since the document for the own monitoring on the NHIWD specifies that only 85% of the first stage capacity of the depot are filled up, the model calculated that with a 9% increase of waste disposal per annum the first stage will be used till 2016.

Figure 3.1-16: Emission levels from the NHIWD for disposal up to *2016* shows the evolution of the emissions of some gases from the Depot at 50 % (volumetric %) content of methane in the landfill gas.

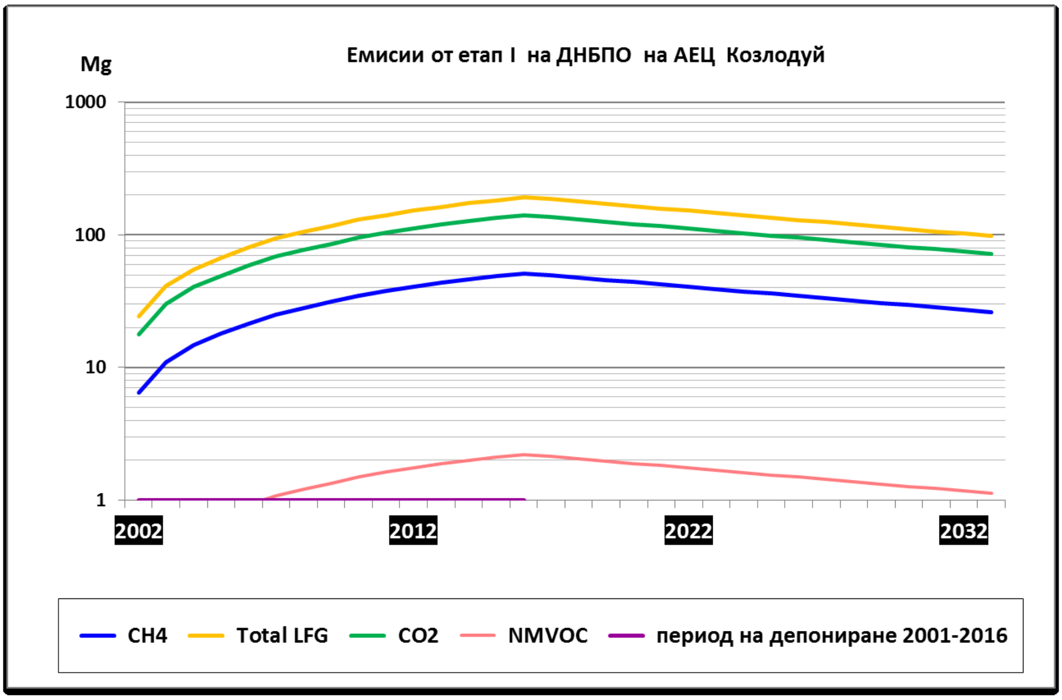

FIGURE 3.1-16: *EMISSION LEVELS FROM THE NHIWD FOR DISPOSAL UP TO 2016*

[32] http://www.epa.gov/nrmrl/appcd/combustion/cec_models_dbases.html

The inventory of emission quantities in 2012 from the body of the Depot is presented in ***Table 3.1-12***: Gas quantities (in tons), emitted for 2012 from the *NHIWD*

TABLE 3.1-12: *GAS QUANTITIES (IN TONS), EMITTED FOR 2012 FROM THE NHIWD*

CH_4	CO_2	NMVOC	Landfill gas
40.76	111.83	1.75	152.6

3.1.2.1.4 Emissions by the vehicle traffic along second-class road II-11

The Kozloduy NPP site is linked with the national road network through a road of the second class, with two-way traffic, with asphalt paving and well-marked. This is Road II-11, section Oryahovo – Mizia – Kozloduy – Lom, which passes south of the Kozloduy NPP and the site of the National Repository for the Disposal of Radioactive Waste and continues along the unflooded terrace of the Danube River. In this way the traffic of the inter-settlement passenger transport and the transit cargo traffic, is taken away from the power plant site.

According to data for 2010 on the average annual 24-hour intensity of the road traffic, assessed at counting checkpoints of the Road Infrastructure Agency, and specifically for Road II-11 from the national road network at Additional Counting Checkpoint (ACC)-205 in the section Kozloduy – Lom and ACC-496 in the section Mizia – Kozloduy, the emissions of the regular traffic in the area around the power plant have been assessed[33].

Table 3.1-13*: Average annual intensity of motor vehicle traffic – diagnosis for 2010 and estimate* for *2015-2020* presents the data on the 24-hour intensity of the vehicle traffic for 2010 for the 6 main vehicle categories: light passenger vehicles, light cargo vehicles, medium cargo vehicles, heavy cargo vehicles, buses (interurban) and heavy cargo vehicles with a trailer. The estimated intensity for 2015 and 2020 was made on the basis of the traffic increase for the various types of motor vehicles from 10% to 18%.

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

TABLE 3.1-13: AVERAGE ANNUAL INTENSITY OF MOTOR VEHICLE TRAFFIC – DIAGNOSIS FOR 2010 AND ESTIMATE FOR 2015-2020

Year	Counting Checkpoint	Light vehicles	Buses	Light cargo vehicles	Medium cargo vehicles	Heavy cargo vehicles	Cargo vehicles with a trailer and tugging vehicles with semitrailers	Total cargo vehicles	Total vehicles
2010	ACC-205	798	17	267	24	13	38	342	1 157
	ACC-496	6 185	252	964	166	48	150	1 328	7 765
2015	ACC-205	938	20	314	28	14	45	401	1 359
	ACC-496	7 266	295	1 134	195	53	177	1 559	9 120
2020	ACC-205	1 102	24	369	33	16	53	470	1 597
	ACC-496	8 535	346	1 333	229	59	208	1 830	10 711

The assessment of emission levels of individual pollutants from the road transport for 2015 is made using Tier **2**[34] **(Tier 2)** of the European *Emission Inventory Guidebook **EMEP/EEA CORINAIR'2009*** on the primary pollution from: (a) passenger vehicles (**NFR** code **1.A.3.b.i**), **(b)** light cargo vehicles under 3.5 tons (**1.A.3.b.ii**), (c) heavy cargo vehicles over 3.5 tons and (d) buses (**1.A.3.b.iii**) in the section **Transport.** This is the basis for the calculations of the following emissions:

- Ozone precursors – CO, NO_X, NMVOC (non-methane volatile compounds),
- Greenhouse gases (CO_2, CH_4, N_2O),
- Acidifying substances (NH_3, SO_2),
- Fine Dust Particles (FDP) – only the FDP2.5 fraction, since the higher fraction $FDP_{2.5 \div 10}$ is negligible in the soot from the exhaust gases,
- Carcinogenic compounds:
  - ✓ PAH – polycyclic aromatic hydrocarbons (Benzo (α) pyrene, Benzo (b) fluoranthene + Benzo (k) fluoranthene, indeno (1,2,3-cd) pyrene – for unleaded petrol)
  - ✓ POP – Persistent Organic Pollutants
  - ✓ Toxic substances (DIOX – Dioxins and furans (for unleaded petrol))
- Heavy metals.

[34] Methods of different complexity are used to determine the emission levels of greenhouse gases (GHG) using the IPCC methodology. The level of complexity of the method is marked as Tier X, i.e. the higher the X number, the more complex and accurate the method.

The following emissions are not included – those from fuel evaporation (**NFR** code **1.A.3.b.v**), those from tire and brake wear (**NFR** code **1.A.3.b.vi**) and those from road pavement wear (**NFR** code **1.A.3.b.vii**).

Table 3.1-14*: Existing emission load in kilograms per 1 kilometre of the respective road section (kg/km),* shows the emission load in kilograms per 1 kilometre of the respective road from the national road network.

TABLE 3.1-14: EXISTING EMISSION LOAD IN KILOGRAMS PER 1 KILOMETRE OF THE RESPECTIVE ROAD SECTION (KG/KM)

Year	Counting Checkpoint	CO	NMVOC	NOx	N2O	NH3	Pb	PM2.5	Ideno Pyrene	B(k)F	B(b)F	B(a)P	CO2	SO2	benzene	tCO_2eq
2010	**ACC-205**	1.665	0.159	0.978	0.009	0.016	2.36E-06	0.036	6.38E-07	7.78E-07	9.50E-07	5.25E-07	301.87	0.00384	0.0048	**0.31**
	ACC-496	10.847	1.051	5.890	0.058	0.112	1.50E-05	0.193	4.12E-06	5.21E-06	6.24E-06	3.37E-06	1985.80	0.02621	0.0315	**2.03**
2015	**ACC-205**	1.956	0.186	1.144	0.011	0.018	2.77E-06	0.042	7.49E-07	9.09E-07	1.11E-06	6.17E-07	354.28	0.00451	0.0056	**0.36**
	ACC-496	12.741	1.234	6.900	0.068	0.132	1.76E-05	0.226	4.84E-06	6.10E-06	7.31E-06	3.96E-06	2330.78	0.03078	0.0370	**2.38**
2020	**ACC-205**	2.298	0.219	1.339	0.013	0.022	3.25E-06	0.050	8.79E-07	1.06E-06	1.30E-06	7.24E-07	415.85	0.00530	0.0066	**0.42**
	ACC-496	14.964	1.449	8.084	0.080	0.155	2.07E-05	0.266	5.68E-06	7.15E-06	8.57E-06	4.65E-06	2735.84	0.03615	0.0435	**2.79**

3.1.2.1.5 Measured concentrations

The National Environmental Monitoring System (NEMS), which performs the atmospheric air control within the territory of the country, does not have at its disposal a fixed measurement station for the region of the Kozloduy Municipality.

In 2011, in adherence to the approved operation schedule for the Mobile Automatic Stations (MAS) for the performance of additional measurements in regions where stationary checkpoints are lacking or restricted in number, the Mobile Automatic Stations (MASs) for control over the quality of atmospheric air conducted measurements at the North/Danubean Region RACAAQ in the Municipality of Kozloduy for 52 24-hour periods, which were carried out by the Pleven Regional Laboratory.

Within the Environmental Impact Assessment (EIA), the average 24-hour parameters from the protocols of these measurements will be analysed and compared to their relevant average 24-hour norms.

The EIA Report will also assess the diesel fuel combustion emissions in the Diesel Generator Stations (DGS), based on the consumed fuel.

3.1.2.2 ATMOSPHERIC ACTIVITY

Aerosols **–** the radioactivity of atmospheric air is examined on a weekly basis at 11 control checkpoints within the 100 km Monitoring Zone (MZ) around the NPP. Summary of the conducted aerosol monitoring for the period 2009-2011. (Results from the Radio-Ecological Monitoring of the Kozloduy NPP, Annual Report, 2011) shows that the results are within the normal limits and the operation of the Kozloduy NPP, as a potential source of ground air pollution with radioactive substances, **has not resulted in any change of the radiation gamma background** and atmospheric radioactivity.

The values for the total beta-activity in ground air (***Figure 3.1-17:*** *Gamma-spectrometric analysis of 137Cs and 7Be in ground air (mBq/m3) from the area of the Kozloduy NPP, checkpoint-9 (village of Harlets), 1992 – 2011)* are within the normal parameters, characteristic for this geographical region, within the range from 0.50 to 0.68 $\mu Bq/m^3$. The results are closely comparable throughout the years. The content of ^{137}Cs from 0.8 $\mu Bq/m^3$ to 10 $\mu Bq/m^3$ with an average value of 2.8 $\mu Bq/m^3$ is within the minimal detectable activity for this analysis method, and 10^6 times lower than the standards for the country, established under the *Regulation on the Basic Norms of Radiation Protection, 2012*.

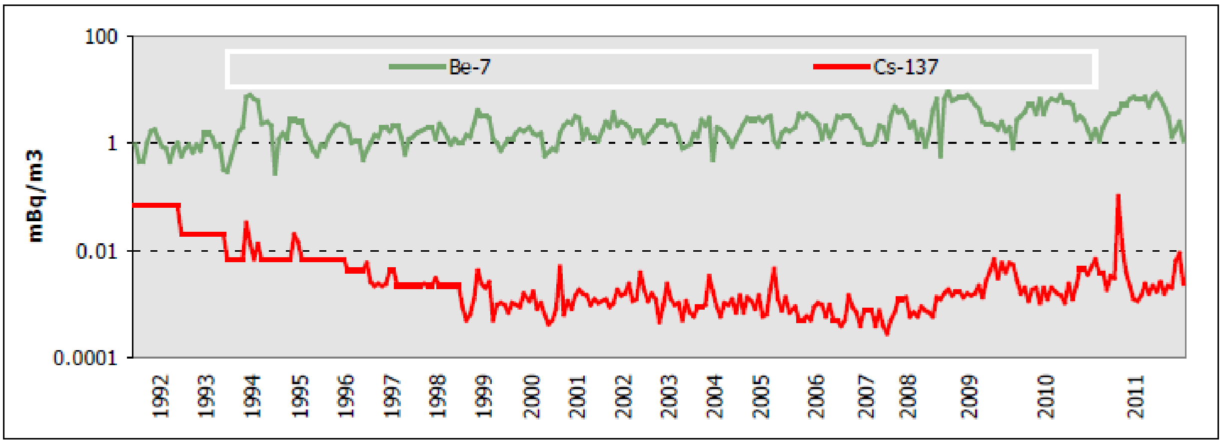

FIGURE 3.1-17: GAMMA-SPECTROMETRIC ANALYSIS OF ^{137}CS AND ^{7}BE IN GROUND AIR (MBQ/M^{3}) FROM THE AREA OF THE KOZLODUY NPP, CHECKPOINT-9 (VILLAGE OF HARLETS), 1992 – 2011

The monitoring data establishes a relative increase of long-lived beta-activity in the aerosol filters of some of the control checkpoints, mainly during the winter months. This is due to the snowfall during this period.

No significant negative impacts are expected.

Atmospheric depositions – atmospheric depositions are controlled on a monthly basis at 33 of the 36 control checkpoints within the 100 km Monitoring Zone around the NPP. A slight seasonal dependence has been established, with maximum values during the spring-summer period, which is due to the intense rainfall and self-cleaning of the atmosphere, resulting in a reduced aerosol activity and respectively an increased deposition activity.

The controlled total beta-activity of atmospheric depositions varies within the range 0.058 Bq/(m^2.d) ÷ 1.96 Bq/(m^2.d) with an average value of 0.43 Bq/(m^2.d). The results are comparable to previous multi-annual measurements and represent natural values characteristic for the region. The results for ^{90}Sr in atmospheric depositions display a stable reduction tendency due to the self-cleaning of the atmosphere from the Chernobyl ^{90}Sr.

It is generally recognized that the radioactivity of atmospheric depositions within the 100 km zone is within the normal limits and has not been affected by the operation of the NPP.

Background gamma radiation – In 2011 a total of 1551 measurements were made on the background gamma radiation at the control checkpoints and routes using portable dosimetric devices and stationary thermo-luminescent dosimeters. Out of them, 1299 measurements were made using portable dosimetric devices at a total of 77 control checkpoints within the 100 km zone. For independent passive control of the gamma background radiation, a total of 63 thermo-luminescent dosimeters TLD-4 were used (70 pieces of UD-802AS respectively), for a total of 252 measurements. The summarized data and results for 2011 and its comparison to that for the period 2007–2010 shows the following:

- The gamma background radiation at points of NPP's fence and at the control checkpoints and the settlements within the 100 km Monitoring Zone is completely comparable to the natural background radiation of 0.05 μSv/h ÷ 0.15 μSv/h;
- The radiation situation in the area is stable and has not been changed by the operation of the Kozloduy NPP.

3.1.2.3 FORECAST OF IMPACT

Regarding non-radioactive pollutants during the construction, operation and decommissioning, the EIAR will assess the expected concentrations into atmospheric air, both for the Bulgarian and the Romanian territory within the 30 km zone (Ministry of Environment and Forests, Republic of Romania, Outgoing No. 3672 RP 18.10.2012) from respective activities in those stages. The cumulative effect of the transport traffic on the regular traffic along the national road network will be also assessed.

3.1.2.3.1 Modelling of non-radioactive pollution

The AERMOD model

To assess the dispersion of emissions from sources during the construction of each of the 4 sites, a model used by the U.S. Environmental Protection Agency (EPA) ***ISC-AERMOD***[35] (Industrial Source Complex) will be applied. Windows interface of the model is developed by Canadian software company *Lakes Environmental.*

AERMOD consists of three modules:

- Atmospheric dispersion module (**AERMOD**),
- Terrain pre-processor (AERMAP), which is used in the presence of a complex terrain to describe the height of each receptor,
- Meteorological pre-processor (**AERMET**), which is used to prepare meteorological data input for simulation by the dispersion module.

AERMOD requires two types of hourly meteorological data: one, referring to the surface values of meteorological parameters, and another one, describing their vertical profiles, serving to render the vertical non-homogeneity in the structure of the surface boundary layer. The vertical mixing of pollutants with ambient air is limited in the event of stable stratification (a positive change of temperature with the height). The dispersion in unstable thermal conditions (strong convection) is not Gauss-like and physically it is described via turbulent convective flux due to which higher concentrations of pollutants are registered close the source.

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[35] http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod

Based on the ground characteristics of the underlying surface: roughness height, albedo and Bowen ratio (moisture amount which depends on the surface type – urban, rural, forest, water and so on, and varies depending on the season and wind direction), ***AERMET*** calculates the parameters of the surface boundary layer, which account for its development and which affect the pollutants dispersion. These parameters include surface friction velocity (measure of velocity that relates shear between layers of flow); surface heat flow (thermal energy vertical transport); mixing layer height at day; mixing layer height at night, and more.

In the ***AERMET*** model, the stable atmospheric condition is determined based on Monin-Obukhov's length which is a measure of heat transfer near the earth's surface. The relationship between Monin-Obukhov's length and the 6 atmospheric stability classes of Pascal-Gifford is the following.

	L Values	Stability Conditions	Pascal-Gifford Class
Small negative	$-100 \text{ m} < \mathbf{L} < 0$	Very unstable	A
Large negative	$-10^5 \text{ m} \le \mathbf{L} \le -100 \text{ m}$	Unstable conditions	C
Very large(- or +)	$\lvert \mathbf{L} \rvert > 10^5 \text{ m}$	Neutral	D
Large positive	$10 \text{ m} \le \mathbf{L} \le 10^5 \text{ m}$	Stable	E
Small positive	$0 < \mathbf{L} < 10 \text{ m}$	Very stable	F

AERMOD includes several improvements compared to the standard Gaussian jet models with respect to description of turbulence, dispersion under convective and stable conditions, effective lifting of the jet above the physical height of the source, pollution diffusion in urban environment accounting for a complex terrain[36].

The final results are the concentrations of a given pollutant at some previously chosen calculation grid points (the so-called receptors) or the deposition of some amount of polluting substance on the earth's surface (dry, wet, or a total of dry and wet).

MODELLING RATIONALE

The extraordinary gaseous and dust emissions during the construction stage result from the earth excavation works, the dust material processing, and the wind erosion of the open earth mass embankments, as well as the gaseous emissions from the transportation vehicles and construction machinery (internal combustion engines).

Input data for dust emissions

In calculating the quantitative emission values for all sources, the dust emissions will be taken into account, calculated based on the emission factors of the US Environmental Protection Agency (EPA) for operation in open dust areas, as well as the internal combustion engine (ICE) emissions of the equipment working at the site, obtained using

[36] http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_mfd.pdf

the emission inventory methods EMEP/EEA, 2009, Chapter: ***Stationary construction machinery***.

The effects of each source has been accounted for within a time schedule (i.e. they are a function of time), and the data has been integrated into the so-called "HOURLY EMISSION RATE FILE" (HOREMIS – Hourly Emission), which is an hourly effects schedule for each individual source.

Input parameters for the modelling process

The first step is to develop a new model by denoting the precise coordinates and boundaries of the model for the 4 sites by introducing a precise terrain map in an appropriate format. In this specific case, a shapefile will be used. Later on, using the software module ***AERMAP*** to calculate the topography, precise data will be assigned for the altitude of all objects, including the pollution sources and the receptors for the specific project.

The next step in the modelling process is the introduction of the so-called receptor grid at a given height (in this case, the ground), in whose nodes the expected ground level concentrations are calculated. After data entry, the model completeness is verified, then the software programme is started the dispersion models are prepared, where each of the considered 4 alternative sites is an area pollution source.

Input meteorological parameters – data for 2012

For the purposes of the model, the software programme ***AERMET*** is used to create a surface and a vertical profile meteorological parameter (respectively .SFC and .PFL), representative for the 4 sites. During the preparation of this file, the terrain specifics (arable area, coniferous forest, deciduous forest, water area and so on) is accounted for, whereas the primary meteorological data for them, prepared using the synoptic model **MM5,** are purchased from the **Lakes Environmental Software** for a point with coordinates representative of the region.

TRAFFIC ORACLE Model

The pollution will be determined, pursuant to the European standards and the respective Bulgarian legislation, using the *Method for determining the diffusion of harmful substance emissions from transport vehicles and their concentration in the surface atmospheric layer – based on the software product* **TRAFFIC ORACLE**, **DIFFUSION** module. It provides statistical or typological assessments of the pollution levels for a specific pollutant.

Brief description

The **DIFFUSION** module is based on a jet Gaussian model and calculates the pollution from linear or area-based sources in the atmospheric ground layer through the following typological assessments:

- → Calculation of the expected maximum single concentrations of harmful substances,

- Calculation of the expected climatic average (monthly or annual) concentrations using the respective "wind rose",
- Calculation of the expected averaged concentrations (hourly, 24-hour, monthly or annual) using the respective hourly meteorological file,
- Calculation of the maximum possible single pollution under the respective most unfavourable meteorological conditions.

The values of the harmful substance emissions from motor vehicle engines are presented in g/(m.s) or g/s with a linear or area-based source respectively, and their concentrations in the ground atmospheric layer are presented in mg/m^3.

We make the assumption that the pollution from transport vehicles during their movement along road sections could be approximated as continuously acting linear sources.

MODELLING RATIONALE

With respect to air pollutant emissions, the cumulative impact is due mainly to the gas emissions from transport activities related to the national and municipal road network project – delivery of raw materials and materials, earth masses, and workforce transportation.

The objective of the modelling is:

- To make a quantitative assessment of the pollution share from the delivery of raw materials and materials during construction into the existing pollution, caused by the average 24-hour intensity of vehicle traffic along a used section of the national road network,
- To evaluate the pollution in settlements through which the traffic passes.

With respect to the generated **gaseous radioactive emissions**, the technical aspects will be analysed – envisaged annual output amounts, origin, composition and physical and chemical forms, management, release methods and paths. A model will be made for the distribution of waste fluids into the atmosphere, surface deposition, and secondary suspension.

It is necessary to describe the requirements for the monitoring of the releases – release sample collection, measurement and analysis undertaken by the operator or the competent authorities, fundamental characteristics of the monitoring equipment.

3.1.2.3.2 Modelling of radioactive pollution

The assessment of the environmental radiation impact in the event of radionuclide contamination during the normal operation will be performed using a software product based on the EU-adopted methodology CREAM (Consequences of Releases to the Environment Assessment Methodology) Radiation Protection 72 – Methodology for assessing the radiological consequences of routine radionuclide releases into the environment.

- To assess the radiation exposure of the population within the 30 km Urgent Protective Action Planning Zone (UPAPZ) to gaseous and aerosol releases – the LEDA- CM software programme, adapted to the geographic and meteorological characteristics of the region of Kozloduy NPP, will be used. The methodology accounts for both the external and the internal impact of radioactive releases and evaluates the individual effective dose, the annual individual equivalent dose, and the critical group dose, as well as the collective population dose by age groups.

After the model is prepared and analysed, the output data for the annual effective doses for the population within the area with a 30 km radius around the Kozloduy NPP will be derived.

3.2 WATER

3.2.1 SURFACE WATER

3.2.1.1 CURRENT STATUS

Several rivers from the basin of Ogosta River and the rivers westward of it flow through the region of the existing Kozloduy NPP site, namely:

- 10 km to 30 km southward and southeastward – the Ogosta River with water body code BG1OG100R014 and the Ogosta River – the Skat River with water body code BG1OG307R013;
- 10 km to 30 km eastward and southward – the Skat River with water body code BG1OG200R008;
- 20 km to 30 km westward – the Tsibritsa River – two water bodies with codes BG1WO800R016 and BG1WO800R017;
- In the immediate vicinity of the NPP and of greatest significance to it, northward of the site flows the Danube River with the name “Danube River RWB01“ and code BG1DU000R001.

With respect to these rivers, all requirements of the Water Basin Management Plan (WBMP) are in effect, as well as the measures to it, as addressed in Program 7.1.5, Program 7.1.6, Program 7.1.7, Program 7.1.8, according to Letter No. 3804/January 08, 2013 of the Basin Water Management Directorate – Danube Region (BWMD-DR), aimed at: emission regulation through prohibition of the introduction of pollutants from point sources, prohibition of the introduction of pollutants from diffuse sources, prevention of water pollution with priority substances, and prevention or reduction of the impact of emergency pollutions. These requirements will have to be observed during the implementation of the Investment Proposal (IP) for the New Nuclear Unit (NNU).

The water body of the BGTR7 type, with code BG1OG100R014 – the Ogosta River, is 3.175 km long (part of the Ogosta River water body), it is strongly modified and it has been qualified in the Water Basin Management Plan (WBMP) as being in good chemical condition and moderate ecological condition, but it has also been assessed as a water body „at risk" for the achievement of the ecological objectives. During the construction of Kozloduy NPP, the mouth of the Ogosta River was modified to provide service water supply from the Danube River to the NPP. It was shifted eastward, under the Bank Pump Stations (BPSs).

Small dams have been constructed in the region, which are run by the respective municipalities, as well as dams which are run by Napoitelni Sistemi EAD (Irrigation Systems EAD). On the Ogosta River, near the town of Montana, the Ogosta dam has been constructed which is on the List of Large and Complex Dams in the Country from Appendix 1 to the Water Act. It impacts greatly the river's flow regime. Apart from the Ogosta dam, another such dam near Kozloduy NPP is Shishmanov Val (Asparuhov Val) dam, 10 km away from the NPP. This water basin was constructed for the needs of the irrigation system of the same name. The water basin is fed by the Danube River through a floating pump station; its capacity is 7 mill. m^3. The dam is defined in the Water Basin Management Plan (WBMP) as an artificial water body with code BGW0900L017 and its registered area is 2 km^2.

Due to the constantly high level of groundwater on a large area of the lowlands in the region of Kozloduy NPP, a system of drainage channels and facilities have been constructed, including slope water running down the north slopes of the plateaus. These systems protect the region in case of abundant precipitations and prevent bogging of the lowlands. The drainage systems include three types of channels: drainage, collector, and main. The water from the main channels is transferred to the Danube River over the embankments by pump stations (PSs). These drainage facilities are essential for the protection of agricultural land in the area and the existing infrastructure.

The Main Drainage Channel (MDC) is collecting the four flows of NPP wastewaters (domestic and faecal wastewaters and rain water) of NPP: by Electricity Generation-1 and Electricity Generation-2 (two stream) as well as from the Open Switchgear. The drainage systems of Electricity Generation-1 and the Open switchgear are mixed, and the sewerage system of Electricity Generation-2 is separate. A small quantity of industrial waste water from the Electricity Generation-2 has been discharged into the sewerage system of Electricity Generation-1. Rainwater from the electric convertors sites pass through oil-retainers. Domestic and faecal wastewaters from the Electricity Generation-1 and the Open Switchgear are discharged without treatment. A treatment facility has been built for domestic wastewater from Electricity Generation-2.

The Danube River plays the most important and vital role with respect to the existing Kozloduy NPP site and all proposed new alternative NNU sites.

The Danube River is used for circulation and service water supply to all consumers at the Kozloduy NPP site. The total area of the international Danube basin is 817 000 km^2, and its total length is 2 857 km. The river is an international water transport corridor. In relation to the threat to the river water's ecological state as a result of the intensified man-induced impact on the banks and the transport traffic, established by the countries along the river, as well as for the purpose of preserving a number of protected areas and habitats, affected by its water, in 1992, the decision was made to establish an International Committee for Preservation of the Danube River (ICPDR). The Republic of Bulgaria has ratified the Convention for Protection of the Danube River. The first Management Plan for the entire Danube basin is in effect in the Republic of Bulgaria, as well as the Basin Management Plan for the Danube region. In this Plan, the river is classified as a river named Danube RWB01, with code BG1DU000R001. It has been defined as a strongly modified water body of moderate ecological state and poor chemical state. An Action Program aiming to achieve good chemical condition and good ecological potential during the next planning periods until 2021 and 2027 has been prepared and is being implemented. These requirements will be applicable with respect to the ecological commitments during the implementation of this Investment Proposal. The river is subject to control physico-chemical monitoring and operative monitoring under a special National Monitoring Program for major physico-chemical indicators, priority and specific pollutants, and hydro-morphological quality elements, according to the Program of the International Committee for Preservation of the Danube River (ICPDR) which is included in the National Environmental Monitoring System (NEMS) implemented by the National Environment Agency (NEA) and the Regional Laboratories. Under the same Program, control and operative hydro-biological monitoring is also performed. To implement the Monitoring Program for the Danube River, as well as monitoring of the condition of the Ogosta river, Order No. РД-715/August 02, 2010 of the Minister of Environment and Water is in effect.

NPP Kozloduy EAD has arranged and carries out on a regular basis a mandatory own non-radiation waste waters monitoring according to the conditions in the licenses for discharging – at the discharge points of the above mentioned four waste water streams into the MDC, as well as at the HC-1 and HC-2 discharge points in the Danube River. The temperature and the physico-chemical parameters of the water in CC-1, fed by the Danube River, are also monitored. Additional intra-institution monitoring and control is also performed of all points of discharge into the Main Drainage Channel (MDC), HC-1 and HC-2, the Danube River, and the quantity and quality of waste waters collected in the sewer network, which originates from external users on the territory of the NPP. NPP Kozloduy also performs hydrological monitoring of the Danube river, as well as quantitative and chemical monitoring of groundwater in the site's region at the water collection points specified in the relevant licenses, inclusive of groundwater on the territory of external establishments, such as the Decommissioning Specialized Division and the Radioactive Waste Specialized Division of SE RAW. Summarized statements of the conducted monitoring are submitted periodically and once a year to the Basin Water Management Directorate – Danube Region. Automated equipment is used to that end, as well as manual portable equipment. For the purpose of performing the monitoring, Annual Non-Radiation Monitoring Programs and Annual Reports on the performed monitoring are prepared. The control monitoring of all points of waste water discharge on the territory of the NPP is performed by the bodies of the Ministry of Environment and Water at the Executive Environment Agency and the Regional Laboratory – Vratsa

(Letter of the MoEW, Regional Inspectorate for Environment and Water – Vratsa, Outgoing No.B2975/January 10, 2013).

The Plant Non-Radiation Monitoring Program implemented by Kozloduy NPP, accounts for the work of the existing Waste Water Treatment Stations and the local treatment facilities. The monitoring of non-radioactively polluted wastewater shows slight organic pollution. Occasionally, the presence of oil products and boron is registered. Waste water containing oil products is generated at the Turbine Hall of Electricity Generation-1 and Electricity Generation-2, the Fleet park, the Fuel and Oil Facility, the Diesel Generator Stations of Electricity Generation-2, etc. The slight waste water organic pollution is expressed in single cases of minimum exceeding of the Individual Emission Limits for organic indicators and biogenic elements, such as BOD_5 (Biological Oxygen Demand), total phosphorus (such as PO_4) and total nitrogen. These recorded and reported cases of exceeded values are largely due to the operation mode of the Wastewater Treatment Plant for municipal waste containing faecal matter for Electricity Generation-2 (low organic loading and high hydraulic loading, i.e. dilution with water not containing organic pollutants, such as, rain water), which disturbs the biological treatment process. During the recent years, this tendency has been rectified, as a result of which the performance of the Wastewater Treatment Plants has improved. Measures have been taken to reduce the amount of input waste water. There is a persisting tendency for non-observance of the Individual Emission Limits for the indicator „boron in waste water” discharged into the Main Drainage Channel. The reason lies in the increased boron content in the potable water – below the norms pursuant to Protocol № 1-E/24.01.2012, but higher than the Individual Emission Limits stated in the permit. The control of the IEL's observance with respect to physico-chemical waste water pollution and the Danube River is performed by the External Accredited Laboratory (RL-Vratsa (Regional Laboratory at the Executive Environmental Agency), and during the last couple of years, over 100 samples have been collected, accompanied by protocols of the performed tests for the individual indicators**.**

The water amounts used in 2011, compared to the allowed amounts, are shown in ***Table 3.2-1:*** *Water amounts used in 2011 compared to allowed quantities.*

TABLE 3.2-1: WATER AMOUNTS USED IN 2011 COMPARED TO ALLOWED QUANTITIES

Place of abstraction	Allowed amount, [m^3]	Used amount, [m^3]
Surface water from the Danube River	5 000 000 000	2 660 788 000
Shaft well "Valyata"	788 400	216 700
Well "Ranney – 5"	1 600 000	2 729
Six shaft wells (Shaft Pump Stations 1÷6)	7 884 000	24 779

The amount of used water from the Danube river is about 53.21% of the allowed quantity, and the amount of groundwater – only 2.38 % of the allowed quantity.

Waste water amounts

The amounts of waste water generated in 2011, as measured by the Hydro-Technical Facilities and Building Structures Department are compared to the allowed quantities and presented in ***Table 3.2-2****: Waste water flows and amounts from NPP Kozloduy in 2011*

TABLE 3.2-2: WASTE WATER FLOWS AND AMOUNTS FROM NPP KOZLODUY IN 2011

Flow	Water origin	Allowed amount, m^3	Generated amount, m^3
Flow № 1 (Trapezium Channel – Main Drainage Channel)	Industrial, domestic, and rain water from Electricity Generation-1	3 900 000	680 000
Flow № 2 (Ø300 – MDC)	Domestic waste water after the treatment plant/ Electricity Generation-2	450 000	16 000
Flow № 3 (Ø1000 – MDC)	Treated industrial waste water from the Turbine Hall, the Diesel Generator Station, the Fuel and Oil Facility, etc.	6 600 000	1 895 000
Flow № 4 (Open Switchgear– MDC)	Domestic wastewater from the Open Switchgear	1 095	1 000
Flow HC-1 – Danube River	Cooling and industrial wastewater from Electricity Generation-1 and Electricity Generation-2	1 050 000 000	2 114 288 000
Flow HC-2 – Danube River	Cooling and industrial wastewater from Electricity Generation-1 and Electricity Generation-2	2 230 000 000	507 647 000

Remark: The amount of waste water discharged through HC-1 exceeds the maximum of the allowed quantity, but the total amount of waste water discharged through HC-1 and HC-2 does not exceed the maximum of the allowed amount for both channels, which is 3 280 mill. m^3. During the reported period, the amount of discharged waste water is less than the allowed quantity.

Summarized results from the physico-chemical tests of waste water

In 2011, the waste water samples were selected and analysed by an accredited laboratory – the Regional Laboratory (RL) at the Executive Environment Agency (EEA), town of Vratsa, and the laboratories of NPP Kozloduy – Engineering Chemistry (EC) section, Testing and Calibration Laboratory, and Physico-Chemical Control Laboratory.

The following waste water samples have been selected and analysed:

1. Regional Laboratory at the Executive Environmental Agency, town of Vratsa

- → 2 samples from Open Switchgear during 1st and 2nd quarter;
- → 12 samples from the Trapezium Channel (TC) during 1st, 2nd, 3rd and 4th quarter;
- → 5 samples from Ø 1000 during 1st, 2nd, 3rd and 4th quarter;

→ 10 samples from HC-1 during 1st, 2nd, 3rd and 4th quarter;

→ 11 samples from HC-2 during 1st, 2nd, 3rd and 4th quarter.

2. Physico-chemical Laboratory – Engineering Chemistry Section

→ 3 samples from the Open Switchgear during the 1st and 2nd quarter;

→ 15 samples from TC during 1st, 2nd, 3rd and 4th quarter;

→ 18 samples from Ø 1000 during 1st, 2nd, 3rd and 4th quarter;

→ 11 samples from HC-1 during 1st, 2nd, 3rd and 4th quarter;

→ 10 samples from HC-2 during 1st, 2nd and 3rd quarter.

3. Testing and Calibration Laboratory – Engineering Chemistry Section

→ 3 samples from the Open Switchgear during the 1st and 2nd quarter;

→ 12 samples from TC during 1st, 2nd, 3rd and 4th quarter;

→ 13 samples from Ø 1000 during 1st, 2nd, 3rd and 4th quarter;

→ 9 samples from the HC-1 during 1st, 2nd, 3rd and 4th quarter;

→ 12 samples from the HC-2 during 1st, 2nd, 3rd and 4th quarter.

Remark: Because of the low water level and weak water flow conductivity, in 2011 no samples from Ø 300 were selected.

Discharging at the Trapezoidal Channel (TC)

All recorded values are below the individual emission limits specified in the license for this flow, except for the results for the „boron" indicator, for which the restriction reads „not allowed" and "undissolved substances" (***Table 3.2-3**: Recorded emission values exceeding the Individual Emission Limit Values at the TC discharging point*

TABLE 3.2-3: RECORDED EMISSION VALUES EXCEEDING THE INDIVIDUAL EMISSION LIMIT VALUES AT THE TC DISCHARGING POINT

Indicator	Number of analysed samples	Number of exceeded values	IELs, [mg/dm^3]	Mean value, mg/dm^3	Maximum value, mg/dm^3
Boron	6	6	Not allowed	0.04	0.04
Insoluble substances	9	1	50	-	56

Discharging at Ø 1000

Exceeding of the Individual Emission Limits (IELs) has been observed for the „boron" and "phosphates" indicators.

All recorded values are below the Individual Emission Limits (IELs), specified in the license for this flow, except for the results for the „boron" indicator, for which the restriction reads „not allowed" and "phosphates" (***Table 3.2-4:*** *Recorded emission values exceeding the Individual Emission Limits (IELs) at the Ø 1000 discharging point*).

TABLE 3.2-4: RECORDED EMISSION VALUES EXCEEDING THE INDIVIDUAL EMISSION LIMITS (IELS) AT THE Ø 1000 DISCHARGING POINT

Indicator	Number of analysed samples	Number of exceeded values	IELs, mg/dm^3	Mean value, mg/dm^3	Maximum value, mg/dm^3
Boron	15	13	Not allowed	0.05	0.09
Total phosphorus (such as PO4)	12	1	2	-	2.45

Discharging of waste water from the Open Switchgear

All recorded values are below the Individual Emission Limits (IELs), specified in the license for this flow, except for the results for the „boron" indicator, for which the restriction reads "not allowed" and "insoluble substances" (***Table 3.2-5:*** *Recorded emission values exceeding the Individual Emission Limits at the Open Switchgear discharging point*)

TABLE 3.2-5: RECORDED EMISSION VALUES EXCEEDING THE INDIVIDUAL EMISSION LIMITS AT THE OPEN SWITCHGEAR DISCHARGING POINT

Indicator	Number of analysed samples	Number of exceeded values	IELs, mg/dm^3	Mean value, mg/dm^3	Maximum value, mg/dm^3
Boron	3	1	Not allowed	0.11	0.11
Insoluble substances	9	1	50	-	56

Hot Channels

HC-1

No cases of exceeded Individual Emission Limits (IELs), specified in the license for waste water discharging, have been observed for this flow.

HC-2

No cases of exceeded Individual Emission Limits (IELs), specified in the license for waste water discharging, have been observed for this flow.

Taking into account the analyses results it could be summarized that only for the waste water discharged into the Main Drainage Channel (MDC), some relatively low values of the „boron" indicator have been recorded, however, they are within the limits of the values recorded for the drinking water of the town of Kozloduy and the water in the Danube River (Protocol No. 1-E/January 24, 2012).

Radio-ecological monitoring

The in-house radiation environmental monitoring is regulated by the long-term radiation monitoring program of the environment implemented in NPP Kozloduy. The program is based on the requirements of the legislation on this matter and on good international practices and the extensive expertise of the Radiation Monitoring Department.

The monitoring zone includes the area of the industrial site of NPP, the 2-kilometer zone of urgent protective measures and landmark posts within a 100-kilometer radius.

Annual Programs and Annual Activity Reports are prepared for the implementation of radio-ecological monitoring.

The radio-ecological monitoring scope complies in full with the national and European regulatory requirements, including Article 35 of the EURATOM Agreement, EU Recommendations 2000/473/EURATOM and 2004/2/EURATOM. Subject to this monitoring are the sewerage of domestic waste water of NPP, natural water bodies, drinking, groundwater, and industrial waste water. The sample selection sites are 7, analysing natural water (catchments, drillings, water catchments, water bodies/ and bottom sediments – at 4 points along the course of the Danube River, and at the Ogosta River, the Tsibritsa River, and the Kozloduy dam. Monitoring of groundwater from about 80 boreholes (piesometres) alternated after a definite scheme, water from 10 spray ponds, and the drainage collectors for rain and waste water. Analyses for total beta-activity, strontium-90, tritium, and radionuclide composition are performed.

The monitoring comprises:

- → periodic control of the gamma background radiation at the site and within 100 km from the NPP,
- → laboratory radioactive analysis of samples from major ecological components at the site and within 100 km from the NPP,
- → automated radiation monitoring of the gamma background radiation in the towns and villages within the 30 km Urgent Protective Action Planning Zone.

The monitoring of the industrial site, the gas-aerosol and liquid radioactive releases, the mains water, the service and waste water from the NPP, and the monitoring in the region of Specialized Division Radioactive Waste-Kozloduy, are regulated by separate documents.

The results from the monitoring report that tritium content in domestic waste water samples throughout the year 2011 was lower than the minimum detectable activity (3.8 ÷ 7.7 Bq/l) with a few exceptions that are below the standard for potable water – 100 Bq/l (Regulation №9 of 16.03.2001). The maximum measured activity of ^{3}H is 40.1 Bq/l – December, 2011.

The specific activity of ^{90}Sr in all samples was lower than the minimum detectable activity – 0.0010 ÷ 0.0014 Bq/l. These are values typical of natural water bodies.

Water discharged from units 5 and 6 throughout the year had a specific activity of ^{134}Cs and ^{137}Cs, as follows: for ^{134}Cs < 0.0025 – 0.011 Bq/l, for ^{137}Cs < 0.0015 – 0.0011 Bq/l. The analysis of these data reports that throughout the year the discharged sanitary water from the strict control zone had gamma radiation background values lower than the minimum detectable activity.

The total beta-activity of the water of the Danube River, the Ogosta River, the Tsibritsa River, and the Shishmanov Val dam varies between 0.012 Bq/l and 0.15 Bq/l, which is about 30% of the control level (0.5 Bq/l, Regulation No. H-4/2012[37]). The maximum measured value for the water of the Danube river is 0.087 Bq/l, according to the Annual Report of Kozloduy NPP EAD for 2011. Tritium content in surface water samples is somewhere about the minimal detectable activity – up to 8.0 Bq/l. The total beta-activity measured for the drinking water sources in the region varies between 0.024 and 0.088 Bq/l. These values are much lower than the allowed drinking water norms under Regulation No. 9/March 16, 2001.

A detailed Annual Radio-Ecological Monitoring Report containing analysis of all the results for the relevant year is submitted to the Bulgarian Nuclear Regulatory Agency, the National Radiobiology and Radiation Protection Centre at the Ministry of Health, and the Executive Environment Agency at the Ministry of Environment and Water.

Hydrological data about the Danube River

No rivers flow through the NPP's territory. The Bulgarian inland rivers closest to the NPP are the Ogosta River and the Skat River. The natural topographic conditions and the remoteness of these rivers exclude the possibility for them to have any impact whatsoever on the NPP's state. No direct impact on these open currents is possible, either.

The Danube River is the only one of decisive significance for the operation and security of Kozloduy NPP. The NPP site is located on the terrace of the Danube River. The site's level is formed on a washed site of considerable size, designated during the NPP's design and having a non-floodability reserve in case a 10 000-year high wave along the Danube River is generated.

Between the NPP site and the Danube River, dikes have been erected which are sized to withstand a 1000-year high wave along the Danube river with the required normative reserve. The drainage systems in the region have been sized to carry away surface water from intensive rain of different duration and 0.01 % provision of the precipitation height.

[37] Regulation for the Characterization of Surface Water, prom. SG, No. 22 of March 05, 2013

In relation to the assessment of the NPP state on the part of the IAEA during the period 1991-1992, a cycle of hydrological, hydro-geological, and hydraulic calculations and studies for assessment of the NPP selection and site elements has been carried out. Part of these results have been analysed and assessed in the EIA for Kozloduy NPP, 1999, and major conclusions are presented hereunder in these Terms of Reference. After this mission, no interrelated hydrological study has been assigned or carried out. Separate studies have been carried out which do not cover the same period, so their results have been used without the possibility to be subject to a completely reliable assessment or interpretation.

The mentioned EIA Report pays serious attention to the maximum and minimum flow characteristics of the Danube River. In this respect, in Bulgaria, official results from only one study of the maximum flow have been published (Zh. Nikolov, BAS-1981). For the purposes of the design of various facilities along the Danube River, different studies have been carried out at the University of Architecture, Construction, and Geodesy, the National Institute of Meteorology and Hydrology, the Institute of Water Problems of the Bulgarian Academy of Sciences (BAS)[38] and Energoproekt AD, which differ in the amount and analysis of the information about the maximum flow and probabilistic assessments. Actually, in Bulgaria, there are no official publications on the use of stochastic models to determine the maximum sizing water amounts for the section from the town of Silistra to the town of Novo Selo.

Routine observations of hydrological elements are carried out on a daily basis by the Executive Agency for Maintenance and Study of the Danube River, town of Ruse (water stands, water amounts, water temperature and ice phenomena). Measurements and observations of these elements during various time periods have also been carried out by Energoproekt AD, NPP Kozloduy EAD, etc. Measurement expeditions for hydrological elements have been conducted by the NIMH, the UACG, Stefan Modev ET (Sole Trader Company). For the purposes of the mentioned EIA, available data from the following sources have been used:

- → The main hydrometric stations in the section of Oryahovo – ^{km}678 and Lom – ^{km}749.3,
- → Observations of the water stands at ^{km}704 (Executive Agency for Maintenance and Study of the Danube River) and ^{km}678 (Energoproekt AD),
- → Data from field measurements during the period 1978 – 1991.

In the section of the NPP Kozloduy, regime water level observations are carried out, as follows:

- → ^{km}678 – Oryahovo Hydro-Meteorological Station(Executive Agency for Exploration and Maintenance of the Danube River, town of Ruse),

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[38] IWP – former Institute of Water Problems, Bulgarian Academy of Sciences, which merged into the National Institute of Meteorology and Hydrology.

→ ^{km}687.50 – Bank Pump Station (NPP Kozloduy),

→ Data from field measurements during the period 1978 – 1991.

The conducted studies comply with the requirements of the IAEA for processing of the "entire available hydrological information, while checking the same for available systematic mistakes, as well as technical errors". The requirement "It is expedient to store this information in a hydro-meteorological database..." is addressed as a recommendation to the Hydro-Technical Facilities Department of NPP Kozloduy, which is currently organizing this activity.

The report's requirement reading that "...particular attention should be paid during the clarification of the natural hydrological characteristics and the hydro-morphological characteristics of the river bed and the river terrace, roughness characteristics, etc., and the multi-annual peculiarities of the river-bed processes should be made clear ..." has been fulfilled in accordance with the available information and the conducted studies. The lack of updated batimetric or topographic map of the river bed for the section of the Danube River located in the region of NPP Kozloduy does not allow making a complete hydraulic assessment of the flow capacity of the river bed at low and high water.

The performed study concludes that the Iron Gates water-power systems do not regulate flow during periods greater than 1 week because of the lack of regulating amounts. Therefore, their impact on the monthly and annual river flow is insignificant.

The variation of the Danube River flow has been determined to be greatest during low water months (August – January). The river flow is most stable during the high water period (February – July). The annual river flow is determined with 95% provision of over 4300 m^3/s.

Accounting for the results from the study performed for the needs of the EIA[39], the authors have determined that when NPP Kozloduy operated at its full power (3760 MW – with six running reactors and capacity of the cold (intake) channel of 180 m^3/s with proven maximal capacity of 200m^3/s), even in a strongly low water year (security of 99%), the Danube River water consumed by the NPP was very small – only 4.5 % of the river flow.

In normal operating mode with average annual output of 2500–3000 MW, the required water amount for the NPP's cooling system is about 2.7 % – 3.5 %. Such operating mode would be commensurate with the currently running power units 5 and 6 plus the NNU.

The irrecoverable water losses at NPP Kozloduy have been estimated to 0.00092% of the Danube River flow and 0.044 % of all water used by the NPP, and the reasonable conclusion has been made that NPP Kozloduy does not affect the Danube River's flow.

Ice phenomena have been considered in the EIA Report for NPP Kozloduy in 1999, insofar as they create or might create a risk for NPP's operation or security.

[39] EIA Report for NPP Kozloduy, 1999.

Observations of the ice regime of the Danube River have been carried out since the end of the last century. The major recorded parameters are the dates of occurrence and disappearing of ice phenomena (ice drift and complete freezing), as well as their intensity. No systematic observations of ice thickness or ice blocks size during ice-break have been carried out. Most often, ice build-up phenomena have been presented only descriptively.

The section of the Danube River located in the region of NPP Kozloduy pertains to Lower Danube (from Turnu Severin to the Black Sea). The climatic conditions and the complex morphology of the river bed favour the generation of ice phenomena. The most unfavourable form in which these phenomena are manifested is ice build-up. With them, as a result of the building-up of ice blocks, river zones or sections with significant water retention are formed.

Earlier studies (St. Modev, 1991) show that water level retention in the area of the Bank Pump Station at low water may reach up to 3.60 m, and at high water – up to 1.50 m. The probability for the formation of water retentions as a result of ice build-up phenomena at Oryahovo is once in 10 years, and water stands reached after water retention correspond to water stands with recurrence of 0.5%, i.e. once in 200 years. So far, no studies have been carried out regarding the chances of ice build-up at higher water, and the probability for the occurrence of such phenomena has been neither evaluated.

3.2.1.2 FORECAST OF IMPACT

The projection on the impact of the investment proposal will reflect the expected impact on surface and groundwater and will evaluate the need of new water amounts for drinking and household needs according to the recommendation of the Municipality of Kozloduy, stated in Letter No.73 00-128/1 of January 03, 2013 on the great number of workers during construction and the servicing staff of the NNU during its operation. This evaluation will be valid for all proposed alternative sites, irrespective of their location. The evaluation of the need of fresh water for service and industrial needs will be a single option, i.e. one source and one water-extraction system for all sites. The assessment of the different inclusion options and their environmental impact will be made. The projection on the impact of discharging non-radioactive domestic wastewaters, industrial and rain water, will consider in detail each alternative site, namely: the location of the planned treatment facilities, their capacity, and the treatment effect of the planned new underground infrastructure – sewer system, facilities leading to the collector, and discharging facilities.

When estimating the impact of the Investment Proposal, emphasis will be placed on the assessment of the ecological state and the chemical state of the water receiving body collecting all waste water from NPP Kozloduy and the NNU to the Danube River. Its ecological potential and ecological state will be assessed as pertaining to a body of moderate ecological potential and poor chemical state. The available knowledge and the adopted standards for assessment of chemical state quality (Directive 2008/105 Appendix 1) regarding the priority substances and assessment of the contribution to the organic pollution receiving waters according to the regulatory norms will be applied. According to the Water Basin Management Plan, the Danube River has been qualified as a water body at risk in achieving the ecological objectives. The results from the National Monitoring System will be considered and the possible impact from discharging of waste water and radioactively polluted water will be accounted for. The report of EIA will analyse and assess in detail each site with respect to the possibility of building-up and migration of radionuclides depending on its characteristics as regards the design characteristics related to the maintenance of acceptable risk level. The possibility for the sites flooding by a high river water level, increase of groundwater, destruction of the Hydro-Technical Facilities constructed along the Danube River, and other combinations of natural and technogenic phenomena will be analysed and assessed.

The EIA Report will consider in detail and comprehensively the expected impact of the IP's construction and operation on the ecological state of the Danube River water body in the Bulgarian section and also, in the transborder aspect (Letter of the Ministry of Environment and Forests (Republic of Romania) with Outgoing No. 3672 RP 18.10.2012).

Related analysis, estimation and projection on the impact will be made as regards liquid RAW releases by assessing the statutory collective annual doses for the population resulting from these releases.

A modeling program adapted to the hydrology of the region of NPP Kozloduy will be employed to assess the dose exposure to liquid releases. A conservative assessment of the dose exposure for a critical population group will be used. The program is based on the methodology adopted by the European Union called CREAM (Consequences of Releases to the Environment Assessment Methodology) Radiation Protection 72 – Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment.

The following basic criteria for assessment of the impact of the construction and operation of the NNU at the proposed alternative sites can be formulated:

- → Criteria related to the location, which will assess the considered sites with respect to the impact of the IP's construction and operation on the available infrastructure having importance for the region or for the existing site of the nuclear plant, and the physical impact of the construction and operation on surface water;
- → Criteria related to the options of providing technical water supply using water from the Danube River and other available water sources of the existing infrastructure, and leading the warm spent water and all wastewater to the receiving water body;
- → Criteria related to the security and safe operation of the new nuclear unit in view of the risk of natural events – flooding by river high water or technogenic risk – dam burst in an area above the site location;

→ Criteria related to the impact caused by the introduction of polluting substances into the water and their migration, including the thermal impact.

The thermal pollution of the Danube River will be discussed in 3.9.4 Harmful physical factors.

3.2.2 GROUNDWATER

3.2.2.1 CURRENT STATUS

According to the Water Basin Management Plan, the Kozloduy NPP site and the pertaining boundary territories overlay parts of the following water bodies:

→ Groundwater Body defined by code BG1G0000QPL023 – porous water in the Quaternary – between the Lom River and the Iskar River. The Kozloduy NPP site falls entirely over this water body, which occupies an area of 2890 km^2. This is the first aquifer. Collectors of porous types of groundwater are gravels of various sizes with sandy clayish filler, at some places – with sand streaks covered by loess depositions. Normally, groundwater in not pressurized. The following features of the water body have been identified: average thickness of the groundwater body – 25 m, average water transmissibility – 13 m^2/d, average filtration coefficient – 2 m/d, average module of the ground flow – 1.1 l/s.km^2, area of the feeding zone – 2888 km^2, natural resources – 2310 l/s. The direction and rate of exchange with surface water has been qualified as disturbed. According to the performed risk assessment of the chemical and quantitative state, the groundwater body has been qualified as **not being at risk.** According to the Danube Water Management Plan, the protective action of the covering layers is 90% favourable and 10% medium;

→ Groundwater Body defined by code BG1G0000QAL005 – porous water in the Quaternary – the Kozloduy lowland. Falls within the в east-northeast part of the Kozloduy NPP site and the boundary territories. Occupies an area of 39 km^2. Collectors of the porous type of groundwater are gravels, sands, clays, and sandy clays covered by sandy clays and clays. Normally, groundwater in not pressurized. The following features of the water body have been identified: average thickness of the groundwater body – 13 m, average water transmissibility – 1155 m^2/d, average filtration coefficient – 89 m/d, average module of the ground flow – 4 l/s.km^2, natural resources – 160 l/s, area of the feeding zone – 39 km^2. The direction and rate of exchange with the Danube river is direct. According to the performed risk assessment of the chemical and quantitative state, the groundwater body has been qualified as **being at risk**. There is detected pollution with Fe and Cl from anthropogenic impacts in the UWB chemical state. According to the Danube Water Management Plan, the protective action of the covering layers is 10% medium and 90% poor;

→ Groundwater Body defined by code BG1G0000QAL005 – porous water in the Neogene – Lom-Pleven depression. The Kozloduy NPP site falls entirely over this water body lying under the Quarternery aquifer. It occupies an area of 3065 km^2. It is represented by an upper and a lower layer, as follows:

- Collectors of fresh, porous-type groundwater, not pressurized, in the upper layer – gray-greenish clays, sandy clays, and clayish sands alternating with low-power coal lenses covered by sandy clays and loess. The following characteristics have been determined for the upper layer: average thickness of the groundwater body – 70 m, average water transmissibility – 140 m^2/d, average filtration coefficient – 2 m/d, average module of the underground flow – 0.8 l/s.km^2, area of the feeding zone – 618 km^2. The direction and rate of exchange with surface water is disturbed. According to the performed risk assessment of the chemical and quantitative state, the groundwater body has been qualified as being at risk with respect to the chemical state and as not being at risk with respect to the quantitative state. NO_3, Mn and other pollutions resulting from agricultural activities have been identified. According to the Danube Water Management Plan, the protective action of the covering layer is 10% medium and 90% poor;
- In the top of the lower layer there are clays (water impermeability), under them come sands of various grain sizes (aquifer) with small-power clayish streaks. Pressurized nature. The following features have been identified for the lower layer: average thickness – 100 m, average water transmissibility – 2500 m^2/d, average filtration coefficient – 25 m/d, natural resources – 1730 l/s. No exchange with surface rivers was established. According to the performed risk assessment of the chemical and quantitative state, the groundwater body has been qualified as not being at risk with respect to the chemical and quantitative state. According to the Danube Water Management Plan, the protective action of the covering layers is 95% favourable and 5% medium.

During the outlining of the groundwater bodies, the criteria applied in the Dutch approach, Strengthening of the capacity and enhancement of the national groundwater monitoring system of Bulgaria towards implementation of the Water Framework Directive 2000/60/EC, have been taken into account, as implemented by a team from the Hydrogeology Department of the Institute of Geology at the Bulgarian Academy of Sciences based on a contract signed with the Dutch company ARCADIS EUROCONSULT BV. Their identification was performed by the Executive Environment Agency with the help of the Basin Directorate. The major materials used were a geological map (GIS, vector, M 1:100 000), hydro-geological maps (GIS, M 1:500 000 scalar, M 1:200 000, for certain, more water-abundant regions of the country, to scale M 1:25 000).

The characterization of the water bodies is a requirement of the Water Framework Directive 2000/60/EC, based on expert criteria for the objectives of the loading and impact assessment, adopted at national level (IMPRESS review). They have been taken from the criteria developed by the International Commission for the Protection of the Danube River and have been adapted to the national conditions. In performing the assessment, the Guide on Application of the Framework Directive on Water developed under Twining Project BG 03/IB-EN-02 has been used as well.

The assessment of the protective action of the cover layers of the Groundwater Bodies has been performed based on an expert assessment of the characteristics of the geological units. The analysis is based on the rate of revealing of the groundwater body on the Earth's surface and the anthropogenic loadings on the revealed parts of the bodies. Three groundwater body classes have been isolated – with favorable, medium, or unfavorable action on the cover layers.

The three water bodies on which the territory of NPP Kozloduy falls have been qualified as water-protection zones, from which water for human consumption is drawn, with average 24-hour capacity of above 10 m^3 or which are used for water-supply of more than 50 people, according to the requirements of Article 7, point 1 of Directive 2000/60/EC and Article 119 of the Water Act.

The drinking water protection zones for groundwater bodies have been determined based on issued water-extraction licenses for drinking and household water supply and established Sanitary Protection Zones around the water-extraction equipment under the terms of European legislation transposed into the Water Act and Regulation No. 3/October 16, 2000 on the terms and conditions for investigation, design, approval and operation of Sanitary Protection Zones around the water-extraction equipment for drinking and municipal water supply and around mineral water sources used for healing, prophylactic, drinking, and hygienic needs.

The water from the Groundwater Body defined by code BG1G0000QPL05 – porous waters in the Quarternery – Kozloduy lowland is characterized by total beta activity and content of natural uranium below the admissible values according to Regulation No. 9/March 16, 2001 on the quality of water for drinking and household purposes, and the specific activity of the studied radionuclides (^{40}K, ^{137}Cs, ^{54}Mn, ^{109}Cd, ^{226}Ra, ^{232}Th, ^{214}Pb, ^{214}Bi) is below the maximal admissible values, according to the Regulation on the basic norms of radiation protection, 2012.

According to information provided by the water management Basin Directorate – Danube region, Pleven, by Letter with Outgoing No. ЗДОИ-380/February 11, 2013, on the territory of the water body, one monitoring station is watched closely, namely the shaft well-P2 BC Kozloduy, which has been assigned to perform major monitoring of the physico-chemical indicators of the 1st and 2nd group and specific pollutants of the 1st group of metals and metalloids and 2nd group of organic substances.

The results from the analysis of the performed monitoring show that all observed indicators are within norm according to the quality standards regulated by Regulation No. 1 (2007) *on the investigation, use, and preservation of groundwater*, as amended and supplemented the State Gazette (SG) No. 15, 2012.

Longstanding research of drinking water conducted by NPP Kozloduy under the environmental monitoring program show that the values for the total beta activity are considerably lower than the maximum admissible values according to the requirements of Regulation No. 9/March 16, 2001 on the quality of water for drinking and household purposes, and the content of technogenic ^{90}Sr and ^{137}Cs is several ten times lower than the norms according to the Regulation on the basic norms of radiation protection, 2012.

To implement the recommendations of the report of EIA of 1999 and the provisions of Decision No. 28-8/2001 on EIA, proper non-radiation monitoring is carried out at NPP Kozloduy.

On the territory of the industrial site of Kozloduy NPP, a total of 181 boreholes (piesometres) have been drilled. Of them, 76 are located on the territory of EP-1, 52 – on the territory of Electricity Generation-2, and 53 in the region of the Spent Fuel Storage Facility and the Lime Production Facility.

Since the commissioning of the Radioactive Waste Processing Shop in 2001, exploration of 26 new piesometres has started.

Under the Groundwater Radioactivity Study Program, at the industrial site of Kozloduy NPP, sample collection from 115 boreholes is carried out. Of them, 27 are located on the territory of Electricity Generation-1, 29 – on the territory of Electricity Generation-2, 26 are in the region of the RAWPW and the RAW storage depot, 25 in the regions of the WSF, the Lime Production Facility, and the site for temporary outdoor storage of solid RAW, and 5 – on the waste depot.

In August 2004, sample collection and analysis of three new reference drillings located at the input and output of the aquifer, in the immediate vicinity of the industrial site, was initiated.

Water samples from the boreholes have been analysed four times in a year for total beta-activity and tritium content.

The European requirements regarding the application of Article 35 of the EURATOM Agreement for monitoring of environmental radioactivity levels for the purposes of assessment of the dose exposure of the population as a whole are regulated by Recommendation 2000/473/Euratom of June 08, 2000 of the European Commission. This Recommendation is of major significance for the standardization and unification of the applied practices in the field of radioecological monitoring of EU member-states. The terms and the general requirements for monitoring types, monitoring and sample collection (dense or spaced) networks, control periodicity, monitoring scope, and the requirements for sample collection and analysis of the major controlled environmental features have been defined. Furthermore, the amount of sample-accompanying information, and monitoring data management and transfer have been regulated.

The institutional environmental radiation monitoring is regulated by a long-term environmental radiation monitoring program of NPP Kozloduy. The Program is based on the regulatory requirements in the field, as well as on the good international practices and the extensive operating experience of the Radioecological Monitoring Department. The Program has been coordinated with the Ministry of Environment and Water, the Ministry of Health, and the Bulgarian Nuclear Regulatory Agency and complies with the international recommendations in the field, including Article 35 of the EURATOM Agreement and Recommendation 2000/473/Euratom. To provide independent control, radiation monitoring programs are implemented by the controlling authorities: the Executive Environment Agency at the Ministry of Environment and Water and the National Radiobiology and Radiation Protection Centre at the Ministry of Health.

To localize and assess the potential impact of NPP Kozloduy on the environment and the population, 2 control zones of different radius around the NPP have been designated: Precautionary Action Zone – 2 km, and Urgent Protective Action Planning Zone – 30 km. Subject to monitoring is also the territory of the industrial site itself. For comparison, sample collection and measurements are carried out at reference points located within up to 100 km from the NPP, where no impact from the NPP's operation is expected. Laboratory and automated control of the environmental components is carried out.

Practice shows that the results from the radioecological monitoring feature much lower values than the values established by the regulatory documents. Therefore, most often, comparison of the current results with results from previous years of operation and prior to the NPP's commissioning is used. This approach allows recording and analysing even the slightest tendencies for change in radioecological circumstances. The preoperation measurements in the region of NPP Kozloduy were carried out during the period 1972–1974 by the National Radiobiology and Radiation Protection Centre (then bearing the name Scientific Institute for Radiology and Radioactive Hygiene.

The available environmental water radioactivity data at NPP Kozloduy during the preoperation period show the following contents: Cesium -137 -10.0 mBq/l ± 6.0 mBq/l; Strontium -90- 7.0 mBq/l ± 6.0mBq/l; total beta-activity 420 mBq/l ± 170 mBq/l.

During the implementation of the modern monitoring program, particular attention is also paid to drinking water sources in the region of the NPP. The drinking water for the town of Kozloduy, village of Harlets, NPP Kozloduy, and the town of Oryahovo has been tested on a monthly basis for beta-activity and tritium. ^{90}Sr and ^{137}Cs are determined twice in a year and for the water mains of the town of Oryahovo – four times a year.

The results are identical with those from previous years and are many times lower than the statutory norms, which shows that the radiation state of drinking water sources in the region has not been affected by the operation of NPP Kozloduy and complies completely with the sanitary norms.

At the industrial site itself, about 115 boreholes are controlled to assess possible pollutions on a local scale. The control is carried out on a quarterly basis.

Out of 115 boreholes measured for total beta-activity in 2011, with 110 of them, the total beta-activity throughout the year has not been even a single time greater than 0.75 Bq/l, according to Regulation No. 1/2007 on the investigation, use, and preservation of groundwater.

According to the Environmental Radiation Control Program, the water from boreholes with total beta-activity greater than 1.5 Bq/l has also been subject to gammaspectrometric testing to find out its radionuclide composition.

With the gamma-spectrometric measurements, minimal technogenic ^{60}Co activity has been recorded only in two drillings, and traces of ^{137}Cs – in one drilling. The values of 0.3÷0.5 Bq/l comply with the Maximum Admissible Values. Increased tritium content has been measured only in some drillings at the industrial site. These are but local sections, located in the immediate vicinity of equipment with radiation potential – dedicated bodies, RAW storage and processing equipment. Tritium activity varies from background levels in most drillings to a maximum of 12 kBq/l in the region of AB-3 of Electricity Generation-2. Total beta-activity varies within the range from typical background values to 3 Bq/l in the region of the RAW storage facility.

The radioactivity from the other drillings at the site and the reference drillings is very low (below or about the MAV), which evidences that the aquifer in the region has not been affected by the operation of the NPP.

The groundwater within the 2 km Precautionary Action Zone (PAZ) outside the site of NPP Kozloduy has been tested at 8 exploration boreholes (piesometres). Five of them are located in the region of the Depot for Non-Radioactive Household and Industrial Waste. A total of 4 of these 8 piesometres are reference ones and are used for comparison and global assessment of the impact on the aquifer in the region around the site. Sample collection and analysis is performed on a monthly basis. Tritium activity and total beta-activity of the samples is tested, and at the reference drillings, gamma spectrometric analysis is also performed.

In 2011, the results for the total beta-activity of groundwater around the site of the DNHIW vary between <0.055 and 0.39 Bq/l, with average value of 0.11 Bq/l. These results are within the normal limits for groundwater, lower than the groundwater norm (1 Bq/l, Regulation No. 1 of October 10, 2007 on the investigation, use, and preservation of groundwater).

The analyses for tritium in groundwater show activity of <4.2 to 60.3 Bq/l, with average content of 13.3 Bq/l. All results are below the MAV, except for one piesometre from the DNHIW. These are very low values, even below the norm for drinking water (100 Bq/l, Regulation No. 9 of March 16, 2001).

On the overall, the radiation characteristics of the aquifer at the site input and output are not affected by the operation of NPP Kozloduy. The radiation indicators are within the limits of the admissible norms.

3.2.2.2 FORECAST OF IMPACT

For the purposes of the Report on EIA, an Estimate of the impact will be prepared based on an assessment of the effectiveness of the performed actual studies, including the results from groundwater monitoring in 2012 and current studies from 2013. The implementation of the following mandatory activities under the project, ensuring unbiased assessment of the impact of the Investment Proposal (IP) on groundwater will be analysed in detail:

→ The prepared conceptual model of the hydrogeological circumstances will be assessed, in order to analyse the established groundwater feeding sources and the drainage zones. The localized vulnerable zones of the industrial site will be analysed and the protective action of the groundwater bodies' covering layers will be assessed based on expert assessment related to the characteristics of the geological units, thickness of the aquifer layer, and restrictive beds. The prepared and assessed models for underground water flow, quality, transmissibility, and retention coefficient will be assessed. The criteria for the preparation of a conceptual model should comply with Guide No. 26 A. Conceptual Model for Groundwater of the General Strategy for Application of the Framework Directive on Water;

→ The filtration and migration characteristics of the hydrogeological environment for all sites will be defined, which will be used in the investment project to forecast radionuclide migration[40]. The methodology of the forecast – forecasts for radionuclide migration, in the studies so far has been made using the computer codes: MODFLOW – in the analysis of hydrodynamical characteristics, and MT3DMS – in the forecast of pollutant migration;

→ The impact estimation will be subject to the following criteria:

  ✓ Assessment of the groundwater regime, including water level behaviour and capacity change in the part of the considered water body on which the investment proposal falls. The assessment criteria are defined in Regulation No. 1 of October 10, 2007 on the investigation, use, and preservation of groundwater, in effect since October 30, 2007 issued by the Ministry of Environment and Water, the Ministry of Regional Development and Public Works, the Ministry of Health, and the Ministry of Economy and Energy, as promulgated in the SG No. 87 of October 30, 2007, as amended the SG No. 2 of January 8, 2010, as amended and supplemented the SG No. 15 of February 21, 2012.

  ✓ Assessment of the properties of underground water. The criteria for assessment of the chemical state of groundwater are:

    - the groundwater quality standards determined pursuant to Article 135, para. 1, point 2 of the Water Act;
    - the groundwater pollution thresholds determined under the terms of Article 118b of the Water Act.

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[40] Clarification of the dispersion characteristics of soil and water environment in the region of NPP Kozloduy for the purpose of analysing the possible migration routes of the radionuclides from the NPP into the soil and the hydrosphere, 1991, Aquater partnership, Leader: Prof. M. Galabov, 1992

- ✓ Assessment of the impact of the investment proposal on the water protection zones, including the groundwater properties used for Drinking and Municipal Water Supply. The criteria for assessment of the chemical state of the groundwater used for PMWS are the requirements of Regulation No. 9 of March 16, 2001 on the quality of water intended for drinking and municipal needs, as promulgated the SG No. 30 of March 28, 2001, as amended the SG No. 87 of October 30, 2007, in effect since October 30, 2007, as amended and supplemented the SG No. 1 of January 4, 2011, as amended the SG No. 15 от February 21, 2012, in effect since February 21, 2012;
- ✓ Assessment of the hydrogeological environment. Emphasis will be placed on the possibility for harmful impact of groundwater as a result of the utilization of the investment proposal, the possibility for the occurrence of suffosion, diffusion, subsiding, mixing of aquifers with different properties.
- ✓ Assessment of the ecosystems depending on the regime and properties of groundwater. The assessment criteria have been defined in the Water Framework Directive (WFD), in effect since December 22, 2000. Its purpose is to establish a water protection framework (for surface, ground, coastal, or international water). By the WFD, the EU member-states undertake to protect from future deterioration and to improve the quality of water ecosystems. The major objective is to achieve “good ecological status” by 2015. The natural state of water ecosystems (flora and fauna) is used as criteria.

→ In carrying out of the investigations linked with the investment project, assessment of the hydrological circumstances will be made, which will include:

- ✓ the expected concentration of the radioactive material in groundwater at the closest point of the region from which water for drinking and household purposes is taken;
- ✓ the characteristics of radionuclide retention in the soil;
- ✓ the transfer routes and the arrival times of the radioactive material from the point of release to the consumption source;
- ✓ the transfer capacity of the surface flow, the intermediate flow and the drainage into groundwater;
- ✓ the pollution susceptibility of the aquifer layer at different levels; and
- ✓ time and spatial distributions of radioactive material concentrations in groundwater as a result of an emergency release from the NPP.

- → To assess the hydrochemical and radiological examination of groundwater, the investment project will provide analysis of the results from the monitoring program implemented over the years prior to the accomplishment of the Investment Proposal (IP), its effectiveness, the manner of interpretation of the results, and its applicability to the Investment Intention (II). A task of utmost importance will be to make a comprehensive survey and interpretation of the performed analyses of water samples during the period 2007–2012, preparation of graphs illustrating the concentration of the examined elements and their joining in a single information system for all monitoring programs. Seasonal isoline maps will be prepared, indicating water level behaviour and pollutant concentration in water. The assessment criteria have been defined in Regulation No. 1 (2011) *on water monitoring;*
- → Assessment will be made of the location of the constructed monitoring stations, their technical condition, depth, structure, and the information obtained from them regarding the examined water and the water body they refer to. Where needed, new monitoring stations will be proposed in the NNU construction zone.
- → The available information does not contain any data of drawn seasonal hydrodynamic and hydrochemical groundwater maps. Under the investment project, seasonal hydrodynamic maps will be drawn, evaluating the filtration depression zones.
- → For the purposes of the EIA, the possible releases into groundwater during normal and emergency operation of the NPP will be assessed, which might affect the quality of groundwater, directly or indirectly, through soils and surface water:
  - ✓ Indirectly – through infiltration of surface water which has been polluted with radioactive material released by the NNP or infiltration of radioactive liquids from storage tanks;
  - ✓ Directly – accident in the NPP which may allow radiation material to penetrate into groundwater. The protection of groundwater quality from such events will be taken into account in the safety analysis of emergency states and the need of a geographic protective barrier will be assessed.

3.3 LANDS AND SOILS

3.3.1 LANDS

3.3.1.1 CURRENT STATUS

The Investment Proposal (IP) includes 4 sites whose main characteristics are presented in ***Table 3.3-1:*** *Basic features of the alternative sites for the location of the NNU.*

TABLE 3.3-1: BASIC FEATURES OF THE ALTERNATIVE SITES FOR THE LOCATION OF THE NNU

Site	Total area, decares	Land	Municipality	Property
1	550	Harlets	Kozloduy	NPP – 24.7 decares; Public organizations and state and private property – 525.3 decares
2	550	Harlets	Kozloduy	NPP – 202.7 decares; GBC-ECM AD – 68.6 decares; private plots – 278.7 decares
3	530	Harlets	Kozloduy	NPP – 66.5 decares; private agricultural land – 463.5 decares
4	210	Harlets, Town of Kozloduy	Kozloduy	NPP – 161 decares; Enemona AD – 49.0 decares

Table 3.3-1: *Basic features of the alternative sites for the location of the NNU* presents the four sites by type of property.

Figure 3.3-2: *Kozloduy NPP project sites by type of sustainable land use* presents the four sites by the type of sustainable land use. As can be seen, none of the four sites falls withon forest area.

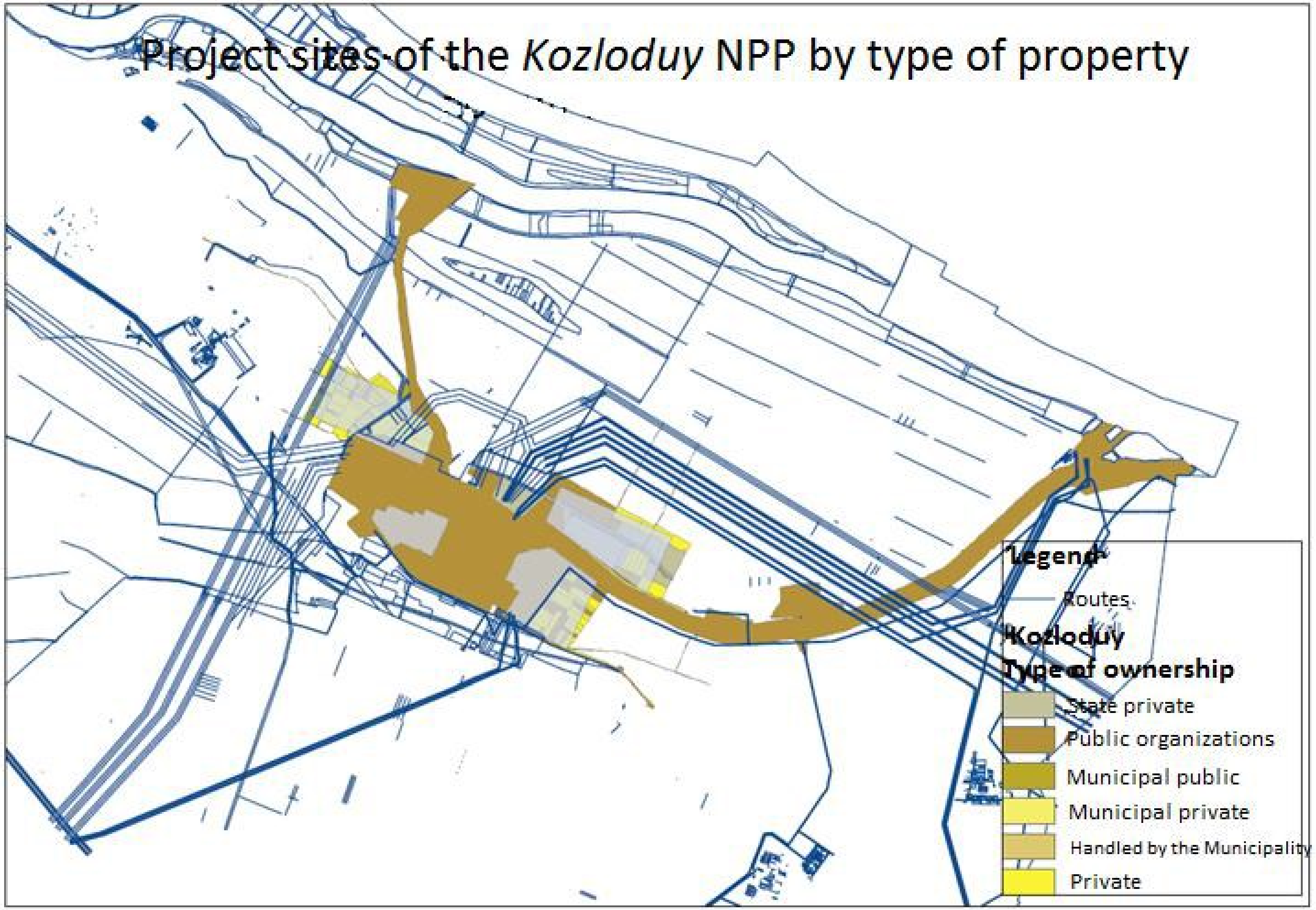


FIGURE 3.3-1*: KOZLODUY NPP PROJECT SITES BY TYPE OF PROPERTY*

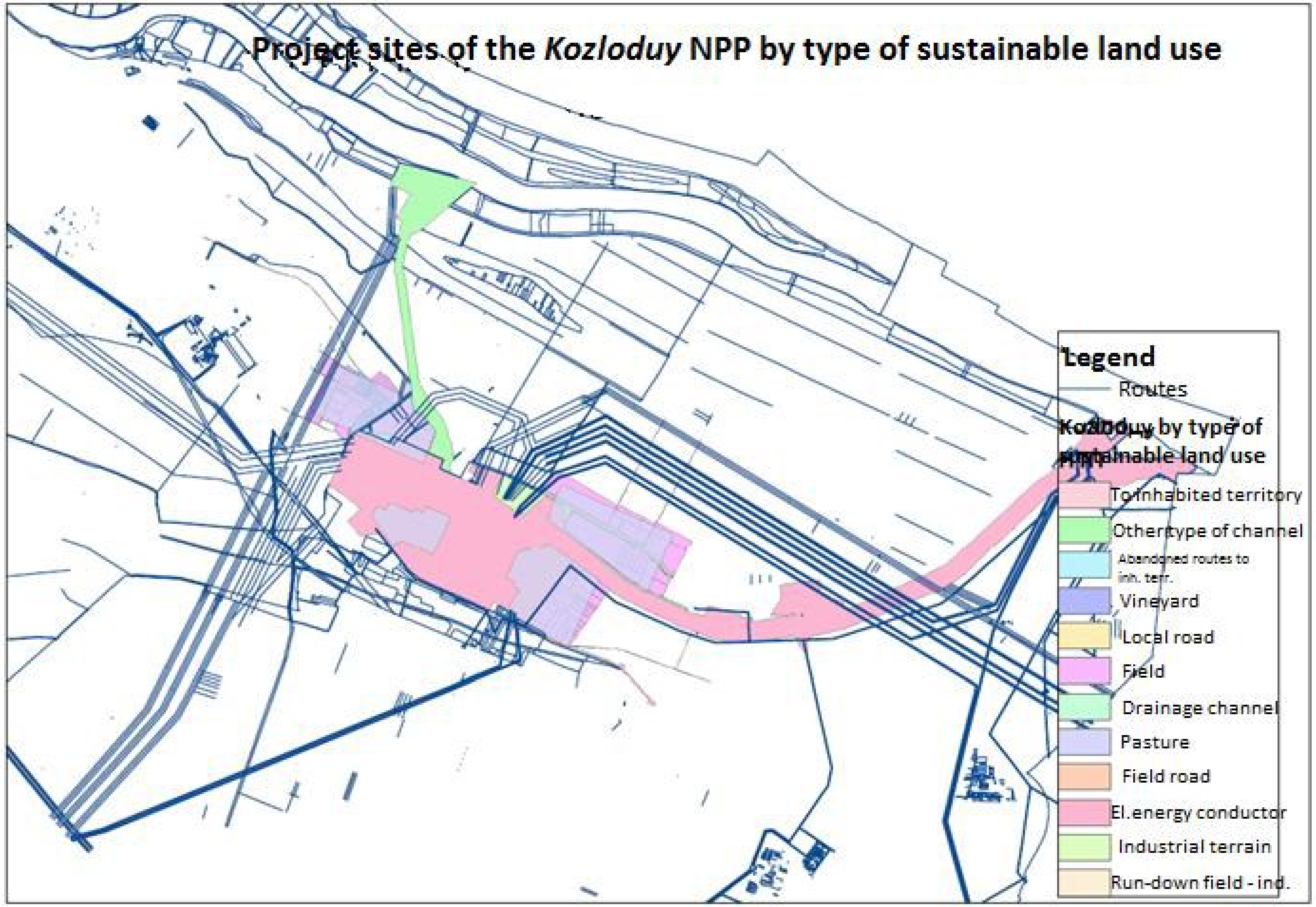


FIGURE 3.3-2: KOZLODUY NPP PROJECT SITES BY TYPE OF SUSTAINABLE LAND USE

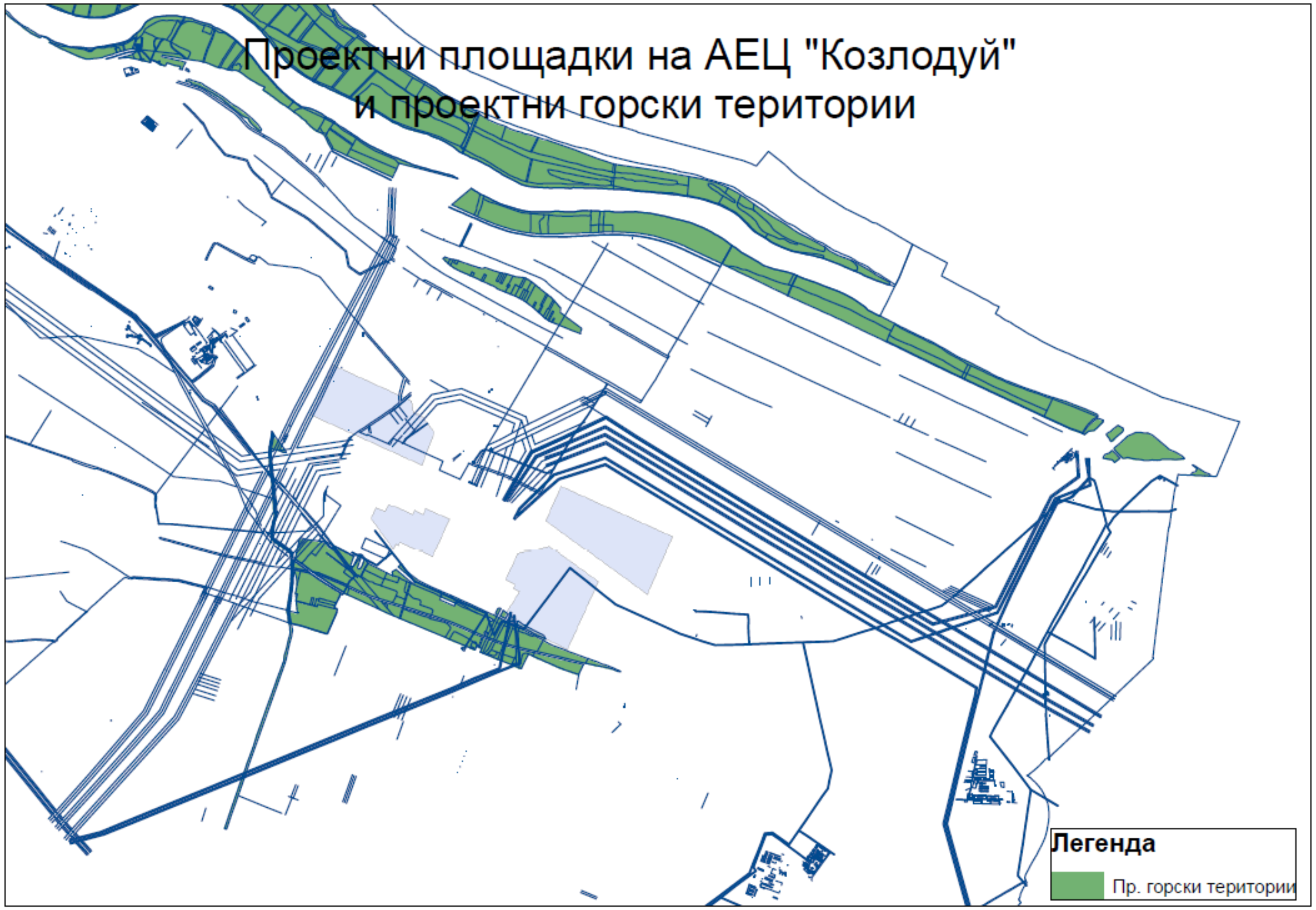


FIGURE 3.3-3: PROJECT SITES OF KOZLODUY NPP AND PROJECT FOREST TERRITORIES

FIGURE 3.3-4: PROJECT SITES OF KOZLODUY NPP BY TYPE OF LAND CATEGORY

Figure 3.3-3: *Project sites of Kozloduy NPP and project forest territories* shows the four sites and the forest territories in the close vicinity. The project forest territories are for example self-afforested deserted plots or ones which have turned from bush-plantedplots to forests.

Figure 3.3-4: *Project sites of Kozloduy NPP by type of land category* presents the four sites by land category. The state of agriculture within the region of NPP Kozloduy has been defined on the basis of information about the structural cover and the land productivity, as well as on the basis of the manner of agricultural land permanent use.

The available data on the distribution of arable land by groups of cultures in the zone of interest show that arable land (52.109 %) is mainly used for grain crops, 8.831 % for technical crops, 3.012 % for vegetables, 2.529 % for vineyards.

The Report on the Environmenat Impact Assessment will provide a survey of the use of agricultural land, the effect on forest areas and settlement territories within the 30 km Urgent Protective Action Planning Zone (UPAPZ) around the NPP. Within the scope of the Terms of Reference, attention is mainly focused on agricultural land for which specific data is available.

According to the Ecological Assessment of the Specialized Detailed Site Development plan (SDSDP), about 12 566 decares lie within in the Precautionary Action Zone (PAZ) of radius of 2 km around NPP Kozloduy, of which 3 012 dka have been allocated for the industrial site of Kozloduy NPP and the site for storage and processing of radioactive waste of the state-owned enterprise RAW – Kozloduy, and the rest is arable land, planted each year with different agrarian cultures. The summary conclusion to be made is that plant growing in the region is focused on grain production but technical cultures and orchards and vineyards are also important. Livestock–breeding is poorly developed and domestic animals are raised in household farms. On the territory of NPP Kozloduy, the main type of land affected by various-purpose activities is agricultural land, which in intended for growing of agricultural crops, part of it being swampy plots, for construction sites, etc. Besides the existing facilities and the operting units of NPP Kozloduy, some privatized buildings are located here. The New Nuclear Unit of the NPP is to be constructed on this territory, too. Four sites are proposed for that purpose. A Register of the New Nuclear Unit site border points specifying the owner and the land area is provided in Letter No. 45/ January 29, 2013 of NPP Kozloduy EAD Legal Division, Appendix 3 to the Letter (Appendix 3 to the Terms of Reference).

SITE 1 – 55 ha

The site is located to the northeast of units 1 and 2 of NPP Kozloduy, between the Open Switchgear and the Valyata locality, in the vicinity of the constructed cold and hot channels –northward of them. The area of the terrain to be expropriated is about 55 ha (NPP – 24.7 decares ; public organizations and state and private property – 525.3 decares), first category, irrigated area located on the first flood terrace of the Danube River. The soils are of the Alluvial-meadow type. The terrain is plain, with slight gradient from northwest to northeast. To provide for the site development, an embankment is envisaged which will raise the level by a volume of about 3.5 mln. m^3. Half of the area is bush-grown.

Open drainage channels fall within the site area, which will be reconstructed.

The available connection to Cold Channel -1 and Hot Channel-1 is an advantage, but the terrain is halved by the drainage channel.

The fact that the site is located on the flood terrace of the Danube and in cases of high water level, there is real danger of floods and damages, is a disadvantage.

The humus layer loess of the arable land should be taken off in advance. The terrain to be expropriated is currently used for growing of agricultural crops.

SITE 2 – 55 ha

The site is located eastward of units 1 and 2 at the Kozloduy NPP site in the direction of the village of Harlets, southward of the constructed cold (intake) and hot (outlet) channels. The area of the terrain to be expropriated is approximately half of the 55 ha, first category, irrigated area (NPP – 202.7 decares; GBS-ECM AD – 68.6 decares; private land – 278.7 decares). The site lies 3 km away from the village of Harlets and 4 km away from the town of Kozloduy. Statement of the buildings for properties and cadastre units within part of the territory of Site 2 has been provided in Letter No.45/January 29, 2013 of NPP Kozloduy EAD Legal Division, Appendix 1 to the Letter (Appendix 3 to the Terms of Reference).

The terrain is at elevation of 37-38 m, hilly, greatly inclined from south to north, better expressed in the southeast part of the site. The soils are of the Alluvial-meadow type. Excavations are envisaged to provide for the site development.

A former farmyard happens to be within the site region, which is currently used as auxiliary production facility of enterprises servicing the NPP. The rest of the terrain is used for growing of agricultural crops.

Two power transmission lines cross the site over its farthest part which do not leave room for any new construction. As the channels are nearby and the connection with them is very good, the site turns out to be a good option for the construction of NNU from the viewpoint of excavation and backfilling works and saving agricultural land.

SITE 3 – 53 ha

The site is located northward of units 5 and 6 of the NPP Kozloduy, near the bypass road of the existing plant. The locality of the site is plain, its altitude varying between +26-28.0 m. The lowland and the site are protected by an embankment reaching absolute elevation of +30.40 m. To the north, the site is limited by the flood plain of the Danube River, lying 3.7 km away from the midstream of the №222000014/19.04.2012 of the site are: the town of Kozloduy -2.6 km to the north, the village of Harlets – 3.5 km to the southeast, the village of Glozhene – 4.0 km to the southeast, the village of Saraevo – 6.0

km to the southeast, the town of Mizia – 6.0 km to the southeast, the village of Butan – 8.4 km to the south; the town of Oryahovo – 8.4 km to the east.

The site is located on plain terrain, slightly inclined to the north, and represents a plot with area of about 53 ha and the following ownership: NPP – 66.5 decares ; private agricultural land – 278.7 decares. For the purposes of the site development, an embankment of at least 10 m is envisaged to raise the elevation. Currently, it is rather a swamp than agricultural land. This is proven by the open drainage channels which should be reconstructed. The soil is of the Alluvial-meadow type, very boggy.

The humus layer and the loess of the arable land should be taken off in advance. According to previous information submitted by Energoproekt AD, the terrain to be expropriated is used for vineyards, fruit trees and other cultures. During the inspection of the terrain in January no such facts were established.

The site's disadvantage is that it is boggy in some parts of the terrain and that large area of private agricultural land will have to be expropriated and paid additionally in order tochange its intended use.

SITE 4 – 21 ha

The site is located westward of units 3 and 4 of NPP Kozloduy and the Spent Fuel Storage Facility of the NPP, southward of the cold and hot channels. The available area is about 21 ha within the boundaries of the expropriated terrains of the NPP. Statement of the buildings for properties and cadastre units within part of the territory of Site 4 has been provided in Letter No.45/ January 29, 2013 of NPP Kozloduy EAD Legal Division, Appendix 1 to the Letter (Appendix 3 to the Terms of Reference).

The terrain coincides with the land on which the existing constructed servicing facilities – Equipment storage facility, Car Repair facility, Assembly facility and Enemona are located. For the purposes of the site development, reconstruction and shifting of basic underground NPP communications are planned, as well as moving these businesses to other locations.

The soil is of the Calcareous chernozem type, sealed in its major part, strongly affected by human activity and degraded. The site is sealed with asphalt and is built up.

The advantage is that no change in the intended use of the land will be required.

The disadvantage is the small area and the fact that there is a great number of buildings to be demolished.

From the analysis of the advantages and the disadvantages of the reviewed sites it becomes clear that the site of least disadvantages is the second site which also has a number of positive economic advantaged.

3.3.1.2 FORECAST OF IMPACT

The construction of the facility, including the associated and the auxiliary facilities involves some changes in the intended use of the land, implies certain impact on some of the soils which will stay covered for a period of more than 70-80 years, change of the balance of the types of land use, and so on.

The Report of Environmental Impact Assessment (REIA) will assess the capacity of the land around and in the region of the NPP to undertake the assumed impacts during the construction and operation of the Investment Proposal and the cumulative effect on it. Subject to assessment and analysis will be the following:

- → Land status within the scope of the sites, subject to assessment;
- → Violation or change of land category;
- → Existing land users and their adaptation to the sites and the facility routes;
- → Violations and changes of land resulting from the implementation of the Investment Proposal;
- → Setting up criteria for ranking and site selection for the location of a new nuclear unit;
- → Occurred violations and changes in land and soil;
- → Land and soil pollution in cases of accidents and incidents.

To finalize the procedures related to change in the intended use (except the cases under Article 73, para. 1, item 5 of the Forest Act) when establishing right to construction or servitudes, another procedure will be applied, related to issuing administrative acts and awarding contracts. The REIA will describe, pursuant to relevant procedures, the following kinds of lands:

- → Subject to change of the territory's intended use pursuant to Article 73 of the Forest Act;
- → For which servitude will be established pursuant to Article 61 or Article 64 of the Forest Act;
- → For which right to construction will be established without change in the territory's intended use pursuant to Article 54 of the Forest Act;
- → Which will be leased pursuant to Article 43 of the Forest Act.

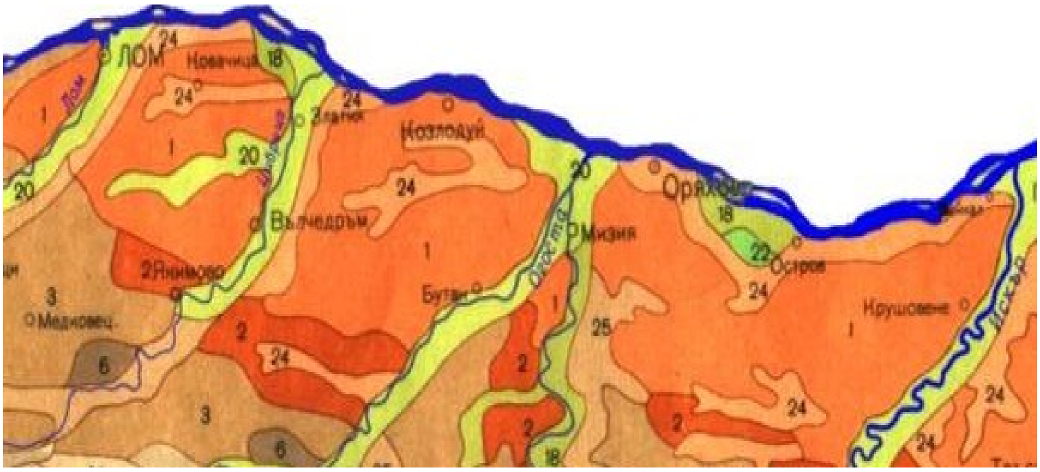
3.3.2 Soils

3.3.2.1 Current status

According to soil geographic regioning, the Municipality of Kozloduy is located in the soil geographic region of the Chernozem (black earth) Danubean subarea, Middle Danubean province and the agro-ecologic region is also the region of Chernozem soils. In the erosion aspect, it lies within the region of plain and hilly regions with non-erosion soils. The soils of the Municipality of Kozloduy appear to be heavy soils in the lowlands –

mainly Calcareous chernozem and Alluvial (Delluvial) meadow (Koinov, V., Iv. Kabakchiev and K. Boneva, 1998[41]). More detailed description of soils is shown in ***Figure 3.3-5:*** *Typical soils in the region of the Municipality of Kozloduy.*

Most widely spread in the 30 km zone around Kozloduy NPP are the **Chernozems.** The soils observed most often around them are Calcareous chernozems loamy, Chernozems typically loamy, Eroded Calcareous chernozems. and Chernozems typical leached heavy loamy.



15 km

FIGURE 3.3-5*: TYPICAL SOILS IN THE REGION OF THE MUNICIPALITY OF KOZLODUY*[42]

Legend:

1 – Calcareous chernozems	20 – Alluvial and alluvial-meadow soils
2 – Typical chernozems	22 – Meadow and Peat-boggy soils
3 – Leached chernozems	24 – Eroded calcareous and typical chernozems
6 – Dark grey forest soils	25 – Eroded leached chernozems
7 – Grey (lesive) forest	26 – Eroded grey forest soils
18 – Meadow chernozems	32 – Grey forest soils

Calcareous chernozems have good general physical properties and structure, they do not have great plasticity and are easy to process. The water regime of these soils is not very good due to the continuous drought in summer and the considerable non-productive evaporation of moisture. Regarding their sustainability to pollution, they are of a high class due to the great quantity of carbonates and the relatively great quantity of humus.

Typical chernozems occur relatively less frequently in the region, being located southward of the Calcareous chernozems, and because of the hilly relief, part of them are also eroded.

[41] Koinov, V., Iv. Kabakchiev and K. Boneva, 1998. Atlas of Soils in Bulgaria. Zemizdat. Sofia.

[42] Koinov et al. Soil Map of Bulgaria, 1968.

Leached chernozems are formed mostly on loess, loam loess and loess-like sandy clays. Unlike the previous soils, they are notable for being better formed and featuring stronger humus horizon and soil profile.

The active soil acidity is within the weak alkaline spectrum of 7.4 pH – 8.4 pH. Lower values are rarely met – in the region of Krushovitsa, (pH=6.0), Manastirishte (pH=5.5) and other.

The buffer capacity of the Chernozems is great. Their physical and chemical characteristics show that the buffer capacity is provided mostly by the dissolution of calcium carbonate and the buffer capacity of such soils is great. A region where wind erosion is strongly manifested – first class, is the Zlatiyata plateau form. Regarding the texture class and humus content indicators which define the susceptibility of the soil to erosion, the Calcareous chernozems are assessed as having a total grade value of 6, i.e. they are of high susceptibility to wind erosion.

The Alluvial and Alluvial-meadow soils are located in flood and over-flood terraces of the Danube, at the rivers of Tsibritsa, Ogosta and Skat that flow into it and their tributaries. They are formed on alluvial deposits under the impact of meadow vegetation and near-by underground waters in the winter-spring period.

The **Alluvial soils** distribution in the reviewed 30 km zone around NPP Kozloduy occupies the flood terrace of the Danube river and the islands in it.

The Alluvial-deluvial soils are available in the locality of the villages of Rogozen and Selanovtsi. Their capacity is 115-160 cm, they have low alkaline reaction and average loamy mechanical composition.

The Meadow-boggy soils, available near the described site are hydromorphic soils which have been formed under the impact of the meadow process and at high groundwaters. Usually water is at a depth of 50 cm – 100 cm, but depending on the humidity of the year, it flows deeper or higher. The ***overmoisturised and boggy soils*** are available northward of the NPP, in the Blatoto locality. These degradation processes occur due to both natural and technogenic causes. The depth of groundwater which is directly connected to the level of the Danube River provides conditions for soils to become boggy.

Anthropogenic soils. They prevail on the territory of NPP Kozloduy, as well as in the 30 km zone surrounding it. At the Kozloduy NPP site, they occur because of the construction activity related to the construction of the NPP.

As a receiver–accumulator and filter, the soil cover accumulates in the soil substrate, alongside with the useful chemical compounds, many hazardous chemical compounds, which are in most cases poisonous to the plants, the animals and the humans, as a result of the industrial and agricultural human activities – through the atmospheric air, precipitations and irrigation water, mineral fertilizers and chemical preparations for protection of plants from weeds, diseases or insects. Most of the heavy metals, such as the microelements, are closely related to soil fertility. Both the shortage as well as the excess of these elements affects the quantity and quality of yield production.

To characterize the components of the environment in a wide geographic region that is assumed to be potentially affected by the operation of the future nuclear unit, it is expedient to assume as a baseline natural and technogenic radioactivity.

In compliance with the requirements of the legislative base for monitoring and control of the pollution around and in the industrial enterprises in Bulgaria within a radius of 100 km and, more particularly, within a radius of 30 km around NPP Kozloduy, the plant's own monitoring of soils was carried out, as well as control on behalf of the state authorities. Greater attention was paid to radiation monitoring. Four independent institutions implemented a large-scale program for monitoring the radioactive pollution of soils – internal bodies (the Environmental Radiation Monitoring) (ERM) of NPP Kozloduy, the National Centre of Radiobiology and Radiation Protection (NCRRP), subdivisions of the MoEW (Regional Inspectorate for Environment and Waters [RIEW]), town of Vratsa) and the N. Pushkarov Institute of Soil Science.

In accordance with the international requirements for radiation monitoring, reference and checkpoints for monitoring have been established around NPP Kozloduy. Their selection has taken into consideration the specific meteorological and geographic conditions in the region and is representative for obtaining reliable and comprehensive information.

During the whole operation period of NPP Kozloduy, the content of the two most hazardous radionuclides in the biological aspect –^{90}Sr and ^{137}Cs has been systematically determined. Some of the institutions have traced the levels of other radiotoxic elements, such as Co-60, Am-241, Ag-110^{m}, the isotopes of U, Ra-226, and in the recent years, also Pu-238, 239+240.

In 2002, when all 6 units of NPP Kozloduy were operating and the environmental impact was greater, the data from the soil monitoring[43] showed that the values for ^{90}Sr were within the limits 0.23 Bq/kg – 1.86 Bq/kg a.d.w, and the average annual content for all 36 checkpoints was 1.01 Bq/kg a.d.w. These are results within the normal limits for this geographic region, characteristic of the deposits caused by the nuclear experiments to the atmosphere and the average at the Chernobyl NPP and the Earth surface. The values are close to the measurements from previous years, with slightly expressed trend of selfcleaning of the upper soil layer. Before the commissioning of NPP Kozloduy in 1972-1974, the average content of ^{90}Sr was 5.0 ± 0.4 Bq/kg a.d.w.

The content of ^{137}Cs in the examined soils varies from <0.4 Bq/kg to 70.3 Bq/kg a.d.w, with average value for 2002 of 18.7 Bq/kg a.d.w. During the past years the activity varied within close limits reaching up to 114 Bq/kg a.d.w in 1996. For some of the checkpoints, the content of ^{137}Cs was considerably lower than the average. This is valid for the industrial site of NPP where, as a result of active construction work, the

[43] Radiation Monitoring Results of NPP Kozloduy in 2002. Annual Report, May 2003, town of Kozloduy.

uppermost soil layer was taken off or replaced by soil from deeper layers. Inhomogeneity in the content of radio cesium is also registered at other checkpoints of the zones of special status defined at that time (2002): the 3 km Sanitary Protection Zone and the 30 km Monitoring Zone (checkpoints 11, 15, 21 and 24).

On the overall, the content of ^{90}Sr and ^{137}Cs in the soil from the region of Kozloduy is lower than that measured in other regions of the country. This is because of the insignificant rainfalls in North-East Bulgaria in May 1986, and accordingly, lower quantity of deposited technogenic radionuclides.

In 2002 (and in recent years as well) in the soils of some of the checkpoints for monitoring of the industrial site (3 and 31÷34), or in their immediate vicinity, ^{60}Co has been detected.

According to data for 2011 of the Laboratory on Radioecology and Radioisotope Studies at the N. Pushkarov Institute of Soil Science, Agrotechnologies and Plant Protection, the content of ^{137}Cs in the surface soil layer of 0 cm – 5 cm (air dry soil) for North Bulgaria is 13 Bq/kg ± 10 Bq/kg (from 0.6 Bq/kg to 46 Bq/kg) and ^{90}Sr – 2.2 Bq/kg ± 0.9 Bq/kg (from 0.6 Bq/kg to 4.2 Bq/kg).[44], [45], [46], [47]

The content of natural radionuclides ^{238}U, ^{226}Ra and ^{232}Th is within the limits of the natural values for the soils in the region, and the content of man-made ^{90}Sr and ^{137}Cs in the surface soil layer does not differ considerably from their content across North Bulgaria, resulting from the residual pollution cased by Chernobyl. Their undeviating content is a proof for the lack of local additional deposits from the operation of NPP Kozloduy. The content of ^{137}Cs varies within the interval 1.53 Bq/kg ÷ 48.5 Bq/kg a.d.w., of ^{90}Sr – between 0.37 Bq/kg ÷3.51 Bq/kg a.d.w., as defined at 36 checkpoints within the 100 km zone around the plant according to data from the 2010 radioecologic montoring of Kozloduy NPP.

According to the Program for Protection of the Environment of the Municipality pf Kozloduy for the period 2004 – 2010[48] in the area of the site no pollution with heavy metal and metalloids has been established. Local spill of oil products has been found ath the Kozloduy NPP site near the Fuel and Oil Facility, and not so heavy pollution with oils,

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[44] Maier D. & Scholl W. ^{90}Sr-Bestimmung in böden und pflanzlichen material (Determination of ^{90}Sr in soils and plants), *Landwirtsch. Forschung., 1082,* 35(3-4):269-274

[45] Najdenov M., Content of Men-made Radionuclides in Soils from the region around "Kozlodouy" NPP", Collection "Scientific Reports and Announcements", Sofia, Agricultural Academy: 1986, pp. 50-68

[46] Ivanka Yordanova, Lidia Misheva, Martin Banov, Donka Staneva, Tsvetanka Bineva "Radioactivity in Virgin Soils and Soils from some Areas with closed Uranium mining Fasilities in Bulgaria" European Geosciences Union – General Assembly Vienna, Austria, session SSS9.1, Radioactive Chemical Species in Soil: Pollution and remediation., 2012

[47] Ivanka Yordanova, Donka Staneva, Lidia Misheva, Tsvetanka Bineva, Martin Banov, "Radioactivity in Bulgarian Soils and Behavior of Some Man-made Radionuclides in Different Soil Types", International Symposium on Managing Soils for Food Security and Climate Change Adaptation and Mitigation,. Vienna, Austria, Synopses, 2012, 171-172.

[48] By data from the Terms of Reference on the scope and content of EIA of the investment proposal for the construction of National Radioactive Waste Storage Facility. 3.01.04-004.ToR/03, p. 195 / 410

oil products and others has been recorded near the gas field in the village of Butan, the landfills of the villages of Harlets and Kriva Bara, near former agricultural facilities.

3.3.2.2 FORECAST OF IMPACT

The implementation of the Investment Proposal is not expected to cause any soil pollution exceeding the maximum acceptable concentration (MAC), due to the plant's operation or the operation of other power units, in accordance with the established principles and rules for safe control of the facilities and with the requirements of the nuclear legislation and the recommendations of the International Atomic Energy Agency (IAEA)[49]. In the process of construction impact is related to the removal of the soil layer. The REIA shall analyze and assess the impact on the soils in the region during the construction, operation and decommissioning of the NPP[50].

More specifically, the REIA will make an assessment of the possibility for the soils to assume the supposed impacts during the construction and operation of the Investment Proposal. Subject to analysis and assessment will be the following:

- → Soil state within the scope of the sites, subject to assessment;
- → Change in soil fertility;
- → Violations and changes resulting from the implementation of the Investment Proposal;
- → Measures for prevention of incurred violations and changes;
- → Required radiological monitoring of soils;
- → Measures for cleaning the land and soils during operation;
- → Measures for cleaning soils in cases of accidents;
- → Characterization of the soil state during the decommissioning of the facilities;
- → Information about the content of natural radioactivity and the main technogenic radionuclides (Cs-137 and Sr-90) in soils within the 30-km zone around NPP and of each individual site will be provided. The techniques applied for the assessment of the radiological pollution of soils, waters and plant cover are provided in Annex 2; [51], [52], [53], [54]

[49] International Atomic Energy Agency (IAEA) – the world's hub for cooperation in the area of nuclear energy.

[50] IAEA, Vienna, TRS No 207, 1981

[51] Methodology for low background determination of natural and technogenic gamma-emitters in soils, water, and agricultural facilities, 2009

[52] Methodology for radiochemical defining of strontium-90 in soils, waters and agricultural facilities, 2009

[53] ISO 18589-2,3:2007; Part 3: Measurement of gamma-emmiting radionuclides

[54] ISO 18589-2,3:2007; Part 2: Guidance for the selection of the sampling strategy, sampling and pre-treatment of samples

→ Comparative analysis will be made for other regions of the country, as well as for the changes over a period of 20 years.

3.4 SUBSURFACE AND MINERAL RESOURCES

3.4.1 SUBSURFACE

3.4.1.1 CURRENT STATUS

In the north-western part of Bulgaria, where the potential sites for the new nuclear unit are situated, geological studies and geophysical surveys (including more than 50 deep boreholes) prospecting for oil and gas were carried out. Reports from these surveys are kept in the Geo fund at the Ministry of Environment and Water. The reports have been analyzed and summarized in connection with the design of nuclear facilities at NPP "Kozloduy"[55, 56, 57] .

The sites area has been subject to geomorphologic surveys summarized by Evlogiev (2006)[58] and the Geotechnical Research Station (2012)[59].

The engineering-geological and hydro geological conditions of the potential sites will be analyzed and assessed in this EIA Report based on the results from surveys that were performed specially for the purpose[60].

In the evaluation of these conditions for sites 2 and 4, which are located on the first non-flooding Danube river terrace, are taken into account the surveys of "Energoproekt" AD in the period 1967-1999 in relation to the design of power units 1 ÷ 6 and other nuclear facilities at Kozloduy NPP. The results of surveys in connection with the National Repository for Disposal of Radioactive Waste at the Radiana have also been considered[61].

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55 Study and activities for security improvement on the NPP "Kozloduy" site – series of reports in connection with fulfilment of recommendations by IAEA, Geophysical Institute, 1991-1992.

56 Assessment of geological conditions for long-term storage of radioactive waste on the site of and round NPP "Kozloduy" and integrated analysis and feasibility appraisal of options for long-term storage of conditioned radioactive waste on and close to the site of NPP "Kozloduy", Geological Institute, 2003.

57 Study of possibilities for construction of deep geological depository. Analysis and division of the Bulgarian territory into regions, establishment of potential accommodating geological blocks for deep burying of radioactive waste, Geological Institute at Bulgarian Academy of Sciences (BAS) under contract of Risk Engineering AD with SE RAW, 2010.

58 J. Evlogiev, Pleistocene and Holocene in the Danube Plain, Doctor's dissertation, 2006.

59 Geotechnical Research Station of the Institute of geology at BAS. 2012. Development of geological and hydrogeological profiles of the plateau through the Radiana site to the Danube River. Contract with SE RAW.

60 Surveying and fixing the location of NNU at the site of Kozloduy NPP EAD, 2013.

61 Report on results from geological, geophysical, engineering-geological, hydrogeological, hydrological and laboratory investigations on project „Confirmation of Radiana Site for construction of National Repository for Disposal of Radioactive Waste, Geotehnika ABC OOD and Institute of Geology at BAS, 2009.

Besides the data of "Energoproekt" AD, for the sites 1 and 3 data of Vodproekt surveys on draining the Kozloduy lowland have also been used[62].

Credible information is available for both deep and close to the surface aquifers, which, according to the Basin Directorate "Danube Region", are within the range of the following groundwater bodies:

- → pore water in the Quaternary – Kozloduy lowland, code BG1G0000QAL005;
- → pore water in the Quaternary – between the rivers of Lom and Iskar, code BG1G0000QPL023;
- → pore water in the Neocene – Lom – Pleven depression, BG1G00000N2034.

3.4.1.1.1 Methodology for the development of the geological section of the EIA Report

The geological section of the EIA Report of shall be compiled based on the following principles and approaches:

- → Environment impacts will be considered from two aspects:
  - ✓ NNU impact on the geological environment components at the different, and
  - ✓ vice versa, what influence could the geological environment, and especially the processes of geological hazard on the safe and long-time functioning of the new nuclear unit, which could affect harmfully the environment.
- → Analysis and assessment of geological data from geological and geophysical surveys for oil and gas conducted after 1960 in the region. Due to the numerous deep boreholes, information necessary for the EIA Report was obtained on the deep geological structure. The other main source of information are reports by Energoproekt AD from engineering-geological surveys performed during the period 1967-1999 in connection with the construction of NPP "Kozloduy".
- → Analysis and assessment of the latest results from surveys in the area of potential sites for the NNU.
- → Consideration of the experience of nuclear countries in the European Union:
- Using only results obtained with the methods and with the technological means of modern geology, consistent with Bulgarian standards and those of the IAEA, as well as the latest scientific achievements.
- Preference of facts to interpretations – superiority is given to data from direct measurements and tests against argumentative results and findings, obtained by analogy with excessive model simplifications, through logical conclusions or conclusions deducted intuitively.

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[62] Development of geological and hydrogeological profiles of the plateau through the Radiana site to the Danube River. Contract with SE RAW, Geotechnical Research Station of the Institute of geology at BAS. 2012.

3.4.1.1.2 Geomorphology of the sites' area

The geomorphologic conditions in the thirty-kilometer zone of sites shall be reviewed in the EIAR. The structure and geomorphologic positions of old abrasion-accumulative level (OAAL) of river terraces from T_6 to T_0 and other relief formations will be described. A map of spatial location of levelled areas and terraces as well as dating of such relief formations will be submitted. The above information will be used both for more comprehensive clarification of local geomorphology and for assessment of neotectonic conditions, as well as to forecast river erosion hazard and other adverse processes.

3.4.1.1.3 Geological structure of the sites' area: tectonics and neo-tectonics

The deep geological structure, tectonic and neo-tectonic conditions will be assessed in the EIA Report from the aspect of long-term safety of the designed new nuclear unit. The main information sources are the following reports:

- Study and activities for security improvement at the Kozloduy NPP site – series of reports in connection with fulfilment of recommendations by IAEA, Geophysical Institute, (1991, 1995);
- Study of possibilities for construction of deep geological repository. Analysis and division of the Bulgarian territory into regions, establishment of potential accommodating geological block for deep burying of radioactive waste, Geological Institute at Bulgarian Academy of Sciences (BAS) under contract of Risk Engineering AD with SE RAW, 2010;
- Identification and revision of active faults in the region of NPP "Kozloduy", Geological Institute at BAS (2013);
- Report of Environmental Impact Assessment (REIA) of investment proposal for construction of National Repository for Disposal of Radioactive Waste at the Radiana area on the land of Harlets village, Kozloduy Municipality, Vratsa District (2011).

The following components of the geological environment described in these reports will be analyzed and assessed:

→ Lithology and stratigraphy of rocks in the geological foundation to a depth of 1000m. Neocene, Palaeogene, Cretaceous and older sediments are found in depth. Cretaceous and Neocene sediments in the area of the site are characterized by platform type horizontal layer arrangement, indicating calm geodynamic conditions whereat these deposits were formed. Furthermore, the lithologic and stratigraphic structure does not suggest availability of unfavourable processes like karstification, diapirism, depth suffusion of soluble rocks, etc.

→ Structure of Quaternary sediments in the area adjacent to the sites: aeolian, lake, alluvial and diluvial deposits.

→ Tectonics, geodynamic and neo-tectonic development in the sites' area with an emphasis on Quaternary (the last 2.5 million years).

The potential sites for the new nuclear unit as well as the existing facilities of Kozloduy NPP are located in the western part of the Moeizian Platform and more precisely in the eastern part of the Lom Depression. That structure has been stabilizing for 2.5 million years, following rather intensive (predominantly negative) fluctuating movements during the Neocene. During the Quaternary the region under consideration underwent slow rise. Old, already faded faults are observed at greater depth. Recent active faults in the Bulgarian section of the thirty-kilometer zone of Kozloduy NPP have not been found.
Analyses and assessments of geological and tectonic structure shall be accompanied by figures and appendices – geological maps, profiles, tables, etc.

3.4.1.1.4 Engineering geological conditions of the potential sites

Additionally to the reports cited above, for analysis and assessment of the engineering and geological conditions the requirements defined in Regulation No. 1/1996 on the design of flat foundations, Chapter III of the Regulation of the Bulgarian Nuclear Regulatory Agency (NRA) of 2004 on ensuring the safety of nuclear power plants as well as the applicable international regulatory documents (IAEA) shall be considered. Potential sites will be considered in pairs according to the location and similarity of conditions (2 and 4, 1 and 3). Common characteristics of the relevant pair will be described first and then their specific characteristics will be considered separately.
Sites 2 and 4 are located on the first non-flooded terrace – T1 on the Danube River with surface on elevation 35 m – 38 m. In the geological profile of the terrace can be distinguished three types of deposits: loess, alluvial and lake (Brusartsi Formation). The loess deposit is 12 m -14 m thick. Loess in the terrace is underlain by alluvium consisting of sand in the upper section and gravel in the lower section. The alluvium top is at average elevation of 22 m -24 m and there is unevenness in elevation 21 m and 25 m. The terrace footing at elevation from 15 m to 18 m is cut in Pliocene clay of the so-called Brusartsi Formation.
From an engineering and geological point of view the greatest interest present the loess deposits, which are studied thoroughly by Energoproekt by field and laboratory methods in connection with the construction of power units 1 – 6 of NPP "Kozloduy".

The most important feature of loess is its susceptibility to sinking following wetting. According to the Regulation on the design of flat foundations (1997) the sinking of loess can be either of type 1 or type 2. Loess foundation of the 2nd type under the effect of its own weight can collapse by more than 5 cm when wetted and depending on the thickness of loess, the collapse may reach up to 1 m. It is dangerous earth bedding, but it does not occur on the potential sites of the new nuclear unit.
Loess foundation of the 1$_{st}$ type, which is the bedding at sites 2 and 4, practically sinks only by the additional load of the equipment, while collapse under its own weight when wetted is less than 5 cm. Elimination of sinking of the bedding is not a serious problem for foundation works.
The loess sinking capacity at units 1÷4 of NPP "Kozloduy" has been overcome through deepening of the foundations to non-collapsing loess and building a soil-cement

bedding[63] (Minkov, Evstatiev, 1975). All loess and upper sandy-clay section of alluvium were removed down to the gravel layer for units 5 and 6 where the load of the foundations is greater. Then ballast and soil-cement beddings were constructed to the foundation elevation.

No problems related to the foundations have been encountered during the long years of operation of NPP "Kozloduy" Continuous geodetic monitoring indicates that actual sinking coincides with the forecast one and ranges averagely from 5.0 cm to 10.0 cm. It has been proven that the soil-concrete bedding acts as a protective barrier against spreading of radionuclides to groundwater.

The sites 1 and 3 are situated in the flooded terrace T_0 of the Danube River, which has elevation 26-28 m. The terrace footing at elevations from 13 m up to 15 m at Site 3 is formed of Pliocene clay (Brusartsi Formation) and at Site 1 – of Miocene sand (Archar Formation). Terrace bed drops to elevation 10 m have been found at some places. Alluvium, with average thickness of about 13 m, has a two-layer structure: gravel-sandy at the bottom section and clayey-sandy at the top section. Alluvium deposits are characterized by high heterogeneity both vertically and in horizontally.

The available geomorphologic map of the sites covers the area from the plateau extending to the Danube River to the north and two kilometers to the east and to the west from there. Three of the profiles on that map are drawn through or close to the sites. The profiles show that three of the river terraces (T_3, T_4 and T_5) have been washed out in the geological past by erosion caused by the Danube River and therefore the T_2 terrace is reduced in width. The EIA Report will describe the time when the erosion processes developed and present evidence that now these processes are not endangering the potential sites.

Description of sites is made using data of the Geotechnical Research Station (2012) and Energoproekt AD (1967)[64,] and (1999)[65], Minkov, Evstatiev (1975). Analysis and findings conform to IAEA Safety Guide Series, NS – G – 3.6, 2004, Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants и IAEA Safety Guide Series, SSG – 9, Seismic Hazards in Site Evaluation for Nuclear Installations, 2010.

Ground structure at Site 2

Site 2 is located on the first non-flooded terrace T_1 of the Danube River to the east of units 1 and 2 of NPP "Kozloduy" in the direction towards the village of Harlets to the south of the Plant cold and hot channels. At this place the T_1 terrace is narrowed by the erosion caused by the Danube River in the distant geological past. The site is bordering to the south with T_2 and with T_0 - to the North. The terrain is low-hilly and its surface is

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[63] Minkov, M., D. Evstatiev, Foundations, facings and screens of consolidated loess soils. Tehnika, 1975.

[64] Scientific Research, Design and Survey Institute for Energy Construction "Energoproekt", 1967 – NPP "Kozloduy" - engineering-geological and hydrogeological conditions at the site.

[65] Scientific Research, Design and Survey Institute for Energy Construction "Energoproekt", 1999 Feasibility study for the construction of a new nuclear capacity with equipment supplied for NPP Belene.

at elevations between 34 m and 37 m. Single-storey warehouses and other service premises are built at the Site. If the NNU is built at this Site, its facilities will have to be founded in an excavation pit.

The engineering-geological conditions at Site 2 are similar to those on the sites of units 1-2 of Kozloduy NPP.

The sub-grade is formed of the following soil types: sinking silty loess with thickness from 7.0 m to 11.0 m forming a collapsible base of type I. In depth follows non-collapsible clay loess layer with thickness of 3 m – 4 m underbedded by alluvial sands and gravels with thickness from 5.0 m to 8.0 m. The latter were deposited on Pliocene clays (Brusartsi Formation) with thickness of 5.0 m – 7.0 m. Under the clays is laid 4 m – 5 m thick sand layer belonging also to the Brusartsi Formation.

Groundwater level is 8.0 m to 10 m from the surface.

The EIA Report will provide the soil mechanics indexes of the soil types.

Ground structure at Site 4

The site is located on the first non-flooded terrace T_1 of the Danube River to the west of Units 3 and 4 of NPP Kozloduy and the spent nuclear fuel storage facility (SNFSF), to the south of the cold and hot channels. The site is located at elevation of about 36 m on built up area between existing service buildings. If the new nuclear unit is built at this site, its facilities will have to be founded in an excavation pit.

The engineering-geological conditions at Site 2 are similar to those at the sites of the first 4 units of NPP “Kozloduy”. The sub-grade is formed of the following soil types: sinking silty loess with thickness from 6.0 m to 9.0 m forming a collapsible base of type I. In depth to 12.0 m – 15.0 m loess becomes more becomes more clayey, less collapsible to non- collapsible but very settling. Underneath lie alluvial sands and gravels with thickness of 4.0 m – 7.0 m. The latter were deposited on Pliocene clays (Brusartsi Formation) with thickness of 6.0 m – 8.0 m.

Groundwater level is 8.0 m to 10 m from the surface.

The EIA Report will provide the soil mechanics indexes of the soil types.

Ground structure at Site 1

The site is located on the flooded terrace T_0 of the Danube River, to the north-east of Units 1 and 2 of NPP “Kozloduy”, between the Outdoor Switchgear and “Valyata”, to the north of the cold and hot channel. Open drainage channels are running through the Site. The terrain is plain with slight slope from south-west to north-east. Its elevation is at 25.0 m – 26.0 m. If the new unit is built at this Site, its facilities will have to be founded on embankment.

The sub-grade is formed of the following soil types: alluvial clay with thickness of 4.0 m to 6.5 m. In the northern part of the site the lower half of the layer is composed of alluvial sand. Under the clay and sand lay alluvial gravels with thickness of 7 m – 8 m, below which are Pliocene sands with thickness from 10 m to 15 m. The latter are deposited on Miocene sands of the Archar Formation and start at elevation of approximately 0.00 m.

Groundwater level varies with the water levels of the Danube River. It comes to the surface or close to it.

The EIA Report will provide the soil mechanics indexes of the soil types.

If it is decided the NNU to be built at this site, the experience of sub-grade preparation for NPP "Belene" could be used.

Ground structure at Site 3

The site is located on flooded terrace T_0 of the Danube River, to the north-west of Units 5 and 6 of NPP "Kozloduy". Open drainage channels are running through the Site. The terrain is plain with slight slope to the north. Its elevation is 25.0 m – 26.0 m. If the NNU is built at this site, its facilities will be founded on embankment.

The sub-grade is formed of the following soil types: sandy alluvial clay with thickness of 3.0 – 5.0 m. In the northern part of the site the lower half of the layer is composed of alluvial sand with thickness of 2.5 – 3.0 m. Under the clay and sand lay alluvial gravels with thickness of 5 m – 8 m, below which are Pliocene sands with thickness of about 15 m. The latter are deposited on Miocene sands of the Archar Formation and start at elevation of approximately 0.00 m.

Groundwater level varies with the water levels of the Danube River. It comes to the surface or close to it.

3.4.1.2 HYDRO GEOLOGICAL CONDITIONS OF THE SITES

3.4.1.2.1 Deep aquifers

There are several aquifers in the region of NPP Kozloduy, including the potential sites, at a depth of hundreds of meters from the surface: Upper Triassic and Cretaceous-Jurassic-(Malm-Valaginian), Upper Cretaceous–Palaeocene, Meotian-Pontian. These aquifers are well studied during the surveys for oil and gas and have been analyzed in former surveys for nuclear facilities in relation to pollution hazard[66].

The EIA Report will provide evidence that hazard from radioactive contamination of deep aquifers is excluded not only because of the great depth where the aquifers are, but also due to the presence of very thick layers of water-impervious sediments separating them from one another and from shallow aquifers.

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[66] Evaluation of geological conditions for long-term storage of radioactive waste at the site of and around Kozloduy NPP and integrated analysis with feasibility assessment of the options for longterm storage of conditioned radioactive waste on and in proximity to the site of Kozloduy NPP , Geological Institute. 2003.

3.4.1.2.2 Shallow aquifers

These aquifers are studied and analyzed in former surveys for nuclear facilities n terms of radioactive contamination [67, 68] etc.

Conclusion may be drawn from the above listed studies that the hydro geological conditions of Sites 2 and 4, as well as of Sites1 and 3, are identical and therefore they will be considered in pairs. Analysis and evaluation of these conditions will have to take into account the requirements of the following regulatory documents: NRA, Regulation on ensuring the safety of nuclear power plants (2004); IAEA Site Evaluation for Nuclear Installation, No. NS-R-3, 2003 и IAEA Safety Guides, No. NS-G-3.2, 2002.

3.4.1.2.3 Hydro geological conditions of Sites 2 and 4

The main hydro geological units at the Danube River terrace T_1, where the Sites are located are as follows:

- Unsaturated (vadoze) zone. Its depth is from 7 to 10 m. It is developed in silty-sandy loess (permeability coefficient = 0.7 m/d).
- Water-saturated zone. It consists of an aquifer with two layers: upper and lower. Both parts of the aquifer are separated by “imperfect” backwater.

*The upper laye*r includes the lower part of the loess, which is clayey (k = 0.2 m/d) and mainly gravel sandy deposits on the terrace with k = 50 – 80 m/d for gravel deposits and k = 11 m/d for sandy deposits. The shallowest bedded aquifer is formed in this layer. Its water flows southwest-northeast. Insignificant part of the recharge is formed by infiltrating precipitation. The main recharge comes in from the adjacent slope and through recharge from Pliocene sands when in direct contact with alluvium of T_1 and T_0. This phenomenon is observed at Site 2. The groundwater level varies between elevations 25.0 m – 27.5 m.

Imperfect backwater are Pliocene clays of the Brusartsi Formation with permeability coefficient k = 0.1 m/d. The layer thickness is from 11 m up to 16 m.

The lower very permeable layer is formed in sandy sediments of the Brusartsi and Archar Formation.

Ground water recharge in T_1 is mainly from the slope adjacent to the terrace. Recharge sources are the sub-loess gravels and outflowing water from the Pliocene aquifer in its contact areas with alluvial sands and gravels. Recharge is formed also from precipitation infiltration.

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[67] Clarification of dispersion characteristics of soil and water media in the region of Kozloduy NPP site with the purpose to analyze possible paths for migration of radionuclides from the NPP into soil and hydrosphere, Akvater, Sofia. 1992.

[68] EIA Report for Kozloduy NPP, Technical University, Sofia, 1999.

3.4.1.2.4 Hydrogeological conditions of Sites 1 and 3

The main hydrogeological units at the Danube River terrace T_0, where the Sites are located are as follows:

- → Unsaturated (vadoze) zone with thickness from 0 m to 5 m. Contains sandy alluvial clay with k = 0.5 m/d.
- → Water-saturated zone. Like terrace T_1, it consists of an aquifer with two layers: upper and lower. Both parts of the aquifer are separated by "imperfect" backwater.

The upper layer contains two sub-layers: clayey-sandy with thickness of 4 m – 9 m (k = 0.5 m/d) and gravel-sandy with thickness of up to 13 m (k = 50 m/d – 80 m/d). The aquifer is recharged by infiltrated surface water from older terraces, from the Danube River and from the lower aquifer in the eastern part of the surveyed region (Site 1) where alluvial gravel of the terrace lies on the sand and Brusartsi and Archar Formation. The aquifer is drained by drainage systems and into the Danube River during low water.

Imperfect backwater are clays of the Brusartsi Formation with permeability coefficient k = 0.1 m/d. The thickness of the layer at Site 3 varies from 5 m up to 16 m. The imperfect backwater in the area of Site 1 is interrupted and the upper and lower permeable layers are in direct contact.

The lower layer, like in terrace T_1, is formed in sandy sediments of the Brusartsi and Archar Formation.
Shallow ground water is drained by the Danube River and at high water levels the river recharges and turns back the natural flow in southern direction creating backwater in the current terrace.

The EIA Report will provide details on all filtration/seepage characteristics of the specified hydro geological units.

3.4.1.3 SEISMIC HAZARD FOR THE AREA OF THEKOZLODUY NPP SITE

Earthquakes as potential external factors for the NPP safety are of great concern worldwide. At the beginning of 1990 the Council of Ministers[69] agreed to the organization and carrying out of international expert assessments for the operating Kozloduy NPP and the designed NPP "Belene". On the grounds of that decision, in June 1990 in Sofia was organized an expert mission of the International Atomic Energy Agency (IAEA). The IAEA experts recommended analyses and expert assessments to be carried out in conformity with newest international standards for seismic safety at NPP sites.

In accordance with the recommended activities the programme "Survey and activities to enhance the security of NPP "Kozloduy" and designed NPP "Belene", 1991-1992"was

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[69] Letter No. 198+0514-6189/04.01.1990 by CoM regarding organization and holding of international exeprt assessments for the operating NPP "Kozloduy" and designed NPP "Belene", 1990.

drawn up. Several annexes were concluded with regard to this programme and the implementation activities continued until the end of 1995.

Implementation of this program involved geological and geomorphologic field surveys and information research in the region and sub-region of NPP "Kozloduy" in order to define the main geological structures and assess their Neocene-quaternary activity. The activity of identified fault structures (such as Ogostenska, South-Moesian etc.) during the Quaternary period was clarified, the seismogenic potential was estimated and their stability during this geological period was proven. Maps were drawn of particular tectonic regions – neotectonic and seismotectonic map of the regional district based on the latest surveys and results and summarizing the former regional surveys for Kozloduy NPP . The NPP Site is located in relatively the most stable area of the south-western part of the Moesian Platform – in the 30 km zone around the Site there are no fault structures with significant energy potential (there is no data for presence of active “capable” fault).

One major recommendation of IAEA is the construction of Local Seismic Network (LSN) around the Kozloduy NPP site. This is a basic IAEA requirement to nuclear power plants' sites[70]. LSN round the Kozloduy NPP site, which was designed and installed in conformity with the IAEA standards[71] was put into operation in 1997 and is located in sub-regional area round the site of the plant. The LSN is intended for monitoring of weak seismicity and precise calculation of main dynamic and kinematic parameters of seismic events occurring in the sub-region of Kozloduy NPP. The conclusion regarding seismotectonic stability of the local zone around NPP is confirmed also by the accumulated database of the existing for 15 years already highly sensitive local seismological network – **in the period 1997-2012 not a single micro-earthquake has been localized within the 30 km area round the site.**

3.4.1.4 METHODOLOGY FOR SEISMIC HAZARD ASSESSMENT

Assessment of seismic hazard on the territory of Bulgaria is of special importance considering the fact that the country is located within the strongly active Aegean seismic zone that is part of the Alpine-Himalayan earthquake belt. The seismic hazard may be defined through methods of seismic division into regions, seismic hazard and seismic risk. For the entire territory of country a prognostic **seismic zoning** was performed based on an integrated analysis of geological, geophysical, seismic and other data from a team of Bulgarian and foreign experts. Results are presented in the publication of Bonchev, et al., in the form of maps including a complex map of possible centre zones (PCZ) and maps of where and how the earthquake is felt. Zones with different magnitude intervals are outlined. However, this map does not allow to evaluate directly the intensity according to the macro-seismic scale.

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70 IAEA Safety Guides, No. 50 – SG – S1, Earthquakes and associated topics in relation to nuclear power plant siting. Vienna,1991

71 IAEA-TECDOC-343, Vienna, 1991

Various maps have been drawn including maps of concussiveness for periods of 1 000 years and 10 000 years. Since 1987 till now the first of them has been standard for ant seismic construction[72]. It is considered when planning buildings, dams, nuclear plants and other engineering projects. With the aim to harmonise Bulgarian standards with European standards, in particular with Eurocode 8 (EC8), it was necessary instead of intensities according macro-seismic scale, accelerations (displacements, velocities) of oscillations of particles at seismic waves propagation to be applied. Since 2012 the **seismic hazard** maps with the new seismic zoning (2009) have been the basis for new earthquake standards of construction in Bulgaria.

The seismic hazard is an assessment of probability for the force of earth movements at specified point on the Earth's surface to exceed a set value during fixed period of time. Earth movements may be expressed through maximum acceleration, maximum velocity and maximum displacement at oscillation of particles caused by seismic waves. Lately, the main maximum earth acceleration is adopted as a parameter for evaluation of earth movements.

There are various methods for assessment of seismic hazard, each of them having advantages and disadvantages. The earliest method is based on observation and later on new methods have developed such as the **deterministic**, statistical, probabilistic, time dependent seismic hazard, spectral hazard. Each of these methods has undergone various modifications in pursuit of elimination of disadvantages. Particularly important are the **probabilistic** methods. They in turn can be divided into historical and deductive. Veneziano et al. in 1984 offered historical method, which requires only a catalogue of historical earthquakes, appropriate attenuation functions of the movements in the studied region and response functions of the site. This historical method was then further developed and in 1995, Frankel presented a probabilistic method to assess seismic hazard, which is based on spatially diffuse seismicity. For the parameter characterizing the earth movements was selected peak ground acceleration (PGA). On the other hand deductive methods, besides a catalogue of historical earthquakes and appropriate attenuation functions of the movements require a description of the possible faults and earthquake zones and the parameters describing the seismicity of these faults and the seismic sources and their characteristics (parameters of seismicity). Foundations of deductive methods are set by Cornell in 1968. Various modifications and applications of this method exist, but the assessment of seismic hazard based on the delineation of seismic sources to this day continues to be associated with many inaccuracies caused by the lack of high-quality geological and seismologic data.

The methodology for a reassessment of seismic hazard for the Kozloduy NPP site in 1991-1992 passes through several stages. The first stage is to create a **seismotectonic model** for Bulgaria and the neighbouring seismic zones affecting the Bulgarian territory. This model was based on information from the seismic zoning in the standards from 1987. The seismotectonic model determines the type, geometry and physical

[72] Standards for designing buildings and structures in earthquake regions. CTUP-BAS, Sofia, 1987.

characteristics of the seismic centres that affect the seismic hazard for NPP "Kozloduy". According to their type, seismic sources in the model are: point, linear, spatial and disperse. Geometry of the source covers position (coordinates), shape, depth, etc. The physical characteristics are defined by the maximum magnitude above specified level (law of earthquake frequency). All parameters of the model are defined with their distributions. Establishment of **laws of attenuation** (acceleration) of impact is the second stage of activities for hazard evaluation. Due to lack of statistics from Bulgarian registers, adequate correlations from other seismic regions have been applied. Regarding Vrancha centre particular attenuation laws were used because of the quite specific nature of impact. The use of two types of attenuation laws is accepted – one for interfocus earthquakes and one for all the rest, while each type is presented by at least two laws with relevant ratings. Computational assessment of seismic hazard (acceleration) is carried out by the method of Cornell, respectively, its implementation into a program EQRISK of McGuire. Seismic hazard is the probability the power of earth movements in a given point of the earth surface to exceed a set value over a certain period of time. Distribution of hazard is described generally either by its probability distribution function P(x) or by probability of exceeding function v(X).

Seismic hazard for Kozloduy NPP site is associated with seismic hazard curves giving the annual probability of exceeding as a function of the magnitude of the maximum acceleration. The frequency of exceeding v (x) is a function of the inaccuracies in time, the strength and localization of possible future earthquakes and also the level of movements of the earth which can be exceeded for the studied site. As noted, the seismotectonic model and attenuation laws are loaded with inaccuracies. Inaccuracies can be reported in two ways: using the logical tree or the Monte Carlo method. Assessment of NPP "Kozloduy" is performed by logical tree for multiple combinations of various inaccuracies and accordingly was obtained the same set of seismic hazard curves for maximum acceleration. All calculations were made based on attenuation laws for free surface level. Calculation procedures register also statistics of results obtaining mean (most likely) ratings and ratings with various confidence intervals. The methods of probabilistic analysis of seismic hazard is based on standardized mathematical model of Cornell and software of McGuire 1976 and Toro and McGuire 1988, later improved by Solakov, et al., 2001.

Seismic risk is determined by the seismic hazard and the vulnerability of facilities and administrative structure for managing the construction and operation of the plant as a result of earthquake effects. From structural engineering and administrative aspect, this risk is quite possible to be minimized, even in the presence of close active fault. Possible contamination with radioactive nuclides premised with partial vulnerability of weak components of the engineering design and administrative systems should not be allowed, regardless of the price. There are a series of actual negative examples to this effect from nuclear capacities in operation round the world. Seismic risk is controllable by man and must be minimized. According to seismic risk assessment, measures are recommended for provision of engineering and structural integrity of facilities and infrastructure as well as for integrity of the administrative structure for plant management allowing to endure the maximum possible impact of the design seismic event without disturbing their structural integrity and without any long-term loss of efficiency.

3.4.1.5 PRESENT DESIGN SEISMIC CHARACTERISTICS OF THE NPP KOZLODUY SITE

3.4.1.5.1 Seismicity analysis

As noted above, the first stage of the assessment of seismic hazard is the construction of a seismotectonic model of regional and local areas around NPP "Kozloduy". Basis for the construction of this model is the analysis of seismicity in the studied region. At the next stage, the results of tectonic and geomorphologic studies are used to support the potential of the model.

Seismicity of the region was studied in detail by the Geophysical Institute of BAS in 1990–1992. A catalogue of earthquakes was used covering the period from 375 B.C. to 1990. Catalogue data was unified and standardised in compliance with current requirements.

The greater part of observed seismic events is related to eight well known seismogenic regions: Sofia, Maritsa, Gorna Oryahovitsa, Kresna, Negorinska-Kraina and Kampuling-Vrancha (shallow and medium deep) and local. Spatial, time and energy characteristics of these regions have been studied in detail. The Sofia seismic zone is located at the shortest distance of 80 km from the Kozloduy NPP site. Maximum epicentre intensity (I_0) of the 9th degree (MSK) of earthquakes is registered in this zone in 1641 and 1958. The observed maximum effect on the Kozloduy NPP site from earthquakes in the Sofia Zone is I_{koz} = 3 (MSK).

Earthquakes within the 150-km region are generated in the earth's crust at a depth of up to 50 km. The maximum density of earthquake hypocenters is observed in deep layers between 5 km and 25 km. Strong inter-focus earthquakes with expressed macro-seismic effects (effects at great distances) are generated at depths from 90 km to 230 km in the Vrancha seismic zone that is more than 240 km away.

The main sources of seismic hazard are earthquake zones beyond the region of the Kozloduy NPP site. The most important among them is the Vrancha zone in neighbouring Romania that has generated events with magnitudes M > 7. Maximum macro-seismic effects on the site I_{koz} = 6 – 7 were observed from the earthquake in 1977 with M = 7.2 and I_0 = 8.0 (MSK). The effect is due to specifics of processes in the centre (strong extension in direction South-West of the isoseismic field).

Earthquakes generated beyond the above specified zones are related to known fault structures that cannot be defined as differentiated due to insufficient data required to obtain the basic characteristics thereof. The strongest earthquakes beyond the defined zones are: the event in North Greece in 1828 with M = 7.5 and I_0 = 10.0 (MSK) and the earthquake in the region of Dulovo in 1882 with M = 7.3 and I_0 = 7.8 (MSK) with observed macro-seismic effects on the Kozloduy NPP Site – I_{koz} = 5 – 6 (MSK).

According to maps of concussiveness for a period of 1 000 years (valid until 2014) (Figure 3.4 1: Map of seismic zoning of Bulgaria for the period of 1000 years) and 10 000 years the area of the plant may be subjected to earthquake effects of VII degree according to the MSK-64 scale wherefore buildings and facilities must be secured with a seismic factor K_c = 0.10[73].

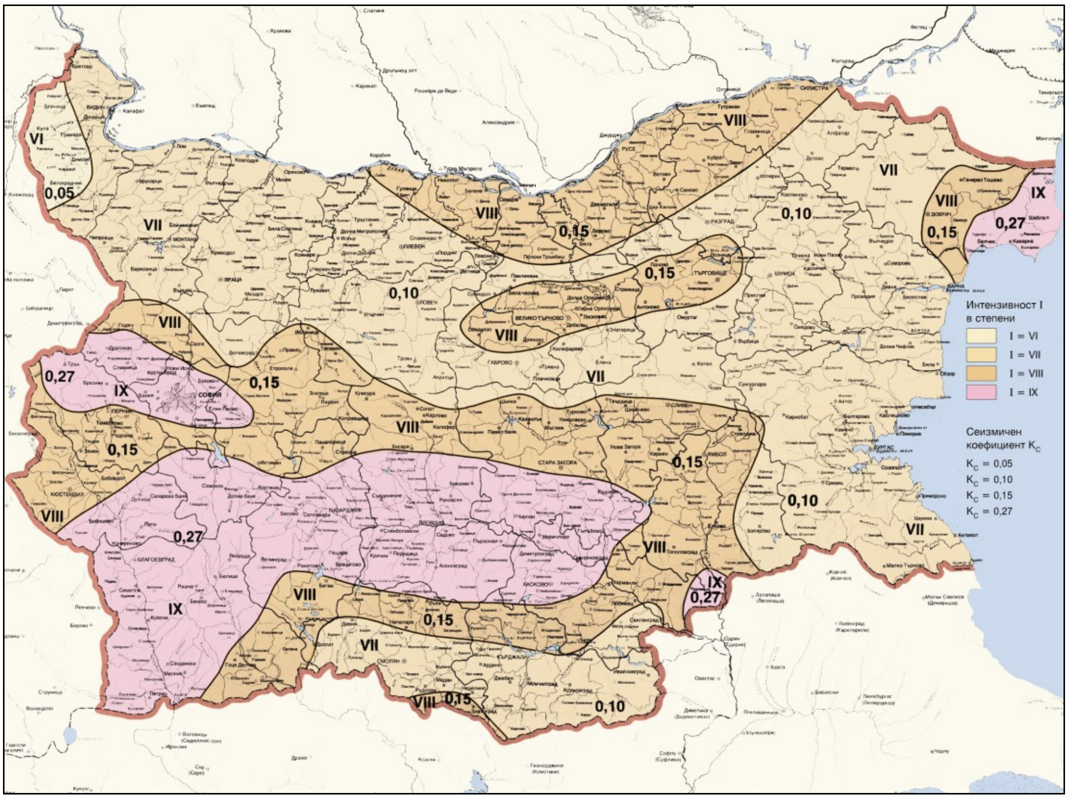

FIGURE 3.4-1: MAP OF SEISMIC ZONING OF THE REPUBLIC OF BULGARIA FOR A PERIOD OF 1000 YEARS

On the recommendation of IAEA the impact of local earthquake has been further studied. Local centres have documented earthquakes with M <4 and fall into the category of the background seismicity.

NPP "Kozloduy is located in the centre of the stable region in the south-western part of the Moesian platform, which is characterised by extremely low seismic activity. During the period of regional instrumental registration of earthquakes (1976 – 1997), on the whole territory of the local 30 km zone only three earthquakes occurred on Bulgarian territory with magnitude of M < 2.0 and one earthquake – on the territory of Romania with magnitude of M = 3.6. After installation of the high-sensitivity local seismic network, it was established that in the period 1997 – 2012 in the local area was not

[73] Regulation No. РД-02-20-2/2012 on design of buildings and facilities in earthquake regions.

registered any seismic event of the smallest possible magnitude. There are also no documented historical earthquakes. Lack of documented seismic activity and extremely weak sporadic seismic events characterize it as seismically "**the quietest**" area in 320 km region.

Seismotectonic characteristics of the regional and local area of NPP "Kozloduy" are defined based on integrated geological, geophysical, geodetic, geomorphologic, seismic, seismologic, etc. surveys[74].

The analyses of tectonic processes in the Moesia Platform are in conformity with the basic objective laws of the last tectonic cycles. Tectonic displacements are observed only along borderlines of the Platform. The tectonic processes ended at the end of Triassic and beginning of Jurassic. Further information on the tectonics of the regional area was obtained from geological and geophysical cross sections constructed from the survey data for the three regional profiles: Mokresh – Shabla, Petrich – Nikopol and Madan – Strazhitsa – Ruse, while for the deep structure and fault tectonics in depth – through results from magnetteluric drilling, gravimetric, geomagnetic and other measurements as well as through analyses of the specifics of macro-seismic fields and seismic conductivity of seismic energy in the particular zones. Best outlined fault system: North-Pre-Balkan (Belogradchik Flexure) cannot be reasonably accepted for seismic lineament. Characteristics of seismic activity are available in disjunctive knots at Krivodol with the Ogosta north-eastern fault, at Chiren with the Chiren north-eastern fault and at Gabare-Drashan with the Dolnolukovit one – all of them are outside the 30 km local zone surrounding the Kozloduy NPP site. According to data from gravimetric and geomagnetic studies, anomalous sites have not been found within the 30 km local zone surrounding the Kozloduy NPP site. A gravity transition is registered beyond that zone with direction Northwest/Southeast– South Moesia fault, which in the studied area reflects in general the Belogradchik Flexure.

The established direct dynamic relation between general structural development of the territory and formation of its relief is applied for <u>geomorphologic</u> assessment of the neo-tectonic activity on the territory. In the local territory is observed quiet tectonic regime that has had effect on sub-horizontal distribution of geomorphologic levels. Here are found only the aforementioned fault lines with sub-equatorial direction. These are evaluated as active during the Late Cimmerian phase and since then have become passive, fossilized under the effect of thick Cretaceous-Palaeogene and Neocene-Quaternary cover. The same conclusion was reached following analysis of the plan of the river-valley grid and the number of hypsometry of Quaternary terrace complex in the transversely developed valleys of Ogosta and Skat rivers.

These characteristics of the 30 km zone are best illustrated by neo-tectonic and geomorphologic studies of Upper Plio-Pleistocene structural level and by the location

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[74] Survey and activities for improvement of safety at the Kozloduy NPP sites, 1991-92, Geomorphology and neotectonics, Sofia, 1992.

and development of the Danube River terraces and the Danube left and right tributaries with the same elevation on both sides of the river.

The local territory of NPP "Kozloduy" does not show any geological and geomorphologic evidence of the presence of active fault structures of Quaternary age and lineamentation is weakly expressed or is almost missing.

Seismic surveys found that within the 30 km zone there were **no faults** of Jurassic – Palaeogene age. Neocene and Quaternary deposits lie almost horizontally with no surface manifestations of tectonic disturbances. Available data reject the existence of "capable" fault, i.e. manifested surface structure with seismic potential and structures within the meaning of the definition given in Safety Guide 50-SG-S1 (rev.1) of IAEA. Seismotectonic model of the local area (30 km zone) is built by using standard formal procedure for the integration of all available seismologic, geological and geophysical data. The complex lineament zones are marked on the map according to the Triassic – Jurassic fault system. Lineament zones express the highest degree on heterogeneity of physical parameters of the crust and therefore they are considered as zones of potential instability. Lack of evidence for Quaternary activity and movement in the local region as well as the fact that only three micro-earthquakes with magnitude M < 2.0 have been registered on Bulgarian territory (on Romanian territory – only one earthquake with magnitude M = 3.6) give grounds to draw the conclusion that earthquakes with M_{max} > 4.0 should not be expected in the whole local region. The result obtained is consistent with the seismic zoning of the Republic of Bulgaria.

Summarizing the results, the following main conclusions are drawn:

- There are no large fault structures with high energy potential are on the surveyed territories (there is no data for presence of active „capable" fault);
- The Kozloduy NPP site is located in the relatively most stable part of the Moesian platform. This conclusion is confirmed by the accumulated database from the existing for 15 years now local seismological network around the site.

3.4.1.5.2 Design seismic characteristics of the Kozloduy NPP site

Impacts of seismic events through the assessment of seismic hazard are established in two design levels consistent with IAEA recommendations. These are levels of design based earthquake (DBE) and safe shutdown earthquake. For these levels (depending on the specified seismic category) are secured the separate structures, systems and components ensuring safe operation of the plant. For other SSCs the civil engineering standards are applied.

The results of the seismic hazard evaluation for Kozloduy NPP site allow determining the seismic characteristics of the output fluctuations in the earth layers during earthquakes with intensity of design based earthquake (Seismic Level 1 as defined in "Seismic Design and Qualification for Nuclear Power Plants", Safety Series No. NS-G-1.6, IAEA, Vienna, 2003) with frequency 10^{-2} events per year and Safe Shutdown Earthquake (of Seismic Level 2, as defined in "Seismic Design and Qualification for Nuclear Power Plants", Safety Series No. NS-G-1.6, IAEA, Vienna, 2003) with frequency 10^{-4} events per year at the zero level of the site:

- Value of peak acceleration (PGA) for design based earthquake (SL-1) with a recurrence period of 100 years – 0.lg;
- Value of peak acceleration (PGA) for Safe Shutdown Earthquake (SL-2) with a recurrence period of 10 000 years – 0.2g;
- Spectrum of response for free surface;
- Three-component accelograms (with duration of 61s), taking into account the geological conditions at the site.

Effects of local earthquakes M = 4.5 below the Site at depth 5 km and M = 5.0 at 5.0 km distance and 5.0 km depth on structures and equipment are separately analyzed. Peak acceleration (PGA) for both seismic levels, spectrum of response for free surface and the respective three-component accelograms (with duration of 20s) have been defined and discussed and confirmed by IAEA experts in the period 1992 -1995.

Deterministic approach for evaluation of maximum acceleration is applied for seismic sources: Vrancha inter-focus, shallow earthquakes (all shallow sources) and local zone. Results are submitted in the report by the Institute of Geophysics /BAS/ in 1992. The maximum expected magnitude of each seismic source is linked to the point closest to the Site taking into account also to the source size. The peak acceleration is calculated through application of adequate laws of attenuation taking into account the local conditions. The peak accelerations calculated after the deterministic method are much lower than the ones calculated based on probabilistic assessment of seismic hazard (1.35 – 1.7 times).

Dynamic characteristics of the ground layers in the construction site of Kozloduy NPP, according to which the geotechnical model of the profile "free surface" is composed, are determined experimentally. Field measurements are performed for calculation of the velocity of propagation of seismic waves through straight and reverse seismic-logging and seismic profiling.

It is established that transverse waves spread in clays with lower velocity of 170 m/s and with higher velocity (680 m/s) in marls while the velocity of longitudinal waves is 470 m/s in clays and 2 700 m/s in marls. The interval of changes of shearing strain is from10^{-6} to 10^{-1} cm/cm and each lithologic variety is submitted with graphical relation of such strain with the shearing modulus coefficient G/G_{max} (0.0 to 1.2) and attenuation coefficient D (0÷40 %). The elaborations of BAS summarise data for geotechnical seismic model of the "free surface" profile valid for the construction site and, regardless of the heterogeneous geological conditions, allow identification of the "soil-structure" interaction. This data was used in the analysis in the project "Benchmark study for the seismic analysis and testing of WWER-Type NPP" of the IAEA and in the Modernisation Programme of Units 5 and 6, etc. with participation of European and American companies with extensive experience in seismic design and seismic re-evaluation of nuclear power plants

3.4.1.5.3 Integrated criteria for selection of one out of the four potential sites

Selection by seismotectonic, geologic and hydro geologic indications of one of the four potential sites for the construction of NNU will be made on the basis of the NRA Regulation of 2004 on ensuring the safety of nuclear power plants and the following documents of IAEA: Safety Guide Series NS-R-3, 2003 и NS-G-3.6, 2004; Specific Safety Guide Series SSG-9, 2010 и SSG-18.

The following site conditions have been considered for the criteria selection:

- → Tectonic and seismic environments at the four sites are the same: existence of active tectonic faults in the 30 km Bulgarian zone is not proved and the seismic characteristics at the four sites for the respective seismic levels should not differ substantially from the current seismic characteristics of Kozloduy NPP site (with relatively similar geological characteristics);
- → Prior to the construction works at each site exist possibilities for applying sub-grade improvement methods so that the bearing capacity to be consistent with the load and settlings to be within admissible limits.

The following criteria are applicable for selection of one out of the four sites under the above described conditions:

- → Depth of groundwater level;
- → Risk of raising the level of groundwater at the site in the event of rising level of the Danube, resulting from extreme combination of hydrological and weather circumstances (demolition of Zhelezni Vrata facility in combination with excessive precipitation on the catchment basin of the river);
- → Risk of secondary deformations in the earth base caused by seismic impacts on structures (the greater the elastic module of the base, the lower the ground water level, the smaller the deformations);
- → Sorption capacity of earth base toward migration of radionuclides (the lower the permeability coefficient and the greater the soil sorption capacity, the greater the attenuating capacity).

3.4.1.6 FORECAST OF IMPACT

3.4.1.6.1 Exogenic (surface and pre-surface) geological processes

Impacts of the following processes shall be analyzed in the EIA Report:

- → River erosion: effects thereof are always evaluated for construction of nuclear facilities near a large river (IAEA Specific safety guide No SSG-18, 2011). On the grounds of river terraces dating, made in Item 3.4.1.1.3, is proven that the erosion activity of the river at the first non-flooded terrace (Sites 2 and 4) had faded 71 000 years ago and terminated 6 000 years ago at the flooded terrace, therefore its activation is not expected in the next few millennia

→ High natural groundwater level and presence of water-rich aquifers close to the elevation of nuclear facilities foundations. Proof shall be given that groundwater level at the first non-flooded terrace (Sites 2 and 4) is sufficiently deep below the minimum admissible one while at Sites 1 and 3 on the flooded terrace a thick structural embankment shall be needed to move the facilities away from the ground water level.

→ It has been proven that long-term raise of groundwater level and flooding the site of the facilities is impossible. Short term raising will be studied in the most unfavourable combination of hydrological and climatic factors and will be demonstrated that the facilities located at the non-flooded terrace of the Danube River are not threatened by this phenomenon (IAEA Safety Guide Series, SSG – 18, 2011).

→ For Sites 2 and 4 will be analyzed in the risk of sinking and settlement of loess. The methods to overcome this danger will be described. The experience of constructed facilities of NPP "Kozloduy" will be used.

→ Manifestation of other processes of geological hazard such as karsts and landslides is impossible because there are no conditions for this.

The Plant is located on the non-flooded terrace of the Danube and is not endangered by flooding or erosion activities. The ground water level is at 10 m – 12 m from the ground surface.

Sub-grade was scraped up to depth of 12 m – 14 m in loess followed underneath by alluvial deposits of the terrace and Pliocene clays. Foundation works for all nuclear facilities in the loess for Units 1÷4 were carried out through deepening of foundations and erection of soil-cement bedding and a combination of soil-cement and gravel beddings for Units 5 and 6. These preparatory works eliminated the hazard of loess collapse and reduced sub-grade settling to 5 cm – 10 cm. Furthermore, the soil-cement bedding stands successfully for additional engineering barrier with regards to radionuclides spread.

Sites 1 and 3 are located on the flooded terrace T_0 of the Danube River at elevation of 26 m – 28 m. The terrace footing at elevations from 13 m to 15 m at Site 3 is formed in Pliocene clays (Brusartsi Formation) and at Site 1 is formed in Miocene sands (Archar Formation). Alluvium with average thickness of about 13 m – 14 m has a two-layer structure: gravel sandy in the bottom section and clayey-sandy in the top section and is characterized by high heterogeneity in both vertical and horizontal directions. Groundwater is springing on the surface or close to it.

If any of these sites is selected for the construction of NNU, the foundation will have to be constructed on a thick structural embankment, including removal of weak alluvial materials. The experience from NPP "Belene" where the earth base is similar to sites 1 and 3 can be used.

Sites 2 and 4 are located on the first non-flooded terrace T_1 of the Danube River with a surface at elevations 35 m – 38 m. Three sediment complexes are distinguished in the geological profile of the terrace: loess, alluvium and lake (Brusartsi Formation). The loess complex is 12 m – 14 m thick. Under the loess lies the terrace alluvium, composed of sands in the upper part and gravels – at the bottom. The alluvium top is at average elevation of 22 m –24 m. The terrace footing at elevation from 15 to 18 m is cut into Pliocene clays of the so-called Brusartsi Formation.

Groundwater levels at the sites are at average of 8 m – 10 m of the surface.

In the event the NNU is to be built at these sites, the foundations will have to be laid in excavation pit. Foundation works will be performed in collapsible loess and the solutions applied to the existing power units can be used.

Impact projection on geological environment at Sites 1 and 3

Sites 1 and 3 have similar engineering-geological and hydro geological conditions since they are located on the recent, flooded terrace of the Danube River. In the event the NNU is to be built at these sites, the design will most probably have to provide for sub-grade preparation as at the site of NPP “Belene” and will include removal of weak layers off to gravels and construction of a thick structural embankment up to elevation of 34 m – 35 m.

Major problem of the geotechnical and hydro geological conditions of sites 1 and 3 is the high level of groundwater. In emergency situations caused by the demolition of "Zhelezni Vrata" a short-time rise is possible.

According to the source based in Geotechnical Research Station (2012), unlike the other sites, at Site 1 there is no clayey layer under the alluvial gravels and they, along with the sands of the Brusartsi Formation are in hydraulic connection with the sands of the Archar Formation. This facilitates the potential spread of radionuclides with groundwater streams.

Impact projection on geological environment at Sites 2 and 4

Sites 2 and 4 have similar engineering-geological and hydro geological conditions since they are located on the first non-flooded terrace of the Danube River. Unfavourable effects on the geological environment are not to be expected with sub-grade previously prepared as at the existing units of NPP “Kozloduy” and normal operation mode. The presence of a thick layer of Pliocene clay under alluvium sands and gravels in the non-flooded terrace will impede to the maximum the migration of radionuclides toward the aquifer under the clays of the Archar Formation. Any accidents with dams upstream of the Danube would cause minimum rise of groundwater level.

3.4.1.6.2 Endogenic (seismo-tectonic) geological processes

Kozloduy NPP is located in quiet tectonic zone of the Earth's crust – on the Moesian Platform. Active faults have not been established within the 30 km zone of the plant. Regarding seismotectonic conditions, the project sites have the same parameters as the site of the existing power units.

It is not expected that the implementation of the investment proposal will modify significantly the endogenous parameters of the geological environment. The selection of the site is subject to a related project, which is being implemented in parallel with the current EIA, and the assessment will be made according to art. 25, item 1 of the Regulation on ensuring the safety of the nuclear power plants (2004). The impact during the construction is related to removal of the soil layer and other exogenic parameters of the geological environment.

The impact of endogenous processes on the safe long-term operation of the new nuclear unit, which can cause harmful effects on the environment, will be reported in detail in the EIA Report, in the section on seismic hazard analysis. There is no doubt that the design scheme will be an extension of principles for the existing plant sites and will develop them further in a state-of-art way. The spatial solution of the new building within the framework of related procedures will be developed with a view to existing build-up and general final appearance of the energy site. Building structures will conform to technological demands and, according to specifications, will be resistant to external seismic effects, following-up the principles of design and construction of the existing sites of Kozloduy NPP.

In studies of the Geophysical Institute of BAS for seismic safety of Kozloduy NPP, adopted at IAEA missions in 1992, a main conclusion is reached that earthquake with acceleration 0.1 g can be expected once in100 years, and the maximum shutdown 0.2g – once in10 000 years. Data on engineering-geological conditions at the site, physical and mechanical characteristics of the soil and response spectrum of the Site is summarized to solve the problem of soil-construction interaction.

The behaviour of facilities and systems in the Units in time of earthquake during the last years was analyzed in detail by Risk Engineering OOD in relation to SAR and PSA. The analyses were submitted with the report *"Assessment of response to capacity of building structures of Kozloduy NPP Units 5-6 and identification of probability parameters of elements fragility for the purposes of PSA, level 1, with account to seismic initiators"* and were discussed afterwards in the EIA report for Units 5-6 in 1994. Building structures response was rated, probability parameters of the elements fragility were identified, probability analysis was performed for failure of critical structure elements in earthquakes and the behaviour of Units in the event of earthquake was modelled after the method "tree of events".

Protective functions to be undertaken at occurrence of various initial events have been defined to prevent failure of the core and limit consequences from eventual failure. In the construction of the fault tree analyses conservative assumptions were made and were not included operator's actions in the event of an earthquake, etc. passive equipment failures due to demolished building structure. Simultaneously, the elements were grouped by design criteria, method of seismic qualification and parameters of response.

Summarized assessment of forces and displacements in the structure of the reactor building of unit 5 in the event of earthquake demonstrates good behaviour of the unit and reliability of its structure for safe shutdown seismic impact.

Studies within the project "Benchmark study for the seismic analysis and testing of WWER-Type NPP" where building structures and equipment were tested under seismic impact initiated by explosions at about 2 km southwest of the site of EP-2 is of exceptional importance. Identified were dynamic parameters of housing and equipment in the reactor building and turbine hall of Unit 5, acceleration and amplitude-frequency parameters of particular equipment types, for example main circulator pump, etc. Proposals for technical solutions were submitted.

Units 5 and 6 of NPP "Kozloduy" are equipped with installation for industrial seismic protection (IISP), which automatically shuts down the reactors in the event of earthquakes with accelerations higher than a specified threshold (0.05g). Since 1993 a system of accelerographs SASCES (System for Accelerographic Seismic Control of Equipment and Structures) has been put into operation. It includes accelerographs type ETNA (6 pcs.) and SSA-2 (4 pcs.) located on the free area and at various elevations of units 3 and 5.

The system supports seismic control of equipment and structures, registration and data backup. The layout of the accelerographs is approved by the IAEA. Schedules are developed for monthly, six-monthly and annual inspection. Written procedures are developed for each activity in accordance with the quality assurance system. A report is issued for each inspection. Activities are performed by qualified personnel. Reports are archived with the file of the relevant device.

Geodetic measurements of structures and equipment are performed in NPP "Kozloduy" according to an approved schedule. Cadastral services are provided on the territory of the company. Resource management includes passporting, control of status and development of engineering and construction sites through specialized monitoring and measurements, programs for complex and 72-hours tests on newly build facilities and equipment, post-maintenance and reconstruction tests, development and/or provision of measures for corrective action on the sites, change management. Within the Programme for modernization of units 5 and 6 and the Investment Programme seismic qualification was performed of all structures, systems and components (SSCs) in SSEL (seismic safe shutdown equipment list).

3.4.2 Natural Resources

3.4.2.1 Mineral resources

3.4.2.1.1 Current status

At the time of drafting the Terms of Reference, there is no data of mineral resources in the territory of the four sites. For the purposes of the EIA Report further studies will be carried out by the National Geological Fund and references will be made to extracts from databases and specialized maps and registers of MEET.

3.4.2.1.2 Impact projection

If in the process of drafting the EIA Report is established information for presence of mineral resources, then a projection of the impact of IP thereon will be developed.

3.4.2.2 Building materials /rubble, sand, etc./

Rubble and sand will be some of the building materials that will be present in all key stages of the construction of NNU from site preparation through construction of underground and ground communications and the main ground construction of buildings and facilities at the site. The building properties of the materials according to the specifics of the site and the associated construction works will be specified in technical design related to the implementation of the IP. Supply of the construction site with the necessary quantities of river gravel and sand will be carried out from regulated under the WA ballast quarries inside or outside the region. This is regulated with the Water Act. Authorisation is issued by Executive Agency for Exploration and Maintenance of the Danube River – Ruse for extraction from the Danube, by the Ministry of Environment and Water (MoEW) for extraction from dams according to Annex 1 to the WA and by the Basin Directorate for Water Management in Danube Region (BDWMDR) for ballast quarries along interior rivers.

3.4.2.2.1 Current status

Rubble and sand from the Danube River are extracted from 24 locations under permits issued by the competent authority – Executive Agency for Exploration and Maintenance of the Danube River – Rouse. Extraction from the Ogosta Dam is also permitted and the authorisation is within the powers of MoEW. There are some small ballast quarries on Ogosta and Iskar rivers where the licensing regime is managed by BDMDRW. These quantities are likely to be insufficient regardless of the selected site. The materials shall be considered during the next design stages including locations of extraction and application during the preparation of building mortars. Site selection for implementing the IP will be of significance with regard to access via construction roads, existing Concrete Batching Plants and location of new ones.

3.4.2.3 FORECAST OF IMPACT

The extraction of inert building materials from the dynamic reserves of water bodies – rivers has a significant impact on the ecological status of the water body, so its authorization has restrictive measures with certain prohibitions in WA, art. 118h, as well as prohibitions for extraction from riverbeds introduced by the River Basin Management Plan (RBMP) and included in the Programs of Measures. In the EIA Report this point will be assessed in detail in terms of impact.

3.5 LANDSCAPE

3.5.1 CURRENT STATUS

The Sites, subject to Investment Proposal, are part of the territory owned by Kozloduy NPP EAD and the 30-km zone thereto entering the Western sub-region of the Danube Plain as part of the Mizia Region.

According to the map with **regional landscape zoning** of Bulgaria[75], the territory of Kozloduy NPP EAD is located in the:

A. North Bulgarian landscape *zonal district;*

- I. North Danube-plain landscape sub-district;

  4. Zlatiyski landscape *region*;

  5. Dolnoiskarski landscape *region;*

- II. South Danube plain landscape sub-district;

  13. Lyutensko-Borovanski landscape *region.*

Specified structures within the 30-km zone round the Kozloduy NPP EAD are presented within the range of:

- Kozloduy Municipality and the eastern part of Lom Municipality: covering part of the Zlatiyski landscape region (4);
- Valchedram, Hayredin, Krivodol and Mizia municipalities: in the Zlatiyski (4) and Lyutensko-Borovanski (13) landscape regions;
- Oryahovo Municipality: in the Dolnoiskarski landscape region (5);
- Parts entering the 30-km zone of the KNPP in Byala Slatina, Borovan and Boychinovtsi municipalities: in Lyutensko-Borovanski landscape region (13).

According to the **typologic classification system of landscapes in Bulgaria** the Project enters the landscape structure characterized by 8 groups, 5 sub-groups and 2 landscape types of the Plain Landscapes class:

[75] Petrov, P. 1997. Landscape structure, B: "Geography of Bulgaria". Prof. Marin Drinov AP, Sofia.

1. Class	Plain landscapes;
1.1 Type	Landscapes with moderate continental meadow-steppe and forest lowlands;
1.1.1. Sub-type	Landscapes of meadow-steppe lowlands;
1.1.1.1. Group	Landscapes of meadow-steppe alluvial lowlands with medium degree of agricultural reclamation;
1.1.2. Sub-type	Landscapes of meadow-marsh lowlands;
1.1.2.2. Group	Landscapes of meadow-marsh alluvium lowlands with comparatively low degree of agricultural reclamation;
1.1.3. Sub-type	Landscapes of forest lowlands;
1.1.3.3. Group	Landscapes of forest lowlands on river islands;
1.1.3.4. Group	Landscapes of forest lowlands over the flood terrace hills with comparatively low degree of agricultural reclamation;
1.2. Type	Landscapes of moderate-continental steppe, meadow-steppe and forest-steppe plains;
1.2.5. Sub-type	Landscapes of chernozem meadow-steppe plains;
1.2.5.7. Group	Landscapes of chernozem meadow-steppe plains on loess rocks with high degree of agricultural reclamation;
1.2.5.8. Group	Landscapes of chernozem meadow-steppe plains on calcareous rocks with medium degree of agricultural reclamation;
1.2.6. Sub-type	Landscapes of forest-steppe plains;
1.2.6.9. Group	Landscapes of forest-steppe plains of loess with high degree of agricultural use;
1.2.6.10. Group	Landscapes of forest-steppe plains on loess rocks with high degree of agricultural reclamation.

Numerical indices of landscape taxonometric ranks are part of the Landscape Map of the country and identify hierarchic landscape classification whereto the territory of the investment proposal belongs.

The accuracy for identification of belonging of a specified landscape of the charts above does not comply entirely with the objectives on territory of the investment proposal. The scale of such maps (M 1:400000) does not allow detailed characterization of considered territory and therefore a more detailed system for landscape classification according to leading/physiognomic component[76] is applied.

3.5.1.1 LANDSCAPES ON THE KOZLODUY NPP TERRITORY

Landscape, anthropogenic. The Kozloduy NPP Site is part of technogenic landscape. The following subtypes thereof occur at the Site:

[76] Petrov, P. 1990. Landscape Science. SU Kliment Ohridski UP.

- Landscape, technogenic industrial: formed by the buildings of Units 1, 2, 3, 4, 5 and 6 of the Kozloduy NPP, administration buildings, electric and other equipment and parking lots;
- Landscape, technogenic communication in the structure whereof enter road communications on the territory of the Kozloduy NPP and existing routes of overhead transmission HV line.

Furthermore, on the territory of Kozloduy NPP there is:

Forest landscape. Physiognomic component of this landscape is tree vegetation. The territory of the landscape is broken by communication lines, buildings, open spaces, etc. Landscape forest is created to arrange green spaces and development of environment. The component structure includes various tree and shrub species. Landscape forest possesses stability and capacity for self-organization and self-regulation.

Aquatic landscape. The leading and physiognomic component is surface water. The component is represented by the intake and outlet canals to the Plant and covers comparatively large area providing grounds to be distinguished as an independent landscape. The latter is unstable in time, the existence thereof depends entirely on the technogenic activities.

3.5.1.2 LANDSCAPE ON THE TERRITORY OF SITE 1

According to the leading landscape-forming component on the territory of that Site, the following landscape structures can be distinguished:

Agrarian landscape. The structure of agrarian landscapes includes pastures and arable areas in the lands of Harlets village.

Technogenic landscape. On the territory of Site 1 is distinguished the variety technogenic communication landscape wherein the technogenic effect is expressed in construction of various drain collectors and field roads.

3.5.1.3 LANDSCAPE ON THE TERRITORY OF SITE 2

The following landscape structures can be distinguished on the territory of that Site:

Agrarian landscape. The appearance thereof is formed by arable areas as part of the Harlets village lands. Arable lands are formed under the effect of purposeful technogenic activity resulting in landscape changes aimed to meet specific demands.

Existence of such landscapes depends on technogenic activities – man may continuously maintain them in a particular state.

Technogenic landscape. The structure includes abandoned buildings and facilities of a former farm yard on the territory of Kozloduy NPP.

Forest landscape. The structure includes tree-shrub massifs on the Kozloduy NPP territory established with the purpose of greening and isolation of the Plant territory.

3.5.1.4 LANDSCAPE ON THE TERRITORY OF SITE 3

Agrarian landscape. The greater part of this Site territory is occupied by arable areas within the Harlets village lands. Landscape agrarian, crop rotation and agrarian of the perennial plants.

Technogenic landscape. The technogenic landscape structure includes open irrigation channels and field roads.

3.5.1.5 LANDSCAPE ON THE TERRITORY OF SITE 4

The Site territory is part of landscape technogenic on the NPP territory. The following varieties thereof occur:

- Landscape technogenic industrial: established by built up service departments – Equipment Office, Car-Repair Shop and Assembly Shop;.
- Technogenic communication: the structure thereof includes all road communications and existing routes of high-voltage overhead transmission lines.

3.5.1.6 LANDSCAPE IN THE REGION OF THE INVESTMENT PROPOSAL

Depending on leading and/or physiognomic landscape-forming components, the landscapes on the territory of the 30-km zone round the NPP are classified as follows:

Forest landscape. Leading and physiognomic component in this landscape is tree vegetation. These are natural territorial complexes of the Kozloduy Municipality forest fund, the eastern part of Lom Municipality, Valchedram, Hayredin, Mizia, Oryahovo municipalities and parts entering the 30-km zone of KNPP in the Byala Slatina, Borovan, Krivodol and Boychinovtsi municipalities.

The landscape horizontal structure is characterized by broken grounds and covers river bank territories and hilly slopes. The structure thereof includes tree species forming also the visual appearance of the landscape. Various species of willows (Salix sp.) and poplars (Populus sp.), Downy oak (Quercus pubescens), Turkish oak (Quercus cerrsi) and Hungarian oak (Quercus frainetto), Field elm (Ulmus campestre), Lime-trees (Tilia sp.) etc. Furthermore, common Acacia cultures (Acacia pseudoacacia) occur as well as pure and mixed cultures of Black pine (Pinus nigra). Belts of poplar cultures (Populus sp.) are grown alongside the Danube and cover the main part of islands. Most common among shrub species are the amorpha speciesn (Amorpha sp.). Landscape forest is characterized by high resistance because of available capacities for self-regulation and self-renewal.

Grassland landscape. That landscape occupies considerable areas in the valleys round the investment proposal territory. Out of the varieties thereof there occurs the “meadow marshy” landscape in micro-depressions of flooded river terraces and in isolated plots round marshes within the region.

Agrarian landscape. Agrarian landscapes present natural-territorial complexes of lands in the municipalities surrounding the NPP territory. The landscape appearance is characterized by arable lands and pastures formed under the effect of purposeful technogenic activities aimed to meet specific demands. Existence of such landscapes depends entirely on the technogenic activities – man may maintain them permanently in a particular state.

Aquatic landscape. Leading and physiognomic component in this landscape is surface water represented by landscape "aquatic river". The structure of river landscapes includes the Danube, Skat, Ogosta and Tsibritsa rivers and tributaries in the catchment areas thereof.

Technogenic landscape. Technogenic landscapes on the territory of the 30-km zone round the NPP are represented generally by the following varieties: "technogenic settlement", "technogenic communication" and "technogenic industrial".

3.5.2 Forecast of impact

The Sites, subject to EIAR, are part of agrarian and technogenic landscape.

The landscape structure at one of the surveyed sites shall change as a result of the investment proposal implementation and the landscape components (geologic base, soils and vegetation) shall be affected. Excavation works shall directly affect the geological base component. The impact is assessed as direct, irreversible, negative, local and small by range. Soils are subject to mechanical impact by excavation-embankment works and the humus layer shall be stockpiled in temporary depots. Vegetation on such plots shall be exterminated. The impact on the soil and vegetation landscape components is assessed as direct, negative, reversible, and local.

The following shall be studied and analyzed in the EIAR:

- → Landscape structure and functions;
- → Analysis and evaluation of pollutants migration;
- → Potential of self-cleaning and self-restoration;
- → Capacities for realization of the investment proposal;
- → Formulation of criteria for site selection;
- → Assessment of expected landscape disturbances and changes;
- → Measures for reduction, prevention and obstruction of negative consequences from the investment proposal realization.

3.6 Biodiversity

The subject of assessment in the report of EIA is the impact of the new unit at one of the four alternative sites designed for erection thereof. Impacts on the biological diversity (protected vegetation and animal species) in the range of the 30-km zone around the Kozloduy NPP shall be analyzed and assessed.

3.6.1 CURRENT STATUS

3.6.1.1 FLORA

According to the geo-botanical zoning of Bulgaria, the territory within the 30-km range of IP is referred to as the Euro-Asian steppe and forest-steppe area, Lower Danube Province, Danube River District, Zlatiyski Region. The territory is forestless and occupied mainly by agricultural cereals and vineyards. There are sparse remains of forests including Turkish oak (Quercus cerris L.), Quercus virgilliana Ten., and Downy Oak (Quercus pubescens Willd). In some places secondary forest associations grow with prevalence of Oriental Hornbeam (Carpinus orientalis Mill.), South European Flowering Ash (Fraxinus ornus L.), etc. Man-made plantations of Acacia (Robinia pseudoacacia L.) are established also. In many places, degraded forests are replaced by bushy associations including the Smoke Tree (Cotinus coggygria). In forestless plots secondary grass formations are formed with the prevalence of Chrysopogon gryllus (L.) Trin.), Yellow Bluestem (Dichanthium ischaemum (L.) Roberty), Bulbous Bluegrass (Poa bulbosa (L.), etc. A series of steppe elements play a part along with the Montpellierian Camphor-fume (Camphorosma monspeliaca L.), Danubian Clustered Broom (Chamaecytisus danubialis (Vel.) Rothm.), Potentilla pirotensis (Borbas) Markova, etc. In places of excessive moisture along the Danube, forest associations occur with prevailing White Willow (Salix alba L.), White Poplar (Populus alba L.) and Black Poplar (Populus nigra L.). On isolated plots there are cultures of hybrid poplars (Populus X euroamericana). Associations are also formed also of marshy and boggy grass vegetation with prevailing Reed (Phragmites australis (Cav.) Trin ex Stend.), Narrowleaf Cattail (Typha angustifolia L.), Lakeshore Bulrush (Schoenoplectus lacustris L.), etc.

Data from the last publication of the Red Book for the Republic of Bulgaria, Volume 1, Plants and mushrooms (Peev, D., etc. on-line)78 show that within the 30-km range of the territory, the following plant species occur: Water Soldiers (Stratiotes aloides), Chinese licorice (Glycyrrhiza glabra), Rumelian Corn-flower (Centaurea rumelica), Yellow Waterlily (Nuphar lutea), (Astragalus dasyanthus), Military Orchid (Orchis militaris), Fringed Water-lily (Nymphoides peltata).

Assessment of flora and vegetation shall cover expected impact during the civil works and operation of the IP on the protected vegetation species, as per the Biological Diversity Act, growing in the area of the investment proposal (IP) – the four alternative sites and those included in the range of impact within the 30-km perimeter.

3.6.1.2 FAUNA

According to the zoo-geographic zoning of Bulgaria, the 30 km area around the Kozloduy NPP is located in the Danube zoo-geographic region, in the belt of plain-hilly and hillyfoothill belt of oak forests. Euro-Siberian and European species prevail with the addition of a significant number of Mediterranean species. The ornitho-fauna also features Euro-Siberian, European and Mediterranean elements. On the one hand, strong anthropogenization of lands in the region (drying up of the Kozloduy swamp, bunding of the Danube River and Ogosta River, Ogosta riverbed regulation, cutting off natural vegetation on the Danube islands, excessive application of chemicals in the Zlatiyata, etc.) has drastically affected fauna and recent complex formation. The fauna may be subdivided in three categories in terms of stability thereof to the degree of technogenic loading: synanthropic, eusynanthropic and ecologically plastic species. The species composition of animal associations has markedly changed due to significant technogenic impact.

TABLE 3.6-1: PROTECTED AREAS FOR THE NATURA 2000 NETWORK AND ACCORDING TO THE RAMSAR CONVENTION, IN THE REPUBLIC OF BULGARIA AND THE REPUBLIC OF ROMANIA, ON THE TERRITORY OF THE 30 KM ZONE

Directive / State	**Birds Directive** (SPA)	**Habitats Directive** (SCI)	**Total**	**Ramsar Convention**
Bulgaria	BG0002007 BG0002008 BG0002009 BG0002104	BG0000199 BG0000508 BG0000527 BG0000533 BG0000614	9	Maintained Ibisha Reserve
Romania	ROSPA0010 ROSPA0023	ROSCI0045 ROSPA0135	4	
Total	**6**	**7**	**13**	**1**

On the other hand, among factors justifying the species richness in the region is the availability of a large ecological corridor (the Danube River), relative proximity of the Danube Delta, migration stream of birds over the territory and low altitude. The Kozloduy NPP is located in the middle of an ecological complex of large swamps with part of them already dried up or transformed into fish-breeding ponds (Bistretsko, Tsibarsko and Kozloduysko Ostrovsko[77], inter-continental dunes (at Bistrets and Duboleni), the Danube islands (Tsibar, Tsibritsa, Svraka, Kozloduy, Kopanitsa), river mouths (Ziu, Ogosta, Skat), flooded island forests, large sand strips (between Lower and Upper Tsibar). A large part thereof is included in the protected areas of the Natura 2000 network and the Ramsar Convention: ***Table 3.6-1:*** *Protected areas for the NATURA 2000 network and according to the Ramsar convention, in the Republic of Bulgaria and the Republic of Romania, on the territory of the 30 km zone****).***

Seven species of worldwide endangered birds occur in that ecological complex during the various seasons of the year: Dalmatian Pelican (Pelecanus crispus), Lesser Whitefronted Goose (Anser erythropus), Red-breasted Goose (Branta ruficollis),

[77] MICHEV, T., M. STOYNEVA (eds). 2007. Inventory of Bulgarian Wetlands and their Biodiversity. Publ. House Elsi-M, Sofia, 364 pp.

Ferruginous Duck (Aythya nyroca), White-tailed Eagle (Haliaetus albicilla), Red-footed Falcon (Falco vespertinus), Corn Crake (Crex crex).

The greater, larger-scale range of the studied territory (with radius of 30 km) and the greater time interval of tens of years are of significant importance to the studies related to biological diversity and conservation. References since the end of the 19th century to date shall be used for description of some elements of ecosystems in the region. The UTM coordinate network is applied with the help of modern atlases that have been compiled for occurrence of plants and animals in Europe, on the Balkan Peninsula and in Bulgaria.

Invertebrates

Populations of terrestrial invertebrates with conservation status are not expected to be found on the territory of the four sites under assessment. The region of the 30-km area round the investment proposal location is very poorly studied in respect of biodiversity of terrestrial invertebrates. One species of mayfly – Brachycercus harrisella (Harris'mayfly), included in the Red Book of Republic of Bulgaria of the category "Critically endangered" (Golemanski, (edit.) 2011)[78] was reported at the Danube at Kozloduy in the period 1955-1964. The species may be treated as both terrestrial and aquatic fauna because of the fact that larvae are developing on bottoms of large rivers and the imago is flying toward the land. The imago (adult specimens) lives shortly and keeps close to the water basins wherefore direct impact is not expected on flying insects since indirect impacts on insects with that short life of imago are very difficult to define. Other data for protected and vulnerable terrestrial invertebrates is not available.

Aquatic invertebrates and invasive species

Water supply from the Danube is foreseen for the circulating water system of the Kozloduy NPP new nuclear unit. Service water supply will also be related to activities in the Danube riverbed. Such activities will affect aquatic invertebrates like zooplankton and zoobentos including mussels, snails and crayfish. Impact on 4 species of water invertebrates is expected in the affected section of the Danube and appurtenant water basins (e.g. lower reaches and mouth of the Ogosta River) as follows: Striped Nerite (Theodoxus transversalis), Thick Shelled River Mussel (Unio crassus) (Endangered species according to IUCN Red List, App. 2 and 3, BDA), Depressed River Mussel (Pseudanodonta complanata) (Vulnerable species according to IUCN Red List), Narrow-Clawed Crayfish (Astacus leptodactylus) (App. 4, BDA).

Invasive alien species

The activities foreseen during the civil works and operations of the new nuclear unit shall affect not only the native species but invasive alien species as well. The effect may be both negative and positive and will in turn reflect indirectly on native species and ecosystems. Not all of the alien species have expressed a negative impact on native

[78] Golemanski (ed.) 2011. Red Book of Bulgaria

species but such an effect may be obtained with changes in the environment (Panov et al., 2009)[79].

The following alien species of aquatic invertebrates and fish with potentially negative impact on native species and ecosystems, have been established or are expected to invade the Bulgarian section of the Danube: Chinese Pond Mussel (Anodonta woodiana), Quagga Mussel (Dreissena bugensis), Asian clam (Corbicula fluminea), Chinese Mitten Crab (Eriocheir sinensis), Spiny-cheek Crayfish (Orconectes limosus) and fish: Paddlefish (Polyodon spathula), Bighead Carp (Aristichthys nobilis), Gibel Carp (Carassius gibelio), Grass Carp (Ctenopharyngodon idella), Silver Carp (Hypophthalmichthys molitrix), Topmouth gudgeon (Pseudorasbora parva), North Amerikan Catfishes (Ameiurus melas/Ameiurus nebulosus / Ictalurus punctatus), Eastern Mosquitofish (Gambusia holbrooki), Black-striped Pipefish (Syngnathus abaster), Pumpkinseed (Lepomis gibbosus), Amur Sleeper (Perccottus glenii) (Schiemer et al.2004[80]; Liška et al.200883[81], Polačik et al. 200884[82]).

The planned activities are expected to create a favourable environment for the introduction of new alien species or increased impact of already existing ones resulting, due to temporary or lasting changes in habitat qualities (increased water temperature, changes in flow velocity, food supply, substrate type, etc.).

Water supply from the Danube is foreseen for the circulating water system of the Kozloduy NPP new nuclear unit. Service water supply will also be related to activities in the Danube riverbed. Such activities will affect aquatic invertebrates like zooplankton) It is expected that the planned activities to create favourable conditions for the entry of new alien species to enhance the impact of existing ones – resulting in temporary or permanent changes in habitat quality (increased water temperature, flow velocity, water quality , food supply , changes in substrate, etc.)

Ichthyofauna

Circulation water from the Danube River shall be supplied to the new power unit whereat part of the civil works shall be carried out in the Danube riverbed: erection of cooling system (drain collectors), renewal of existing and building up new pump stations, increased water traffic, handling works, etc.

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[79] Panov, V. E., B. Alexandrov, K. Arbačiauskas, R. Binimelis, G. H. Copp, M. Grabowski, F. Lucy, R. SEW Leuven, S. Nehring, M. Paunović, V. Semenchenko and M. O. Son, 2009. Assessing the risks of aquatic species invasions via European inland waterways: From concepts to environmental indicators. Integrated Environmental Assessment and Management, 5 (1), pp. 110–126

[80] Schiemer F., G. Guti, H. Keckeis and M. Staras 2004. Ecological status and problems of the Danube River and its fish fauna: a review. In: Welcomme R.L., T. Petr (Eds.), Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries "Sustaining Livelihoods and Biodiversity in the New Millennium", 11-14 February 2003, Phnom Penh, Kingdom of Cambodia. Vol. 1: 273-299.

[81] Liška I., F. Wagner, J. Slobodník 2008. Joint Danube Survey 2. Final Scientific Report. ICPDR, 242 pp.

[82] Polačik, M., T. Trichkova, M. Janáč, M. Vassilev, P. Jurajda, 2008. The ichthyofauna of the shoreline zone in the longitudinal profile of the Danube River, Bulgaria. Acta zoologica bulgarica, 60 (1): 77-88.

Amount of hot water used for cooling will be discharged into the Danube , and through pumping equipment will be injected water (from the Danube and other sources) to maintain the circulation , maintenance of new nuclear power . It is expected that these activities will inevitably affect significantly 15 fish species included in App. 2 BA and occurring within 30 km range of the impact of IP (Drenski, 1951 ; Karapetkova , 1994 , Stefanov, 2007) Danube herring (Alosa pontica), Asp (Aspius aspius), barbel (Barbus meridionalis), Great loach (Cobitis elongata), Plain loach (Cobitis taenia), Balkan loach (Sabanejewia aurata), Ukrainian lamprey (Eudontomyzon mariae), Belopera gudgeon (Gobio albipinnatus), hi redfish (Gymnocephalus baloni), Striped ruffe (Gymnocephalus schraetser), Viyun (Misgurnus fossilis) Sabitsa (Pelecus cultratus), Gorchivka (Rhodeus amarus), Big vretenarka (Zingel zingel), Small vretenarka (Zingel streber)

Herpetofauna

Ten amphibian species and 9 reptile species that are on the list in appendices of the BDA occur in the 30-km zone around the Kozloduy NPP (Biserkov et.al., 2007[83]; Naumov and Stanchev, 2010[84]; Stojanov et al., 2011[85]):

Danube Crested Newt (Triturus dobrogicus), Smooth Newt (Lissotriton vulgaris), European Fire-bellied Toad (Bombina bombina), European Spadefoot Toad (Pelobates fuscus), Caucasian Toad (Bufo bufo), Green Toad (Pseudepidalea viridis), European Tree Frog (Hyla arborea), Agile Frog (Rana dalmatina), Marsh Frog (Pelophylax ridibundus), Edible Frog (Pelophylax kl. eculentus), European pond turtle (Emys orbicularis), Hermann's Tortoise (Testudo hermanni), European Green Lizard (Lacerta viridis), Balkan Wall Lizard (Podarcis tauricus), Caspian Whipsnake (Dolichophis capius), Aesculapian Snake (Zamenis longissimus), Eastern Four-lined Snake (Elaphe sauromates), Dice Snake (Natrix tessellata), Nose-horned Viper (Vipera ammodytes).

Mammals

The following species listed in BDA occur in the area of the 30-km zone: European Hedgehog (Erinaceus europaeus), Mole (Talpa europaea), Mound-building Mouse (Mus spicilegus), Lesser Mole Rat (Spalax leucodon), Eurasian Red Squirrel (Sciurus vulgaris), Edible Dormouse (Glis glis), European Ground Squirrel (Spermophilus citellus), Hamster Dobrogean (Mesocricetus newtoni) and European Hamster (Cricetus cricetus), Least Weasel (Mustela nivalis), European Otter (Lutra lutra), European Roe Deer (Capreolus capreolus), European Badger (Meles meles), European Polecat (Mustela putorius).

Chiropterofauna

[83] Biserkov V., B. Naumov, N. Tsankov, A. Stoyanov, B. Petrov, D. Dobrev, P. Stoev. 2007. Guide to amphibians and reptiles in Bulgaria. Sofia, Green Balkans, 196 pp.

[84] Naumov, B., M. Stanchev, 2010. Amphibians and reptiles in Bulgaria and the Balkan Pennisula. http://www.herpetology.hit.bg

[85] Stojanov, A., N. Tzankov, B. Naumov. 2011. Die Amphibien und Reptilien Bulgariens. Frankfurt am Main, Chimaira, 588 pp.

The following species under the BDA occur within the 30-km area. Common Pipistrelle (Pipistrellus pipistrellus), Nathusius' Pipistrelle (Pipistrellus nathusii), Long-fingered Bat (Myotis capaccinii), Serotine Bat (Eptesicus serotinus), Common Noctule (Nyctalus noctula), Leisler's Bat (Nyctalus leisleri), Savi's Pipistrelle (Hypsugo savii), Parti-coloured Bat (Vespertilio murinus), Greater Horseshoe Bat (Rhinolophus ferrumequinum), Lesser Horseshoe Bat (Rhinolophus hipposideros), Mehely's Horseshoe Bat (Rhinolophus mehelyi), Mediterranean Horseshoe Bat (Rhinolophus euryale), Grey Long-eared Bat horseshoe (Rhinolophus mehelyi), South horseshoe Bat (Rhinolophus euryale), Grey long-eared bat (Plecotus austriacus), Schreiber's bat (Miniopterus schreibersii), Great bat (Myotis myotis), Ostrouh bat (Myotis blythii), Bearded bat (Myotis mystacinus) and Bakembardov bat (Myotis alcathoe).

Ornitofauna

According to Iankov (2007)[86] the nest ornithofauna in the UTM square GP24, wherein the Kozloduy NPP site is located, amounts to 55 bird species. The number of breeding bird species in the neighbouring square (GP25), covering both banks of the Danube with appurtenant Kozloduy and Kopanitsa islands, is 58. Square GP13 with 101 species is distinguished by the greatest species variety among up to now studied UTM squares within the 30-km range. Nidificating stocks of Black-crowned Night Heron (Nycticorax nycticorax) and Black-headed Gull (Larus ridibundus) are also established in this square.

Within the 30-km range of the IP impact also occur about 80 bird species (according to Letter BSPB, Ref. No. 26/14.01.2013) with 28 out of them listed in the Red Book of Bulgaria, 53 species of conservation concern in Europe and 7 worldwide. The species of highest conservation concern are: Dalmatian Pelican (Pelecanus crispus), Black Stork (Ciconia nigra), White Stork (Ciconia ciconia), Lesser White-fronted Goose (Anser erythropus), Montagu's Harrier (Circus pygargus), Red-footed Falcon (Falco vespertinus), Goosander (Mergus merganser), Black-headed Gull (Larus ridibundus), Common Goldeneye (Bucephala clangula), Common Shelduck (Tadorna tadorna), Eurasian Sparrowhawk (Accipiter nisus), White-tailed Eagle (Haliaeetus albicilla), Crested Goshawk (Accipiter gentilis), Smew (Mergus albellus) Common Kingfisher (Alcedo atthis), European Roller (Coracias garrulus), Grey-headed Woodpecker (Picus canus), Syrian Woodpecker (Dendrocopos syriacus), Red-backed Shrike (Lanius collurio), Lesser Grey Shrike (Lanius minor), Ortolan Bunting (Emberiza hortulana), etc. (Michev & Profirov, 2003[87]).

The following species are breeding or feeding in the area under consideration: Whitetailed Eagle (Haliaeetus albicilla), Mallard (Anas platyrhynchos), Great Cormorant

[86] Yankov P. 2007. Atlas of nidifyingbirds in Bulgaria.

[87] Michev, T., L. Profirov. 2003. Midwinter Numbers of Waterbirds in Bulgaria (1977-2001). Results from 25 years of mid-winter count carried out at the most important Bulgarian Wetlands. Publ. House Pensoft, Sofia, 160 pp.

(Phalacrocorax carbo), Pygmy Cormorant (Phalacrocorax pygmeus), Black-crowned Night Heron (Nycticorax nycticorax), Little Egret (Egretta garzetta), Black Stork (Ciconia nigra), White Stork (Ciconia ciconia), Long-legged Buzzard (Buteo rufinus), Montagu's Harrier (Circus pygargus).

During migration the following species are observed: Common Buzzard (Buteo buteo), Lesser Spotted Eagle (Aquila pomarina), Montagu's Harrier (Circus pygargus), Western Marsh-harrier (Circus aeruginosus) and Hen Harrier (Circus cyaneus), White Stork (Ciconia ciconia) and Black Stork (Ciconia nigra), Dalmatian Pelican (Pelecanus crispus) (Data from a project of MoEW for birds migration – LOT 7, Biserkov et.al., 2011[88], EIAR for Valchedrum WPP, RIEA Oryahovo WPP, Michev et al., 2011[89], 2012[90]).

A number of wintering waterbirds such as Mallard (Anas platyrhynchos), Common Teal (Anas crecca), Greater White-fronted Goose (Anser albifrons), Common Goldeneye (Bucephala clangula), Common Shelduck (Tadorna tadorna), Goosander (Mergus merganser) also are observed. Due to the security regime established on the area of the NPP and appurtenant grounds, as well as to the favourable effect of the hot channel, there is a positive effect on these species: Great Cormorant (Phalacrocorax carbo), Dalmatian Pelican (Pelecanus crispus), Mallard (Anas platyrhynchos) etc. (Data from Mediterranean count of waterbirds in Bulgaria (by EEA at MoEW) for the section Tsibar-Somovit, own field investigations).

The assessment on the fauna shall cover expected impact in the time of civil works and operation of IP on protected animal species under BDA occurring in the area of the investment proposal (IP): the four alternative sites, and those in the range of impact within the 30-km perimeter.

Site 1

There are open drain collectors at the Site (***Figure 3.6-1:*** *Site 1. Discharge canal with grown reed*), and part of the latter is used for agricultural crop growing. The Site is located on the grounds of a former Kozloduy swamp. Comparatively large plots are covered by weed or grass associations dominated by Bermuda Grass (Cynodon dactylon), Orchard Grass (Dactylis glomerata) or by shrubs of Blackthorn (Prunus spinosa), Wild Briar (Rosa sp.), etc. The drain collectors are thickly overgrown by Bulrush (Typha sp.) and open water surface is almost lacking. One species has been found as per the BDA: Liquorice (Glycyrrhiza glabra). There are suitable habitats and a nutritive base for specific groups of invertebrates. Drain collectors are a suitable habitat for tailless amphibians and tritons. Scattered shrubby vegetation and applied agricultural practices are the basis for the dwellings of small mammals. The ground

[88] Biserkov et.al. 2011. Red Book of Bulgaria, V. 2, animals On-line.

[89] Michev, T., L. Profirov, J. Nyagolov, M. Dimitrov. 2011. The autumn migration of soaring birds at Burgas Bay, Bulgaria". – British Birds, London.

[90] Michev, T., L. Profirov, N. Karaivanov, B. Michev. 2012. Autumn Migration of Soaring Birds over Bulgaria. – Acta zoologica bulgarica, 64, 33-41.

provides very limited conditions for presence of daytime and winter shelter of bats. Probable bird species that may occur at the Site are: Mallard (Anas platyrhynchos), Common Buzzard (Buteo buteo), Common Moorhen (Gallinula chloropus), Eurasian Coot (Fulica atra), Common Wood Pigeon (Columba palumbus), Little Owl (Athene noctua), European Scops Owl (Otus scops), Syrian Woodpecker (Dendrocopus syriacus), Common Kingfisher (Alcedo atthis), Great Reed Warbler (Acrocehalus arundinaceus), Eurasian Reed Warbler (Acrocephalus scirpaceus), Western Jackdaw (Coleus monedula), Rook (Corvus frugilegus), Magpie (Pica pica), Eurasian Jay (Garrulus glandarius), Hooded Crow (Corvus cornix), Eurasian Tree Sparrow (Passer montanus), Common Blackbird (Turdus merula).

FIGURE 3.6-1: ***SITE 1. DISCHARGE CANAL WITH GROWN REED***

Site 2.

The Site covers part of the former farmyard and agricultural lands (***Figure 3.6-2***: *Site 2. Agricultural areas*). One plant species is established in terms of BDA: Licorice (Glycyrrhiza glabra). The Site provides extremely limited possibilities for the existence and development of a great part of vertebral animals. There are practically no shelters for bats. The Site has low potential as a hunting and feeding territory. Probable bird species that may occur at the Site: Mallard (Anas platyrhynchos) (uses agricultural lands for feeding and resting in winter), Rook (Corvus frugilegus), Great Cormorant (Phalacrocorax carbo), Eurasian Sparrowhawk (Accipiter nisus).

Site 3.

The Site includes open drain collectors, abandoned, and arable agricultural lands, pastures with shrubs and ground depressions (probably parts of the former Kozloduy Swamp with swampy vegetation and prevailing weed associations (Phragmites australis) as well as grass associations dominated by Bermuda Grass (Cynodon dactylon), Orchard Grass (Dactylis glomerata) etc. (***Figure 3.6-3:*** *Site 3. Typical landscape*). One plant species listed in the BDA is recorded: Licorice (Glycyrrhiza glabra).

Drain collectors are suitable habitat for tailless amphibians and tritons, Commons Moorhen, Eurasian Coots, Eurasian Reed Warbler. Scattered shrubby vegetation and applied agricultural practices are the basis for dwellings of small mammals.

FIGURE 3.6-2*: SITE 2. AGRICULTURAL AREAS*

The ground provides favourable conditions as a hunting territory for migrating bat species and limited possibilities for shelter in isolated old trees. Probable bird species that may occur at the Site: Great Tit (Parus major), Blue Tit (Parus coeruleus), Yellowhammer (Emberiza cirtinella), Common Blackbird (Turdus merula), Eurasian Collared Dove (Streptopelia decaocto), Fieldfare (Turdus pilaris), Red-backed Shrike (Lanius collurio) etc.

Site 4.

There are buildings and a parking lot at the Site. The fully technogenic character of the Site does not afford habitats (but there are habitats of low significance) and is not feeding territory for a greater part of vertebrals. The Site provides limited possibilities for daytime summer shelters of synanthropic bird species like: Great Tit (Parus major), Willow Sparrow (Passer hispaniolensis), Brambling (Fringuilla montifringuilla), Blue Tit (Parus coeruleus), Domestic Pigeon (Columba domestica) etc.

FIGURE 3.6-3: *SITE 3. TYPICAL LANDSCAPE*

3.6.2 FORECAST OF IMPACT

3.6.2.1 CONSTRUCTION STAGE OF THE NEW NUCLEAR UNIT

Site 1:

Direct impacts:

- → Possible extermination of specimens of the rare vegetation species Chinese licorice and small-size mammals, invertebrates and larvae thereof by heavyweight transport and construction machines;
- → Possible destruction habitats of animal species, shelters of vertebrate fauna and forest species of bats;
- → Possible mortality of specimens in shelters;
- → Possible changes in natural characteristics of hunting habitats, rest places and nutritive basis with partial or complete extermination of vegetation at sites.

Indirect impacts:

- → Possible deterioration of the vegetation communities and habitats of species
- → Possible introduction and spread of weed, ruderal and invasive plant species.

Site 2:

Direct impacts:

→ Possible extermination of specimens of rare vegetation species Chinese licorice and small-size mammals, invertebrates and larvae thereof by heavyweight transport and construction machines;

Indirect impacts:

→ Disturbance of some bird species and deterioration of their feeding habitats;

→ Possible introduction and spread of weed, ruderal and invasive plant species.

Site 3:

Direct impacts:

→ Possible extermination of specimens of the rare vegetation species Chinese licorice and small-size mammals, invertebrates and larvae thereof by heavyweight transport and construction machines;

→ Possible destruction habitats of animal species, shelters of vertebrate fauna and forest species of bats;

→ Possible mortality of specimens in shelters;

→ Possible changes in natural characteristics of hunting habitats, rest places and nutritive basis with partial or complete extermination of vegetation at sites.

Indirect impacts:

→ Possible deterioration of the vegetation communities and habitats of species

→ Possible introduction and spread of weed, ruderal and invasive plant species.

Site 4:

Direct impacts:

→ Not to be expected.

Indirect impacts:

→ Not to be expected.

3.6.2.2 OPERATION STAGE OF THE NEW NUCLEAR UNIT

3.6.2.2.1 At the sites

Site 1:

Direct impacts:

→ Not to be expected.

Indirect impacts:

→ possible negative cumulative effects on the habitats of species under the BDA.

Site 2:

Direct impacts:

- Not to be expected.

Indirect impacts;

- possible negative cumulative effects on the habitats of species under the BDA.

Site 3:

Direct impacts:

Indirect impacts:

- possible negative cumulative effects on the habitats of species under the BDA.

Site 4:

Direct impacts:

Indirect impacts:

- Additional impacts are not to be expected.

3.6.2.2.2 Impacts due to the implementation of the new nuclear unit beyond the sites

Construction stage of the new nuclear unit

Direct impacts:

- Expected disturbance of species due to noise, vibrations, strong waves resulting from intensified water traffic and earth excavation works.
- Expected changes in number of species and population structure.

Indirect impacts:

- Possible changes in habitats quality and habitats of species;
- Possible changes in quality or reduction of nutritive base;
- Possible contamination by toxic elements, etc.;
- Possible introduction of new invasive alien species.

Operation stage of the new nuclear unit

Direct impacts:

- Possible changes in the biological species population structure;
- Possible mortality of hydrobionts due to suction of larvae or juvenile specimens at maintenance of circulation, engineering and household water supply system;
- Possible risk of radioactive contamination.

Indirect impacts:

- → Possible changes in composition and structure of hydrobionts;
- → Possible changes in quality of habitats;
- → Possible changes in the physical-chemical parameters of water (permanent increase of water temperature, changes in water velocity in some sections);
- → Possible changes in the nutritive base quality;
- → Possible formation of favourable conditions for introduction of invasive species;
- → Possible negative cumulative impacts.

On the grounds of forecasts for impacts resulting from the implementation of new nuclear unit, the Biodiversity component shall be discussed in detail in the Environmental Impact Assessment Report.

3.6.2.3 RESEARCH METHODS

Potential associations of species in the region of Kozloduy NPP and in the region of eventual impact of the new nuclear capacities shall be defined on the grounds of data from main publications on selected model groups to be studied (Hubenov 2007[91]; Chobanov 2009[92]). Field investigations shall be aimed at expert assessment of habitats in terms of what animal species may occur at the four sites territories and in the region of immediate impact of the new nuclear unit.

Two field investigations are planned for the period January-March 2013 at the foreseen four construction sites and surroundings thereof, specific spots with expected impact and in the aquatory of the Danube River and Ogosta River (Bibby et al., 1992[93]).

3.6.2.3.1 Flora, vegetation and habitats assessment

Routing and semi-stationary investigation methods shall be applied. Results shall be used from field investigations in the nearest located protected areas of the Natura 2000 ecologic network in the results of maps drawn of habitats and species habitats in the season 2011 and 2012 seasons as well as consultations with experts, NGO and available data base.

Available references shall be analyzed (Peev et.al On-line[94]; Biserkov et.al., On-line[95]; Bondev, 1999[96], 1997[97], 2002[98], Velchev 1982-1989[99]; 1997[100], 2002[101], Delipavlov

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[91] Hubenov, Z. (2007). Fauna and Zoogeography of Marine, Freshwater, and Terrestrial Mollusks (Mollusca) in Bulgaria. In: V. Fet & A. Popov (Eds.). Biogeography and Ecology of Bulgaria. Springer, 141-198 pp.

[92] Chobanov, D.P. (2009). Analysis and assessment of faunistic diversity of Orthoptera in Bulgaria. Dissertation. Inbstitute in zoology, BAS, pp. 565.

[93] Bibby, C. J., N. D. Burgess, D. A. Hill. 1992. Bird Census Techniques. The University Pres, Cambridge: 257 pp.

2003[102]; Jordanov, 1963-1979[103]; Kojuharov, 1995[104]; Petrova & Vladimirov 2009[105]; 2010[106]; Walter & Gillett 1998[107]) as well as available data base of the state of flora and habitats on the territory subject to impact of the IP and field investigations for assessment of the state of critical areas.

3.6.2.3.2 Assessment of fauna diversity

Three field investigations have also been scheduled also for the period January-March, 2013, at the four potential sites and the surroundings thereof, specific locations with expected impact.

Approaches for direct field investigations shall be used: routing or line transects and point counts (Bibby et al., 1992[108]). Results shall be used from field investigations of the nearest located protected areas on the Natura 2000 ecologic grid as a result of mapped habitats and species habitats during the season 2011 and 2012 seasons. Review shall be made of published scientific results as well as consultations with experts, NGOs and available data bases.

Fish shall be caught by electrofishing according to the European Standard EN 14011.

Bottom macroinvertebrate species (including invasive species) and assessment of the ecological status of water bodies shall be made after the methods instructed in

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[94] Peev, D. (ed).Red Book of Bulgaria, V.1. Plants and mushrooms (in press)

[95] Peev, D. (ed).Red Book of Bulgaria, V.1. Plants and mushrooms (in press)

[96] Biserkov V. et.al. 2011. Red Book of Bulgaria, V. 2, Animals (in press)

[97] Bondev, I. 1991. Vegetation of Bulgaria. Map at M 1:600 000 with explanatory text.

[98] Bondev, Iv. 1997. Geobotanic mapping. B: Jordanova, M.,D. Donchev. Geography of Bulgaria Acad. Publ. 283-304

[99] Bondev, Iv. 2002. Geobotanic mapping. – B: Kopralev, I. (ed.), Geography of Bulgaria. Physical and Social-Economic Geography, Publ. ForKom, Sofia, 336-352.

[100] Velchev, V. (ed.). 1982-1989. Flora PR Bulgaria. Volumes 8-9. Publishers of BAS, Sofia

[101] Velchev, V. 1997. Vegeration types. B: Jordanova M., D. Donchev. (eds). Geography of Bulgaria, Acad. Publ., 269-283.

[102] Velchev, V. 2002. Vegeration types. B: Kopralev, I. (ed.), Geography of Bulgaria. Physical and Social-Economic Geography, Publ. ForKom, Sofia, 324-336

[103] Delipavlov,D. & Cheshmedjiev, I. (ed.) 2003. Guide to plants in Bulgaria. Academic publishers of the Agrarian University, Plovdivв.

[104] Jordanov, D., (ed.) 1963-1979. Flora of Republic of Bulgariea, Volumes 1-7. – Sofia.

[105] Kojuharov, S., (ed.). 1995. Flora of Republic of Bulgariea, Volume10. – Sofia.

[106] Petrova, A. & Vladimirov, V. (eds) 2009. Red list of Bulgarian vascular plants. - Phytologia Balcanica, 15(1): 63-94.

[107] Petrova, A. & Vladimirov, V. 2010. Balkan endemics in the Bulgarian flora. – Phytologia Balcanica, 16(2): 293-311.

[108] Walter & Gillett 1998

Regulation No. 1 for water monitoring (Cheshmedjiev et.al. 2010[109]). According to the Regulation, specimens are collected according to ISO 7828 Standard (Water quality - Methods of biological sampling – Guidance on handnet sampling of aquatic benthic macro-invertebrates, 6, 1985) while metrics are conformable with the European Framework Directive (Directive 60/2000 EC). The following indices are applied for the assessment of the ecological status: the so called „Biotic index" (Gerasimov & Peev, 1999[110]; %EPT (% taxa of the Ephemeroptera, Plecoptera and Trichoptera groups – according to the Biotic index), index KN (Janeva, Russev, 1987[111]); Saprobic index – if the species composition allows, structural parameters – if the species composition allows (Shannon & Weaver, 1963[112]. Gerasimov & Peev, 1999[113]).

3.6.3 PROTECTED AREAS

3.6.3.1 CURRENT STATUS

The four alternative sites for the IP do not fall in protected areas. According to the Register of protected areas and protected areas in Bulgaria (Letter by EEA, Ref. No. 301/20.12.2012, RIEW-Vratsa, Ref. No. B2975/10.01.2013) the territory of the 30-km range of IP impact covers the following protected areas:

Ibisha Reserve Maintained on area of 34.47 ha on the land of Dolni Tsibar village, Valchedrum Municipality; declared by Order No. РД-794/08/10/1984 with the purpose of preserving typical Danube island associations: flood forests and swamps inhabited by protected plant and animal species.

Kozloduy Protected Area covering 10 ha on the land of Kozloduy town, re-classified from hystorical place with Order by MoEW No. РД-639/26.05.2003 for preservation of typical landscape.

Kochumina Protected Area on area of 2.5 ha on the land of Selanovtsi village, Oryahovo Municipality, declared by Order No. РД-2109/20.12.1984 and re-classified by Order No. РД-642/ 26.05.2003; with the purpose of preserving water-lily habitats.

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[109] Bibby, C. J., N. D. Burgess, D. A. Hill. 1992. Bird Census Techniques. The University Pres, Cambridge: 257 pp.

[110] Cheshmedjiev S., R. Mladenov, D. Belkinova, G. Gecheva, I. Dimitrova-Dyulgerova, P. Ivanov and S. Mihov 2010. Development of classification system and biological reference conditions for Bulgarian rivers and lakes according to the Water Framework Directive. - Biotechnology & Biotechnological Equipment 24/2010/SE (special edition/on-line), 155-163.

[111] Gerasimov S., D. Peev, 1999. National program for biomonitoring. Publ. Gealibris, Sofia. 240p.

[112] Janeva I., B. Russev 1987. Comparative analysis about biological methods for quality estimations for running waters. Ist National conference of problems of Biological Monitoring. Plovdiv. 22-24 Oct. 1987, 97-102

[113] Shannon S., W. Weaver 1963. The mathematical theory of communication. Urbana University Illinois Press, 117.Pielou E. 1966. Species diversity and pattern diversity in the study of ecological successions. – Journal of Theorethical Biology, London, 10: 370-383

Gola Bara Protected Area on area of 2 ha on the land of Selanovtsi village, Oryahovo Municipality, declared by Order No. РД-2109/20.12.1984 and re-classified by Order No. РД-643/ 26.05.2003; with the purpose of preserving water-lily habitats.

Kalugerski grad – Topolite Protected Area on area of 0.2 xa, on the land of Selanovtsi village, Oryahovo Municipality, declared by Order No. РД-2109/20.12.1984 re-classified by Order No.РД-644/ 26.05.2003; with the purpose of preserving water soldier (Stratiotes Aloides).

Koritata Protected Area on area of 2 ha on the land of Sofronievo village, Mizia Municipality, declared by Order No. РД-407/07.05.1982 and re-classified by Order No. РД-641/ 26.05.2003; with the purpose of preserving the natural habitat of peony (Paeonia Peregrina) and remarkable landscape.

3.6.3.2 FORECAST OF IMPACT

The existing Kozloduy NPP site is located at sufficiently great distance from any protected natural territories. Nevertheless the EIAR shall include assessment to what extent civil works, operation and decommissioning of new nuclear capacities will not endanger the cenoses therein.

3.6.4 NATURA 2000 SITES

The nearest Protected areas of the European Ecological Network NATURA 2000 to the Kozloduy NPP and sites foreseen for the construction of a new nuclear unit are:

- → Protected area BG0000533 Ostrovi Kozloduy – type "B" according to Directive for habitats and Directive 92/43/EEC for preservation of natural habitats of wild flora and fauna;
- → Protected area BG0002009 Zlatiyata – according to Directive for wild birds;
- → Protected area BG0000614 Reka Ogosta – type "K" according to Directive 92/43/EEC for preservation of natural habitats of wild flora and fauna.

Impact assessment on the subject and objectives of Protected Areas shall be the theme of a particular report on appropriate assessment of the investment proposal with objectives for protected area conservation[114].

3.7 WASTE

3.7.1 CURRENT STATUS

3.7.1.1 NON-RADIOACTIVE WASTE

Assessment of current status shall be made in thereport of EIA in compliance with the

[114] Regulation for terms and order to make assessement of plans, programs, designs and investment proposals compatibility with subject and objectives for protected areas preservation (Approved by DCM No. 201/31.08.2007, Published in SG 73/11.09.2007)

Waste Management Act (WMA), SG 53/2012, and subregulatory acts thereto.

Table 3.7-1: Non-radioactive waste from the Kozloduy NPP EAD for the period 2007 – 2011. shows classification and quantitative characteristics of waste generated on the area of Kozloduy NPP for the period 2007-2011.

TABLE 3.7-1: NON-RADIOACTIVE WASTE FROM THE KOZLODUY NPP EAD FOR THE PERIOD 2007 – 2011.

No	Description	Code acc. to Regulation No. 3	Quantity, tons				
			2007	2008	2009	2010	2011
Hazardous waste							
1	Non-chlorinated hydraulic oils, mineral-based	13 01 10*	-	-	-	-	-
2	Non-chlorinated motor, lubrication and gear transmission oils, mineral-based	13 02 05*	13.10	-	26.60	-	7.8
3	Non-chlorinated insulation and heat-transfer oils, mineralbased	13 03 07*	-	-	4.60	23.14	24.8
4	Deposits from oil-trap shafts (collectors)	13 05 03*	7.60	13.3	-	6	-
5	Oil from oil-water separators	13 05 06*	-	-	2.50	11.5	7.86
6	Diesel oil, boiler and diesel fuel	13 07 01*	-	-	-	-	-
7	Other emulsions	13 08 02*	-	-	-	-	-
8	Waste, mentioned nowhere else (scavenged grease and lubricants)	13 08 99*	-	-	-	-	-
9	Packing containing residues from hazardous substances or polluted by hazardous substances	15 01 10*	-	-	0.20	2.4	3.264
10	Absorbents, filter materials, towels and protective clothes contaminated by hazardous substances	15 02 02*	-	-	-	-	-
11	Obsolete vehicles	16 01 04*	-	-	-	-	234.58
12	Oil filters from vehicles	16 01 07*	-	-	-	-	-
13	Antifreeze liquids containing hazardous substances	16 01 14*	-	-	-	-	-
14	Transformers and capacitors containing PCBs	16 02 09*	-	12.50	-	0.676	-
15	Obsolete equipment containing hazardous components (3), other than mentioned in codes from 16 02 09 till 16 02 12	16 02 13*	-	-	2.10	3.2	4.302
16	Inorganic waste containing hazardous substances	16 03 03*	-	0.50	0.032	-	-
17	Organic waste containing hazardous substances	16 03 05*	-	0.40	-	-	-
18	Gases in pressure vessels (including halons) containing hazardous substances	16 05 04*	-	-	-	-	-
19	Lead rechargeable batteries	16 06 01*	-	-	104.7	20.650	47.469

No	Description	Code acc. to Regulation No. 3	Quantity, tons				
			2007	2008	2009	2010	2011
20	Ni – Cd batteries	16 06 02*	-	-	0.30	1.46	1.9
21	Insulation materials containing asbestos	17 06 01*	0.50	-	13.60	0.06	22.280
22	Building materials containing asbestos	17 06 05*	-	-	-	-	-
23	Deposits from physical-chemical treatment containg hazardous substances	19 02 05*	-	-	-	-	-
24	Solvents	20 01 13*	-	-	-	-	-
25	Photographic chemical substances and compounds	20 01 17*	-	-	-	-	-
26	Fluorescent pipes and other waste containing mercury	20 01 21*	1.40	1.40	0.40	3.5	4.29
Industrial waste							
27	Bran, wood shavings, cuts, pieces, timber materials, chip board panels and veneer, miscellaneous as mentioned in 03 01 04	03 01 05	5.40	0.90	6.40	5.2	7.8
28	Photographic films and paper containing silver or silver compounds	09 01 07	-	-	-	-	-
29	Photographic films and paper, free of silver or silver compounds	09 01 08	-	-	-	-	-
30	Shavings, cuttings and scrap of non-ferrous metals	12 01 01	-	-	6.90	6.2	8.08
31	Shavings, cuttings and scrap of non-ferrous metals	12 01 03	-	-	-	0.22	0.420
32	Paper and cardboard packings	15 01 01	-	0.10	-	-	-
33	Plastic packs	15 01 02	-	-	-	-	-
34	Metal packs	15 01 04	-	-	-	-	-
35	Glass packs	15 01 07	-	-	-	-	-
36	Absorbents, filter materials, towels and protective clothes other than those mentioned in 15 02 02	15 02 03	3.30	3.50	1.50	-	-
37	Obsolete tires	16 01 03	-	15.0	-	2.2	8.212
38	Obsolete vehicles free of liquids or other hazardous components	16 01 06	-	-	-	-	-
39	Antifreeze liquids other than those mentioned in 16 01 14	16 01 15	-	-	-	-	-
40	Obsolete equipment other than that mentioned in codes from	16 02 14	-	7.80	18.2	64.2	54.739

No	Description	Code acc. to Regulation No. 3	Quantity, tons				
			2007	2008	2009	2010	2011
	16 02 09 to 16 02 13						
41	Components removed from obsolete equipment other than that mentioned in code16 02 15	16 02 16	-	-	8.78	71	41.322
42	Inorganic wastes other than that mentioned in 16 03 03	16 03 04	-	2.40	1.80	6.26	4.392
43	Organic wastes other than that mentioned in 16 03 05	16 03 06	-	0.60	5.20	-	-
44	Alkaline batteries (except for 16 06 03)	16 06 04	-	-	-	-	0.099
45	Other batteries and rechargeable batteries	16 06 05	-	-	-	-	-
46	Sediments from physical-chemical treatment other than that mentioned in 19 02 05	19 02 06	5.0	-	-	-	-
47	Infiltrate from waste landfills other than that mentioned in 19 07 02	19 07 03	1234	1139	839	1365.5	1365.5
48	Residues from screens and seives	19 08 01	8.0	-	-	-	-
49	Sediments from urban wastewater treatment	19 08 05	-	-	-	-	-
50	Wastes mentioned nowhere else	19 09 99	-	-	16.0	-	-
51	Ferrous metals	19 12 02	-	1186	1052.9	1314.2	1508.324
52	Non-ferrous metals	19 12 03	-	16.70	143.28	66.955	81.155
53	Sharp tools	18 01 01	-	-	-	-	-
54	Wastes collection and making harmless whereof is not subject to special provisions aimed to prevent infections	18 01 04	-	-	-	-	-
Construction waste							
55	Concrete	17 01 01	15.0	4.3	4.0	3.0	4.0
56	Excavated earth masses other than those mentioned in 17 05 05	17 05 06	-	-	-	-	-
57	Insulation materials other than those mentioned in 17 06 01 and 17 06 03	17 06 04	73.0	131.0	79.0	99.9	265.16
58	Combined waste from civil works and demolition other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	17 09 04	67.50	16.60	111.5	156.5	49.75

No	Description	Code acc. to Regulation No. 3	Quantity, tons				
			2007	2008	2009	2010	2011
	Household waste						
59	Paper and cardboard	20 01 01	74.2	31.30	19.1	6.855	65.03
60	Glass	20 01 02	-	-	-	-	-
61	Medical products other than those mentioned in 20 01 31	20 01 32	0.20	0.20	0.20	-	-
62	Wood materials other than those mentioned in 20 01 37	20 01 38	-	90.39	56.91	131.2	168.1
63	Plastics	20 01 39	-	6.80	0.30	-	-
64	Other fractions nowhere else mentioned (sediments from Cold Channel cleaning)	20 01 99	-	-	-	-	-
65	Bio-degradable waste	20 02 01	28.6	40.0	43.50	44.,3	36.9
66	Soil and stones	20 02 02	2.0	13.0	2,0	-	-
67	Mixed household waste	20 03 01	1114.0	1238.9	881	899	957.35
68	Waste from sewerage systems cleaning	20 03 06	16.0	-	-	-	-

Hazardous waste120[115] – this includes disused luminescent and mercury lamps, rechargeable batteries; packing of chemical compounds and mixes – a great part of chemical compounds and mixes used at Kozloduy NPP EAD are delivered in tankers. When the chemical compounds quantity is smaller the same are supplied in drums, cans, etc.; waste oil products generated at treatment of oil-containing waste water in local treatment facilities on the territory of Kozloduy NPP EAD. Such waste is collected in 5t tankers and removed by an outside company, holder of relevant permit. The total quantity of settled oil products in the treatment facility amounts to about 60t. Sediments from sludge thickeners: annual quantity of about 10 m^3.

Industrial waste – The greater part of industrial waste at Kozloduy NPP consists of metal scrap (old worn-out machine components, worn-out steel ropes, etc.). These are not directly related to the production activity but result from repair of equipment on the work sites. Brass waste is generated further to metal waste during maintenance of brass components.

Construction waste is generated depending on the scope of repair activities performed. Quantities thereof range at about 200 m^2 per annum. Currently excavated earth masses and concrete debris are disposed at the Depot for Non-radioactive Household and Industrial Waste (DNHIW). Building debris management shall conform with provisions of the Ordinace for building debris management and application of recycled building materials (published in SG 89/134.11.2012).

Dimestic waste: it is generated at all work premises of the administration and business buildings, cafes, canteens and during the Plant Site cleaning from branches, leaves, etc.

The strong points of non-radioactive waste management on the Kozloduy NPP EAD[116] are:

- Available own repository for household and industrial wastes;
- Fulfilled programs for radiation and non-radiation monitoring of environment within the repository region;
- Separate collection and treatment of generated waste;
- Introduced accounting for categorisation of waste, keeping of logbooks and issuing periodic and annual reports.

Waste generated on the territory of the Kozloduy NPP shall be classified in the EIAR. Waste management is implemented in compliance with WMA (SG, 53/2012) and subregulatory acts thereto.

Kozloduy NPP EAD has permission to collect waste, transport, utilize and safely dispose it. The Permit is issued by RIEW-Vratsa, that also exercises control on the activities performance.

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[115] Regulation No. 3/2004 for wastes classification, designated by symbol (*)

[116] Program for management of activities related to non-radioactive waste, Kozloduy NPP EAD, 2010.

At present, part of the waste is collected separately but such collection has still not been organized for the remaining waste. The latter includes used grease and lubricants, small batteries, sodium and other lamps with metal halogenides, packing of chemical substances and compounds.

Subject to separate collection and treatment is:

- Waste defined as hazardous due to specific features thereof and/or provisions of regulatory acts;
- Industrial waste, hazardous and utilizable industrial waste are stockpiled temporary in specified locations on the Plant Site, and further on they are sold or transferred to persons with license, complex license or registering document as per the WMA or to organization for utilization. A site of NHIWD is set with Decision 05-ДО-72-01/12.06.2008 of RIEW-Vratsa for temporary storage of waste before disposal, regulating the composition and quantities of waste whereof such storage is allowed. Activities for safe waste disposal in specially designed repository, code D5[117], are allowed at that site. The permit complements the provisions of Decision 05-ДО-72-01/24.01.2006 and has been in force since 31.12.2010 with last amendment in force till 31.12. 2015.[118]

Transportation of waste is carried out by plant-own specialized or all-purpose vehicles or by machines of outside companies operating under contract at the Site.

Radiation control is performed in the protected area of Kozloduy NPP at locations with waste generation and collection in compliance with standard requirements and on the basis of company documents. Containers for household and non-utilizable small-size industrial waste are subject to daily dosimetric control.

Since the beginning of 2001, Kozloduy NPP EAD has used its own Depot for nonradioactive household and industrial waste (DNHIW) compliant with the current applicable standards. Non-radioactive solid household waste and non-utilizable industrial small-size building debris are stockpiled in the DNHIW. Construction and operation of the Depot cover two stages on total stockpiling area of a little more than 1.1 ha. The design capacity of the facility is 45 000 m3 with operation lifetime of 9 years for the first stage and 15 years for the second stage.

The Depot is located at about 3.7 km to South of the Danube River midstream opposite to the 693rd kilometer of the river. The Site borders on the East with canals for service water supply system of Kozloduy NPP, HV overhead lines are located to West therefrom and to South lie a 'lime yard', radioactive waste storage and the open switchyard.

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[117] Wastes management Act, SG 53/2012.

[118] Letter by Kozloduy NPP EAD, Safety and Quality Directorate, Ref. No. Д „Б и К" 190/8.02.13.

Figure 3.7-1: Annual volumes of non-radioactive waste stockpiled in the depot during the period 2001 – 2011 is showing annual quantities of non-radioactive waste stockpiled in the depot during the period 2001 – 2010.

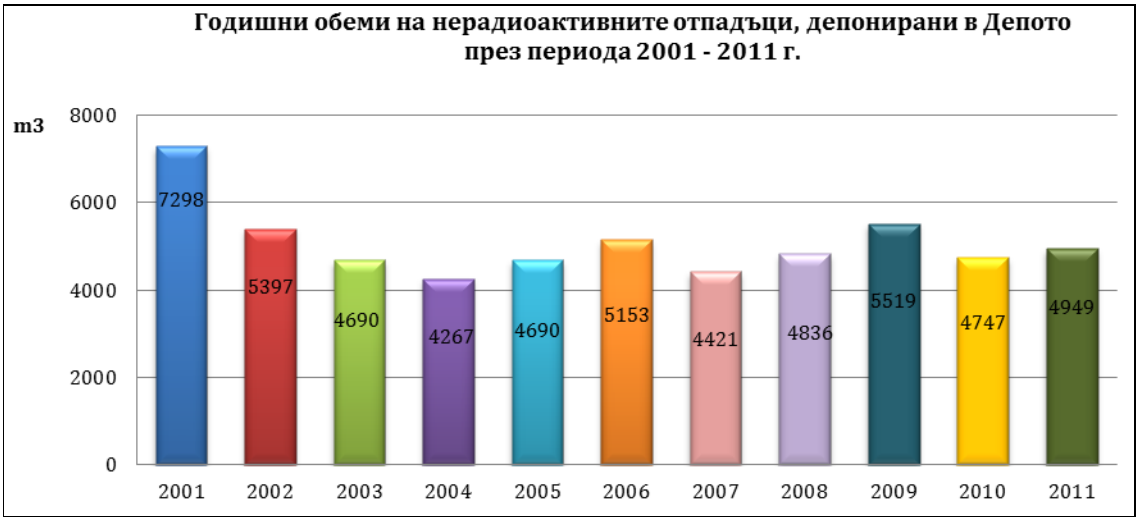


FIGURE 3.7-1: ANNUAL VOLUMES OF NON-RADIOACTIVE WASTE STOCKPILED IN THE DEPOT DURING THE PERIOD 2001 – 2011

Table 3.7-2: *Volume of received waste and time for filling up the DNHIW of Kozloduy NPP EAD* is a characteristic of the volume of landfilled waste time filling DNBPO of NPP "Kozloduy" PLC-generated waste for 2007-2011.

TABLE 3.7-2: VOLUME OF RECEIVED WASTE AND TIME FOR FILLING UP THE DNHIW OF KOZLODUY NPP EAD

Years	Volume of received waste, m³	Volume of received waste with piling, m³	Time for filling up, yyears
by 31.XII 2001	7 298	-	1
by 31.XII 2002	5 397	12 695	2
by 31.XII 2003	4 690	17 385	3
by 31.XII 2004	4 267	21 652	4
by 31.XII 2005	4 690	26 342	5
by 31.XII 2006	5 153	31 495	6
by 31.XII 2007	4 421	35 916	7
by 31.XII 2008	4 836	40 752	8
by 31.XII 2009	5 519	46 271	9
by 31.XII 2010	4 747	51 018	10
by 31.XII 2011	4 949	55 967	11

Source: *Annual reports by Kzoloduy NPP EAD about own non-radiation monitoring*

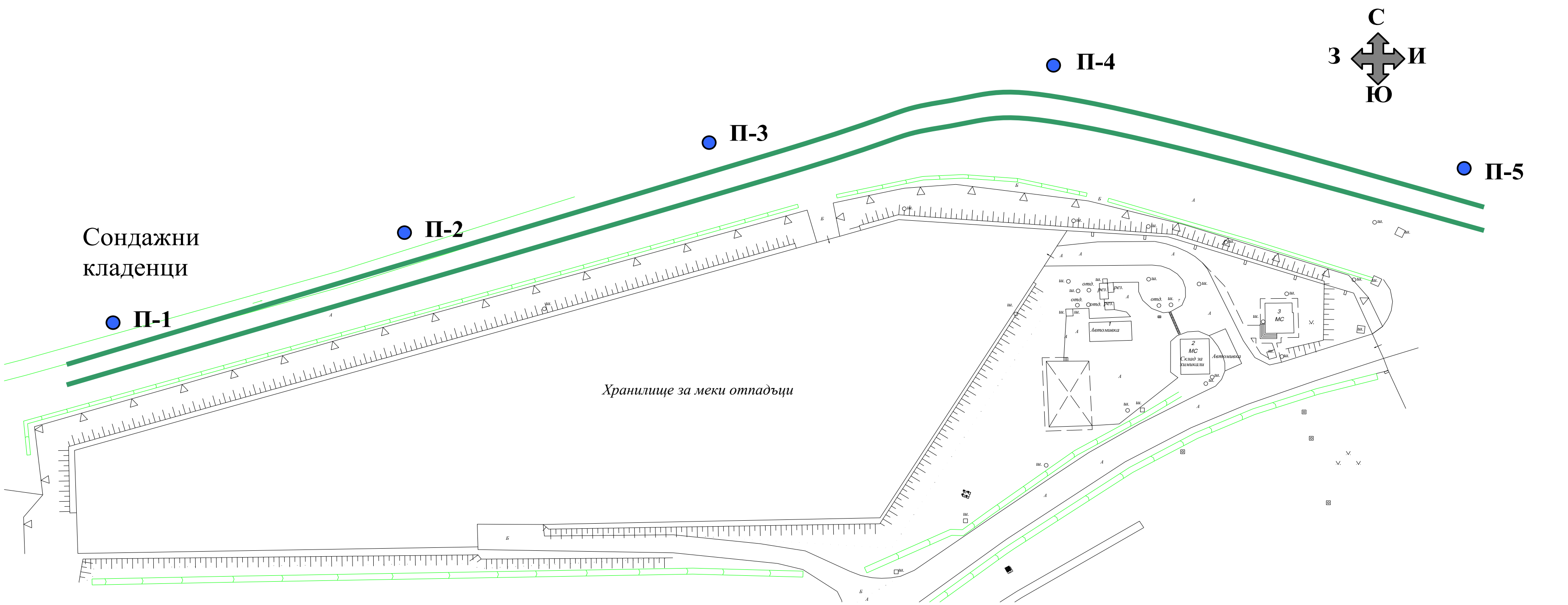
Since the last Annual report by Kozloduy NPP EAD about plant non-radiation monitoring of the NHIWD specifies that only 85% of the first stage capacity of the depot are filled up (from 2001 till 2011) then with a 9% increase of waste disposal per annum the first stage will be used till 2016.

Waste disposal whereof Kozloduy NPP EAD is in possession of a permit valid till 31.12.2015 is foreseen also upon realization of the IP. Should new waste subject to categorisation be generated at the realization of new nuclear unit, such waste shall be characterized as well125. When necessary, should the waste not comply with the depot class, such waste shall have to be treated before disposal126. Kozloduy NPP EAD has a Program for own monitoring of the non-radioactive household and industrial waste depot aimed to identify and ensure organization of efficient own monitoring of the depot for non-radioactive household and industrial waste at Kozloduy NPP. The Program covers:

- → Monitoring of gas emissions from a waste body;
- → Water monitoring;
- → Monitoring the condition of the depot body;
- → Meteorological monitoring.

Figure 3.7-2: *Plan with layout of the voreholes round the depo for household, construction and industrial waste of Kozloduy NPP* EAD presents a plan with location of boreholes for ground water control in four monitoring stations to North of the Depository for household, building and industrial waste of Kozloduy NPP EAD.

The report of EIA shall submit quantitative characteristic and classification of waste generated on the territory of Kozloduy NPP EAD in conformity with WMA and Reguation No. 3/2004 for waste classification during the period 2007-2011.



Boreholes, Depot for light waste

FIGURE 3.7-2: PLAN WITH LAYOUT OF THE VOREHOLES ROUND THE DEPO FOR HOUSEHOLD, CONSTRUCTION AND INDUSTRIAL WASTE OF KOZLODUY NPP EAD

3.7.1.2 Radioactive waste

The Kozloduy NPP radioactive wastes (RAW) management activities cover preliminary treatment, treatment and storage of primary liquid and solid RAW. The said activities are carried out at the Plant Site.

Operation RAW at the Kozloduy NPP site are stored in the various premises as untreated, treated or conditioned RAW and possible alternatives for consequent treatment, release and/or burying thereof are not limited.

The approach accepted since 2005 to date for management of RAW from Kozloduy NPP consists in transferring currently generated solid RAW and liquid concentrate for treatment by the RAW State Enterprise, and stage-by-stage release of historical solid RAW.

Solid RAW that are intermediate level volume-activated materials are stored in special protective facilities (mortuary tubes) located in the central reactor halls of Units 1 – 4 and the auxiliary building (AB – 3) at Units 5 and 6.

Liquid RAW generated at Kozloduy NPP is water-soluble waste mainly, and comparatively small by volume organic substances. The technological radioactive contaminated wastewater is collected through special systems and is treated, whereat distillate and concentrate is obtained. The distillate is released to the environment upon established compliance with requirements of technological regulations for specific and general activity.

The concentrate is stored in tanks of stainless steel located in the auxiliary buildings of the Kozloduy NPP Units. Technologies are being implemented at present for extraction and treatment of concentrates from Units 1-4.

Organic liquid RAW (waste sorbents) are collected and stored in separate tanks in the auxiliary buildings of the Kozloduy NPP Units. A technology is under implementation at present for treatment thereof at Units 1-4.

Sewage sludges and sediments form a comparatively quantity but are referred to as the so called specific waste since their generation is irregular and they require special methods for treatment and storage. A technology is under implementation at present for treatment thereof at Units 1-4.

Annually, Kozloduy NPP generates comparatively small quantities of radioactive contaminated waste oils that are treated and managed as non-radioactive liquid waste.

In 2005, a Specialized Division (SD) for radioactive waste treatment (Kozloduy RAW SD) was established at the Kozloduy NPP Site as a part of State Enterprise RAW.

Technologically, the Division comprises:

- → Line for solid RAW treatment;
- → Line for treatment of secondary liquid RAW and RAW conditioning;
- → Workshop for metal RAW decontamination.

The volume of solid compactable RAW is reduced through compaction with volume reduction coefficient of about 7. Solid uncompactable waste is comparatively small part of the total quantity and is collected in 200-liters drums without any further treatment. Great part of metal RAW are decontaminated in the decontamination workshop and released from regulatory control for recycling or reuse.

The volume of liquid RAW is reduced through evaporation while observing the restriction stipulated in the technological regulations.

Solid and liquid RAW are conditioned through cementation. Conditioned RAW for final disposal is stored in reinforced-concrete containers (RCC). Conditioned RAW from Kozloduy NPP is transported to the temporary storage (until final disposal). The storage is an over-ground reinforced-concrete facility ensuring requisite engineering barriers between stored RAW and environment and staff. The capacity of the CRAWS (Conditioned Radioactive Wastes Storage) is 1 920 reinforced-concrete containers with conditioned RAW (960 containers in each of the two fields: "A" and "B", arranged fourhigh).

RAW is stored also at the 'Lime Yard' site.

Subsites for RAW storage have been differentiated at the 'Lime Yard; site and used by the State Enterprise RAW, as presented in ***Table 3.7-3:*** *Subsites at the Lime Yard site .*

TABLE 3.7-3*: SUBSITES AT THE LIME YARD SITE*

Type of facility	Function	Features
Trench-type storage	Temporary storage of solid RAW categories 1 and 2	Reinforced-concrete design, hoppertype. Separated in forty cells with top manhole, each cell with dimensions 2.7x5.9x6.0 m and capacity 96.5 m3. Instruction by Kozloduy RAW SD for grouping of drums will reach freerelease levels in 60 years
Storage for treated solid RAW	Temporary storage of treated solid RAW categories 1 and 2.	Building type, reinforced-concrete panel design with receiving transport corridor. The storage useful capacity is 1130 RCCs.
Site No. 1 for solid RAW storage in RCC	Temporary storage of treated solid RAW, category 2a, packed in reinforced-concrete containers.	Capacity to hold 130 RCC with external dimensions 1.95x1.95x1.95 m and useful capacity of 5 m3. The site is empty at present.
Site No. 2 for solid RAW storage in RCC	Temporary storage of RCC with solid RAW category 2a.	Capacity to receive 2000 RCC (of the RCC-2 type).
Site for solid RAW storage in multiton containers (MTC)	Temporary storage of low-level solid RAW.	Capacity to receive 14 MTC (large freight container) with external dimensions 5.8x2.2x2.4 m and useful capacity 30m3.
Contaminated soil repository (CSR)	Storage of low level contaminated soil.	Closed reinforced-concrete design with cast-in-situ walls and bottom slab and assembled roof structure: width – 15.80 m; length – 107 m; height – 6.75 m. The whole available capacity is unoccupied at present.

As a part of preparation for Units 1-4 decommissioning, the following Works are in various stages of implementation at present:

- Facility for retrieval and conditioning of spent ion-exchange resins;
- Facility for retrieval and treatment of radioactive concentrate;
- Size reduction and decontamination workshop;
- Facility for high volume reduction and RAW treatment (plasma melting facility);
- Other facilities covering treatment of all types of RAW generated in the course of Units operation and as a result of the decommissioning process.

The state of RAW storage facilities at Kozloduy NPP as at 31.12.2009 according to data presented in the Strategy for management of spent nuclear fuel and radioactive waste till 2030 (approved with Decision of the Council of Ministers on 5 January 2011):

→ **Electricity Production – 1 Site (EP-1) – Units 1÷4 at Kozloduy NPP;**

✓ **State of solid RAW storage facilities:**

- KNPP Units 1-2 RAW repositories (AB-1): 393 m3 untreated solid RAW, fillup – 39%;
- KNPP Units 3-4 RAW repositories (AB-2): 100 m3 untreated solid RAW, 120 m3 compacted, fillup – 22%;
- Mortuary tube (facility for storage of category 2-II) for RAW from Kozloduy NPP units 1-2 (Central Hall – 1): 52 m3, fillup – 64% ;
- Mortuary tube for RAW from Kozloduy NPP units 3-4 (Central Hall-2): 32 m3, fillup – 39%.

It is expected that Units 1-4 shall generate annually some 160 m3 compactable RAW in the form of special clothing, personal protective equipment, plastics, etc. 160 m3 solid RAW are planned for retrieval from each of Units 1 and 2 annually and 40 m3 from each of Units 3 and 4.

✓ **State of liquid RAW storage facilities:**

Evaporate Concentrate Tanks (ECTs) of Units 1 and 2 of Kozloduy NPP (AB-1) are storing a total of 1890 m3 solidified concentrate. A project for concentrate retrieval and treatment is under way. At present some 1140 m3 of boron solution are stored in AB-1 containing approximately 14 440 kg of boron acid. The expected evaporate concentrate to be obtained after treatment shall amount to about 75 m3 – 90 m3. The tanks for spent sorbents shall store about 360 m3 of spent sorbents (ion-exchange resins, activated carbon).

The technological systems contain about 360 m3 sewage sludge and sediments. The expected quantites of liquid RAW upon decommissioning of Units 1 and 2 are as follows: from decontamination of technological facilities – about 570 m3 conditioned RAW and secondary RAW generated in the form of water from special washing machines, special sewage systems, etc. – about 18 m3 of conditioned RAW.

The ECTs of Kozloduy NPP Units 3-4 (AB-2) store a total of 1910 m3 solidified concentrate. A project for concentrate retrieval and treatment is under way. At present some 2700 m3 boron solutions are stored in AB-2. The expected evaporate concentrate to be obtained after treatment shall be about 180 m3 – 220 m3. The tanks for sorbents store 240 m3 of spent sorbents (ion-exchange resins, activated carbon).

The technological systems contain about 410 m^3 of sewage sludge and sediments. Some 2000 m^3 conditioned product is expected from activities related to equipment decontamination upon decommissioning.

→ **Electricity Production – 2 (EP-2) – Kozloduy NPP Units 5&6**

✓ **State of solid RAW depots:**

- RAW repository (AB-3), category 2-I, 2-II: 871 m3 compacted RAW and 15.7 m3 activated materials. Fillup – to about 35 %.
- Storage out of AB-3: 700 m3 compactable low-level waste (dose rate < 1µSv/h and specific activity less than 104 Bq/kg).

✓ **State liquid RAW depot:**

The ECTs store a total of 2100 m3 solidified concentrate with 1310 m3 of them being solidified phase and 790 m3 liquid phase. The free capacity (ullage) is 1491 m3.

Tanks for spent sorbents hold 146 m3 of spent sorbents (ion-exchange resins, activated carbon). The free capacity is 54 m3.

AB-3 stores about 130 m3 of sludge. As at present, no project for sludge retrieval and treatment has been elaborated. Some 180 m3 of evaporate concentrate is expected to be generated annually during the period 2010-2030. About 250 m3 shall be transferred annually for treatment to the Kozloduy RAW SD. With the designed rates of generation and transfer, in ten years time, just the solid phase of historically generated liquid concentrate will remain.

At present there are not any implemented facilities for retrieval and conditioning of evaporate concentrate, sludge, sewage sludge and resins.

Summarised data of radioactive waste stored in SD RAW – Kozloduy is presented in ***Table 3.7-4:*** *Summarised data of radioctive waste stord at the Kozloduy SD RAW according to type and number of packages, as* **of 31.12.2009** [119]

[119] Strategy for management of spent nuclear fuel and radioactive waste till 2030 approved by Decision of the Council of Ministers acc. to Item 5 of the agenda of Record No. 1/05.01.2011, pp. 46/47.

TABLE 3.7-4: SUMMARISED DATA OF RADIOCTIVE WASTE STORD AT THE KOZLODUY SD RAW ACCORDING TO TYPE AND NUMBER OF PACKAGES, AS OF 31.12.2009

SITE	Quantity of sored RAW
Storage for conditioned RAW (SCAWSW), number	**1130 nos. RCC (capacity)**
RCC-1	296
RCC-3	647
TOTAL	**943**
Trench repository for temporary storage of solid RAW, m³	**386 m³ (capacity)**
Untreated	1917
Packed in 210 l drums	4
Compacted with a force of 910 t	983
TOTAL	**2904**
Temporary storage facility of solid RAW, m³	**-**
Untreated	1.917
Packed in 210 l drums	0.840
Compacted with a force, m³	0.983
TOTAL m³	**3.740**
Site for temporary storage of solid RAW in RCC-1	**-**
RCC -1 (nos.)	0
Site for storage of solid RAW in RCC -2	**0**
RCC – 2 (nos.)	233
Site for temporary storage of solid RAW in MTC (large freight containers) [m³]	**420 m³ (capacity)**
Untreated	78
Packed in 210 l drums	125
Compacted with a force of 910 t	0
TOTAL	**203**

Part of RAW is conditioned at the Kozloduy RAW SD and is intended for final disposal in National Disposal Facility for Low and Intermediate Level RAW after the erection thereof in 2015.

The National Disposal Facility for Low and Intermediate Level RAW (NDRAW) is intended for final disposal of conditioned low and intermediate level RAW generated during the Kozloduy NPP operation, decommissioning of Kozloduy NPP and Belene NPP operation.

NDRAW must as well ensure:

- ✓ Capacity for final disposal of the backlog of low and intermediate level RAW generated in the country and stored in places where denerated and in facilities of RAW management of SE RAW;
- ✓ Capacity for final disposal of all RAW expected to be generated till 2075;

According to preliminary calculations, the RAW quantities expected to be disposed in the NDRAW will amount to 138 200 m³ (345 500 t), which determines also the maximum capacity of the disposal facility.

3.7.2 FORECAST OF IMPACT

3.7.2.1 NON-RADIOACTIVE WASTE

The IP Estimate of the impact shall reflect expected changes in the quantitative and qualitative parameters of waste as a factor of impact on environmental components evaluating the necessity of new sites for temporary storage and new facility for wastes treatment. The evaluation shall be single for all sites and justified on the grounds of capacities of existing sites for temporary storage and available facilities for treatment of waste.

3.7.2.1.1 During the construction stage

Solid non-radioactive waste is expected to be generated in the process of activities related to erection of a new nuclear unit as follows:

→ **Construction waste –** expected types of waste in the process of civil works: soil, building debris, etc., are generated at installation of technological equipment, erection of auxiliary concrete structures, etc. Such waste has period for generation limited in duration, the time of civil works on the Project. Impact evaluation and forecast shall be made on the grounds of comparative analysis with standard requirements including the Regulation for building waste management and application of recycled building waste (published SG 89/13.11.2012);

→ **Household waste** – generated by life activities of builders. As early as that stage, separate collection of wastes should be introduced in packages conforing with the provsionsi of Art. 33, Para. 4 of the Waste Management Act (WMA). During civil works on the project, 3000-4000 persons are expected to operate on average annually in the course of five years. Methodologically, accumulation rate[120], work day duration and number of work days in a month shall be considered. The quantity of generated household waste is evaluated to about 1500 m^3 – 2000 m^3 per annum. The existing good practices for household waste management shall probably continue, i.e. such wastes shall not have significant impact on the environment components with environment friendly management thereof. Separate collection should be introduced for household waste in packages meeting the provisions of Art. 33, Para. 4 of WMA. The bio-degradable "green" waste generated through site cleaning for erection of the new nuclear unit should be managed in compliance with the new WMA and sublegislative acts thereto.

→ **Hazardous waste –** temporary storage is foreseen at the construction site in places isolated for the purpose, wherefrom the accumulated specified

[120] Guidelines for calculation of the number and types of required containers and equipment for waste collection and transportation, MoEW, Sofia, 2004.

quantities shall be transferred for subsequent treatment to persons in possession of permit, complex permit or registration document as per the WMA or to organizations for utilization.

The report of EIA shall include the quantities of generated waste in the process of new nuclear unit implementation at that stage. Also, the report of EIA shall submit classification of non-radioactive solid waste according to WMA and Regulation No. 3/2004 for waste classification and measures to be undertaken for environment friendly management of waste.

3.7.2.1.2 During operation

Generation of household, industrial, building and hazardous waste is expected in the process of new nuclear unit operation, since in work premises and on sites of various operation activities, repairs, reconstruction of buildings, premises, etc., conditions are created annually for generation of varying types and quantities non-radioactive waste with impact thereof on environmental components that shall be subject to estimates in the EIAR.

Domestic waste – in the process of operation insignificant increase is expected of the household waste quantity to be calculated on the basis of a methodology as specified in the Guidelines for calculation of the number and types of containers and equipment required for waste collection and transportation, MoEW, Sofia, 2004.

Construction Waste – generation of building waste is expected also at the stage of operation and repair activities. Bearing in mind practices of the Client for building waste management, forecast shall be made of impact thereof on the environment with observation of standard requirements and the Regulation for building waste management and application of recycled building waste (published SG 89/13.11.2012). Generated waste shall be evaluated by types and quantities on the grounds of methodical instruction of the National strategic plan for management of waste from construction works and demolition activities on the territory of the Republic of Bulgaria for the period 2011-2020, MoEW, Sofia.

Industrial non-hazardous waste – various by volume and origin waste shall be generated during operation. Such waste shall be classified in conformity with Regulation No. 3/2004 for waste classification including quantitative and qualitative parameters of waste. The latter shall be managed in compliance with valid laws including the Regulation for requirements to treatment and transportation of industrial and hazardous waste. Other waste generation also expected: Sludge from sewage water treatment plant wherefore measures must be offered in the report of EIA for environment friendly management thereof. Industrial waste shall continue be disposed of at the Depot for Non-radioactive Household and Industrial Waste (DNHIW) of Kozloduy NPP.

A high percent of conventional waste is expected to be formed by waste for reutilization. Such waste shall be stored temporary on locations isolated for the purpose – temporary sites. After accumulation of specified quantities of waste, they shall be transferred under contract for furhter treatment. Final delivery and safe disposalshall be realized on the basis of contracts with persons in possession of permit, complex permit or registration document as per the WMA or organizations involved in waste re-use.

Hazardous waste – in the process of operation machine oils, greases and lubricants are expected to be used that will in time turn into hazardous waste. Various chemical substances and compounds shall be used as chemical reagent. Packing of such chemical substances and compounds are hazardous waste also. During operation release of sludge with hazardous properties is also expected, containing oil products from sludge/oil separators. Such waste shall be managed in compliance with valid laws including the Regulation for requirements to treatment and transportation of industrial and hazardous waste.

All types of non-radioactive waste shall be addressed and classified in the EIAR. Analysis and evaluation of that environmental impact factor shall be performed in compliance with the new WMA (SG 53/2012) and sub-regulatory acts thereto. Qualitative and quantitative parameters of non-radioactive waste generated during operation of the new nuclear unit of Kozloduy NPP EAD shall be specified in detail in the EIA129[121]. Estimate of this environmental impact factor, the cumulative effect included, shall be made on the grounds of a comparative analysis of expected waste from the IP realization and the currently existing waste streams. The estimate shall cover also impact of waste treatment methods applied on the territory of Kozloduy NPP EAD, and available treatment facilities and necessity of new ones, e.g. NHIWD. The EIA report will address in detail the management of non-radioactive waste, treatment thereof and expected impact of that factor on the environment components. Measures for restriction and minimization of such impacts shall be offered in the EIA – R.

3.7.2.2 RADIOACTIVE WASTE

The estimate of the impact within the framework of the report of EIA shall reflect the expected changes in qualitative and quantitative parameters of RAW as a result of the IP realization and as an environmental impact factor on components including evaluation of the necessity of new storage facilities and treatment. The evaluation shall be single for all considered sites and justified on the grounds of capacity of existing repositores and facilities for waste treatment.

According to provisions in the Client's ToR, for IP implementation for a new nuclear unit at the Kozloduy NPP site, one of the two feasible alternatives is related to application of equipment from the nuclear island, ordered for the Belene NPP, and in this sense the forecast of impact within the EIA framework will logically be prepared on the grounds of expected design volumes of RAW and methods for their treatment defined as estimated

[121] After recommendation by RIEW – Vratsa, Letter with Ref. No. B2975/10.01.2013.

values according to the Technical Design for Belene NPP, (***Table 3.7-5:*** *Estimate annual quantity of radioactive waste of the new nuclear unit*).

TABLE 3.7-5: ESTIMATE ANNUAL QUANTITY OF RADIOACTIVE WASTE OF THE NEW NUCLEAR UNIT

Type of waste	Generated waste for one unit, m^3/y	Type of treatment	Waste aftr treatment, m^3/y
Solid radioactive waste			
1. Category 2-I			
1.1 Combustible	175	Fragmentation (when necessary)	8.8
		Sorting	
		Packing	
		Plasma melting	
1.2 Metals	20	Fragmentation (when necessary)	6.5
		Sorting	
		Packing for transportation to the plasma melting facility(if fit)	
		Plasma melting, or	
		compaction, or	
		No further treatment	
1.3 Pipe electic heaters	1	Fragmentation	0.5
		Sorting	
2. Category 2-II			
2.1 Combustible	38	Fragmentation (when necessary)	1.9
		Sorting	
		Packing	
		Plasma melting	
2.2 Метали	5	Fragmentation (when necessary)	2
		Sorting	
		Packing for transportation to the plasma melting facility(if fit)	
		Plasma melting, or	
		compaction, or	
		No further treatment	
2.3 Ion-exchange resins	17	Pyrolysis	6
2.4 Ventilation filters	1	Sorting	0.6
		Compcting	
3. Category 2-III			

Type of waste	Generated waste for one unit, m^3/y	Type of treatment	Waste aftr treatment, m^3/y
3.1 Detection assemblies and waste from radiation surveillance specimens	0.2	Sorting	10 capsules
3.2 Assemblies of reactor internal detectors	0.078	Sorting	4 капсули
3.3 Control rods absorber	0.049	Sorting	7 cartridges
	4. Liquid radioactive media		
4.1 Run-offs from sanitary barriers of buildings	972	Concentration	31
4.2 Water from special washing machines	475	System for treatment of water from special washing machines	3
		Plasma melting	
	Category 2-I		
4.3 Solidified (ionexchange resins)	7	Cementation	20.16
	Category 2-II		
4.4 Ion-exchange resins	7	Joint cementation	57.96
4.5 Evaporate concentrate	13.4		
4.6 Titanium shots	0.07	Cementation	1.8
4.7 Sludge	3	Cementation	1.08

All types of RAW as specified shall be treated and classified in detail in the report of EIA including quantitative and qualitative evaluation of liquid and solid waste generated in the process of new nuclear unit operation at the Kozloduy NPP site. Estimates of the expected impact on environment shall be made in the IEA-R on the grounds of comparative analysis of expected RAW generated as a result of the IP realization and the currently existing streams of generated waste.

3.8 HAZARDOUS SUBSTANCES

3.8.1 CURRENT STATUS

For the purposes of the main and the auxiliary production activities at the Kozloduy NPP site (KNPP), different raw and processed materials are kept and used, among them chemical substances and mixtures. The biggest quantities of industrial chemicals are used for the production of demineralized water and for the maintenance of the waterchemistry regime on the primary and secondary circuits.

The main non-radioactive substances used at KNPP EAD are:

- Industrial and laboratory chemicals: nitric acid, hydrochloric acid, sulfuric acid, oxalic acid, sodium hydroxide, potassium hydroxide, ammonia, sodium hypochlorite, potassium permanganate, ferric chloride, hydrazine hydrate, hydrated lime, etc.;
- Fuel and lubricants: oils (transformer, compressor, turbine, engine, etc.), grease and lubricants, diesel fuel, gasoline;
- Primers, paints, varnishes, adhesives and solvents;
- Ion exchange resins;
- Others.

Conditions are provided at the site for storage of the required quantities of petroleum products – gasoline, diesel and oil, as well as for storage of cooling hydrogen for the power generators, produced by the auxiliary electrolysis facilities. The operation of the service machines shall use diesel fuel and lubricating oils. The diesel fuel must have minimal sulfur content[122].

The good practice must be continued and in the future the deliveries of packed lubricants and engine oils have to be accompanied with material safety data sheets[123].

The hydrogen for cooling of the electric generators is produced by in-house electrolysis facilities.

The environmental impact assessment report shall present information about the chemical substances and mixtures used KNPP, and shall assess the cumulative impact of the additional quantities needed for new unit.

3.8.2 FORECAST OF IMPACT

The estimate of the impact of the investment proposal (IP) will assess the need for new quantities of hazardous substances and mixtures at the implementation stages. The assessment will be well defined for all sites and will be justified because the methodology for impact assessment is based on an analysis of the IP planned values for the quantities of hazardous chemical substances and mixtures compared with the quantitative values in the normative documents[124], [125]. The impact estimate shall take into account the chemical substances and mixtures present at the Kozloduy NPP EAD site and the cumulative impact of the additional quantities needed for new unit[126].

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[122] Regulation on the quality of the liquid fuels, the conditions, the order and the way of their control.

[123] Law on Protection from the Harmful Impact of Chemical Substances and Mixtures / or the Regulation on classification, labeling and packaging (CLP).

[124] Law on the limitation of the harmful effects of chemical substances and mixtures, Regulation on the order and conditions of storage of hazardous substances and mixtures

[125] Regulation on the manner of storage of hazardous substances and mixtures

[126] Recommendation of the Ministry of Environment and Forests (R Romania), letter with outdoung No. 3672 RP 18.10.2012

3.8.2.1 DURING THE CONSTRUCTION

During the construction process, the following shall be used:

- ***Fuels*** – needed for the operation of the construction machines. The proposed method shall be evaluated for filling of the machines with diesel and other fuels, as well as the provided measures for limitation of the impacts of accidental spills and others.
- ***Lubricants*** – it is expected that during the construction period a variety of types and amounts of oils and lubricants shall be used – machine and compressor oil, turbine oil, engine oil, various kinds of lubricants. As a rule, they are delivered with relevant certificates and other documents such as Material Safety Data Sheets specifying the proper way of storage, handling and treatment.
- Other.

3.8.2.2 DURING OPERATION

- **Liquid fuels** – for the operation of the diesel generators providing backup power supply for power generation units, for the consumption of the vehicles and the different plants and units KNPP. Specified quantities of diesel fuel, gasoline, etc. shall be needed The EIA report shall identify exemplary quantitative and qualitative specifications of the fuels and shall analyze the possibilities for their safe storage.
- **Oil and lubricants** – during the operation of the new nuclear unit, it is expected that a variety of types and amounts of oils and lubricants shall be used – machine and compressor oil, turbine oil, engine oil, various kinds of lubricants. As a rule, they are accompanied by relevant certificates and other documents such as Material Safety Data Sheets specifying the proper way of storage, handling and treatment.
- Chemical substances and mixtures – various types of chemical reagents certified for operation in the nuclear industry shall be delivered and used for the main technology process. The main and more important substances and mixes are: ammonia, sulfuric acid, hydrochloric acid, nitric acid, sodium hydroxide, etc. During the storage and use of hydrazine hydrate, ammonia and other substances, there is a potential risk that in case of emergency surge emissions of hazardous toxic substances may occur in the operation and ambient environment.

To ensure the water-chemistry regime ot he KNPP units, and the other production and auxiliary activities, delivery and use is required of large quantities of chemical reagents, some of which are: boric acid, nitric acid, sulfuric acid, hydrochloric acid, sodium hydroxide, technical potassium hydroxide, ferric chloride, ammonia, hydrazine, hydrated lime, etc.

The EIA report shall review the proposed possibilities for air separation and the capacity of the existing nitrogen-oxygen stations to accommodate the requirements of the new power unit.

The delivery of chemical substances and mixtures will continue the good practice and these will be accompanied by Material Safety Data Sheets, which is a prerequisite for their environmentally safe storage and use.

During the construction and the operation of the new power unit, hazardous chemicals and mixtures will be used, with different compositions, properties, hazard category, packaging, etc. and therefore their legally assured use is mandatory. The requirements to the Supplier are activity specific, as well as the proper storage of the chemical substances and mixtures, the preventive measures to minimize accidents and emergencies and the environmental management of their waste.

During the assessment of the suitable site in terms of the location for the implementation of the investment proposal the recommendations shall be taken into account for discharge of dangerous liquids, specified by the Guidelines for evaluation of sites for nuclear power plants, using the following methodological recommendations:

- ✓ During the assessment of the possibility of uncontrolled discharge of dangerous liquids, special attention must be paid to:
    - Flammable gases and vapors forming explosive clouds that can enter the inlets of the ventilation systems and may burn or explode;
    - Suffocating or poisonous gases that may endanger human health and threaten vital safety functions;
    - Corrosive gases and liquids that may endanger human health and threaten the functionality of the equipment;

  The preliminary assessment will include identification of all activities and facilities involved in the processing, manipulation, storage or transportation of flammable, toxic or corrosive liquids.

  Additionally, the EIA report shall develop a detailed assessment including the following:

    - Potential hazards from hazardous liquids, which have not been eliminated in the preliminary assessment;
    - Location of the source of the liquid and maximum stock quantity stored and/or otherwise available quantities;
    - Determination of the maximum quantity of hazardous liquids that could be released, their flow rate and the respective probability of leakage;

- Potential for breaking of a container or any other leakages from the facility storage;
- Probability of leakage of hazardous liquids from a mobile source on the assumption that the maximum transported quantity is released;
- Interaction of the dangerous liquid with the nearby water sources.

The important parameters and properties to be established for incorporation into the design basis for protection of NPP from hazardous liquids, are as follows:

- quantity of liquid or gas;
- surface area of the spillage;
- chemical composition;
- concentration (corrosion potential);
- vapor partial pressure;
- boiling point;
- ignition temperature;
- toxicity.

The EIA report shall describe and analyze the planned use of hazardous chemical substances and mixtures in terms of possible environmental impact. The estimate will be based on the data about the quantities from the feasibility studies and the data about the properties and the composition from the Safety Data Sheets and the existing practices for management of such substances, including instructions, procedures and implemented good practices.

3.9 HARMFUL PHYSICAL FACTORS

3.9.1 NOISE

3.9.1.1 CURRENT STATUS

The construction site of the new nuclear unit will be situated adjacent to or at the Kozloduy NPP site. Four options have been proposed for its location. The inspection established that currently there were no noise sources at Sites 1, 2 and 3. Site 4 represents a built-up production and storage area with limited diverse activity. Six nuclear power units are deployed at the Kozloduy NPP site, with units 5 and 6 still in operation, and the remaining ones have been shut down.

The noise regime at the plant site was established through noise measurements under real conditions, during the development of the 1999 EIAR for the Kozloduy NPP. The equivalent noise level was measured at selected locations of the site, near the major sources of noise into the environment – outdoor switchgears, WWTP, ventilation systems, transport vehicles, etc. The established noise levels were within the range 52 dBA – 97 dBA. At some locations, between the buildings and the outdoor facilities, the noise levels exceed the hygiene standards for industrial areas – 70 dBA. The results of the noise measurements are recorded in Protocol 12/08.1999 enclosed with the EIA Report. It was concluded that the production activity at the Kozloduy NPP site is not a source of noise for the territory of the town of Kozloduy due to the great distance from the site (over 2 km). The study of the noise regime was conducted in compliance with the applicable legislation at the time.

New measurements to determine the noise regime at the Kozloduy NPP site were conducted in 2010 by the MoEW-EEA, Regional Laboratory of the Pleven RIEW, in accordance with the methodology for establishing the total sound power emitted to the environment by an industrial plant and establishing the noise level at the location of impact, MoEW, 2007. (Protocols 618 and 621/13.09.2010). The measurements were conducted along two measurement contours. The first circuit encompasses Electricity Production–1 (EP–1), which includes units 1–4, while the second circuit encompasses Electricity Production–2 (EP–2), which includes units 5 and 6. The contours also include the auxiliary facilities of the reactors that are major sources of noise. The equivalent noise levels measured along the first circuit are within 47.4 dBA – 62.5 dBA, and the one along the second circuit – within the range of 47.3 dBA – 66.6 dBA, none of these exceeds the limit of 70 dBA, set for production and storage areas. The EIA Report will specify the measuring contours and the sound levels measured at different locations. The calculated total sound power levels for the two circuits are: primary circuit – 113.7 dBA, secondary circuit – 119.1 dBA.

The assessment of the existing noise regime at the Kozloduy NPP site will be supplemented based on additional information provided.

The settlements situated near the Kozloduy NPP site are the following:

- town of Kozloduy – 2.6 km;
- village of Harlets – 3.5 km;
- village of Glozhene – 4 km;
- town of Mizia – 6 km;
- village of Butan and town of Oryahovo – 8.4 km.

Due to the great distances to the settlements, the production activity at the Kozloduy NPP site is not a source of noise for their territories.

The Kozloduy NPP site, respectively the sites subject to the EIA, are connected to the national road network via roads II-11 and II-15. The site is not connected to the national railway network.

3.9.1.2 FORECAST OF IMPACT

The noise emission into the environment is connected to the three main stages of the implementation of the IP – construction, operation and decommissioning.

3.9.1.2.1 Construction

The main environmental noise source will be the construction machinery and the transportation vehicles servicing the construction, delivering the necessary materials and equipment, and taking out waste for disposal. The noise levels of the traditionally used machinery and facilities are within the range 80÷105 dBA, based on data from measurements conducted by the NCPHP – city of Sofia, and on publications. The construction machinery will be focused at the selected site. The EIA Report will give the noise characteristics of the individual machines and facilities and the expected equivalent noise level will be determined on-site, in the vicinity of the operating machinery. Furthermore, the expected equivalent noise level created by the transportation traffic servicing the construction project will also be determined, using data on the expected trips of the heavy cargo vehicles and their speed, in accordance with the methodology stipulated in Regulation №6 on the parameters for noise in the environment, considering the degree of discomfort during the different hours of the day, the limit values for the parameters for noise in the environment, the methods for evaluation of the noise parameters and the adverse effects of noise on public health (Ministry of Health, Ministry of Environment and Water, SG issue 58/2006), which adheres to European Directive 2002/49/EC.

The construction works carried out at the site will not be a source of noise for the residential areas in the region, due to the great distances. The impact of the noise emitted by the construction machinery is expected to be on the industrial zone of the Kozloduy NPP. The noise from the construction traffic will affect the settlements in the region through which it will pass, as well as the Kozloduy NPP site when crossing it. The EIA Report will comprise a hygienic assessment of the expected impacts due to noise from the construction and transportation machinery used during the site construction, on territories with a noise regulation regime (the residential areas of the nearby settlements, the industrial site of the Kozloduy NPP, and the site of the new unit). The assessment will be made in accordance with the norms on noise envisaged in Regulation 6 on the parameters for environmental noise, 2006.

3.9.1.2.2 Operation

The environmental noise sources are the primary and the auxiliary technological equipment and the vehicles servicing the production activities. Environmental noise emissions will be determined on the basis of the passport data on the noise characteristics of the planned facilities. In the absence of such data, the Bulgarian legislation (Regulation 6 on the parameters of environmental noise, 2006) allows the use of data from a similar site (with technology and equipment similar to those of the studied investment proposal). The EIA Report will give the environmental noise levels in the environment around the site by means of modelling, in accordance with EN ISO 9613-1,2: *Acoustics*. Outdoor sound propagation. The modelling will be carried out upon the provision of specific inputs data (sound power of the noise sources, coordinates X, Y, Z, incl. heights of the buildings, general plan of each of the alternative sites, type, intensity and routes of the internal transport, etc.). In the event that the full range of data is unavailable during the preparation of the EIAR, data will be used on the environmental noise propagation of a similar site. The EIA report will assess the expected changes in the existing noise levels along the borders of Kozloduy NPP after the construction of the new nuclear unit.

The expected equivalent noise level emitted by the operation traffic shall be determined in accordance with the provided data on the traffic intensity.

It is not expected that the operation of the new nuclear unit at the site would be a noise source of for the residential areas in the region, due to the great distances to them. Noise impact is expected on the industrial area of the Kozloduy NPP. The noise from the operational traffic of the site will affect the settlements in the region through which it will pass and the Kozloduy NPP site when crossing it. The EIA report will make a hygiene assessment of the expected noise impact of the activities related to the operation of the site on territories with a regulated noise regime (residential areas of nearby settlements, the industrial site of the Kozloduy NP and the site of the new unit). The assessment will be made in accordance with the noise limits envisaged in Regulation 6 on the parameters for environmental noise, 2006.

Based on the analyses and the estimate on the expected noise impact to the environmental, the EIA Report will suggest the best site for the implementation of the investment proposal with regards to the factor 'Noise'. A different noise impact on the territories with a regulated noise regime is expected mainly for the alternative sites. At the construction stage, the impact will depend on the different activities for the preparation of the sites and the respective different intensity of the transportation vehicles servicing the construction site. During the operation stage different cumulative effects are expected due to the activities carried out at the sites of the Kozloduy NPP and the new nuclear unit, related to the noise levels at their borders.

If necessary, the EIA report will suggest measures to minimize the noise impact during the construction and the operation of the site.

3.9.2 VIBRATIONS

3.9.2.1 CURRENT STATUS

There is no data on the existing technological vibrations in the environment of the Kozloduy NPP site. The 1999 EIA report on the Kozloduy NPP concluded that the technological vibrations do not occur in the space between the installations and the environment outside the power plant site, and that they exist only within the operational environment. The existing design-based technological equipment is not a source of vibrations to the environment. For machinery and equipment, the propagation of vibrations beyond their source is limited through the implementation of specific technical requirements during their installation: anti-vibration processing of the bases and their foundations by means of rubber pads, insulation joints from vibration-absorbing materials, elimination of the fixed connections between the vibrating platforms and the structural components of the buildings, etc. The vibrations at industrial sites are a factor only of the working environment.

The transportation vehicles servicing the operation of the Kozloduy NP are not sources of vibrations into the environment. They travel along class II roads from the national road network, consistent with the category of the traffic, and as a result the vibrations from heavy vehicles subside over short distances around the road route.

3.9.2.2 FORECAST OF IMPACT

The construction machinery used during the construction of the site is not a source of vibrations into the environment. Vibrations are a factor of the working environment during the operation of the machinery, facilities and vehicles.

The project design does not consider the future technological equipment to be a source of vibrations into the environment.

Therefore, the technological vibrations will not be considered by the EIA report as an environmental factor.

The heavy vehicles used in the different implementation phases of the investment proposal may be a source of vibrations propagating into the ground media only if the route is not consistent with the necessary road category for the respective traffic which must be considered during the preparation of the design transportation schedule.

3.9.3 NON-IONIZING RADIATION

3.9.3.1 EXISTING CONDITION

Non-ionizing radiation (NIR) is a general term for the radiation within the electromagnetic spectrum, whose single photon energies are smaller than the ones required to ionize the atom, i.e. for the detachment of an electron from its electronic shell. These include the ultraviolet (UV) radiation, the visible light, the infrared radiation, the radio and microwave (VHF) electromagnetic fields (EMF – 300 kHz to 300 MHz), extremely low frequency fields (ELF – 1 Hz to 300 Hz), static electric and magnetic fields. Given that the electromagnetic radiation is a part of the NIR, this approach allows for differentiated bandwidth evaluation of the different types of radiation and a comprehensive assessment of the whole NIR range.

NIR, even with high and ultra-high frequency, cannot cause ionization in a biological system. However, they produce other biological effects – by heating, changes in chemical reactions or inducing electrical currents in tissues and cells, and therefore it is necessary to examine them as a potential risk factor for human health. Currently, in Bulgaria there are no regulated thresholds of electrical and magnetic fields within a work environment, except for the frequency range from 0 to 60 kHz. This requires that the evaluation of the electromagnetic fields at work is carried out only in accordance with international documents, such as the ICNIRP Guidelines, IEEE and others. Regarding settlements, they are only affected by Regulation № 9 from 1991 "on the maximum admissible levels of electromagnetic fields within populated territories and establishing safety zones around emitting sites" (SG issue 35 from May 3, 1991, later amended by SG issue 8 from January 22, 2002).

TABLE 3.9-1: MAXIMUM ADMISSIBLE LEVELS OF INTENSITY AND POWER DENSITY OF THE EMF FLOW WITHIN POPULATED AREAS

№	Bandwidth of the emitter	Maximum admissible noise level
1.	from 30 to 300 kHz	25 V/m
2.	from 0.3 to 3 MHz	15 V/m
3.	from 3 to 30 MHz	10 V/m
4.	from 30 to 300 MHz	3 V/m
5.	from 0.3 to 30 GHz	10 $\mu W/cm^2$

The Ordinance determines the standards and requirements for the protection of the population against the harmful effects of electromagnetic fields (EMF) emitted only from communication sources within the frequency range from 30 kHz to 30 GHz – ***Table 3.9-1****: Maximum admissible levels of intensity and power density of the EMF flow within populated areas***.**

For the other bandwidths, the international regulations and recommendations of the European Union are applied. Other applicable provisions are those of the Health Act from January 1, 2005, last amended by SG issue 9 form January 28, 2011.

Hygienically significant values of ELF (**1 Hz – 300 Hz)** are expected on the territories of the substations for high and ultra-high voltage, around the overhead power lines HV, the electrical machinery, the transformers, etc.

Additional sources of electromagnetic radiation in a wide frequency range (ELF and low frequencies up to 300 kHz) are the video monitors for surveillance are control.

The main sources of ELF (microwave) electric and magnetic fields (with industrial frequency of 50 Hz) in the work environment are the open switchgears of the transformer systems, the busbar systems, the circuit breakers, the power lines. Sources of ELF fields (mainly magnetic) can also be the turbine generators, the rectifiers, and the low-voltage power supply systems.

The sources of radio frequency and microwave (UHF) electromagnetic radiation at the Kozloduy NPP are:

→ security systems;
→ mobile connection systems;

→ emergency public address systems.

3.9.3.2 FORECAST OF IMPACT

We can draw the conclusion that the exposure of the personnel to EMF with industrial and radio frequencies is expected to be constant, but with low values, within the established standards for the country, if the design is prepared according to the legal requirements in Bulgaria and the recommendations of the European Commission respectively.

No exposure of the population to industrial frequency EMF emitted from sources in the NPP is expected.

3.9.4 HEAT IMPACT ON DANUBE RIVER

3.9.4.1 CURRENT STATUS

Throughout the period of operation of the Kozloduy NPP, studies have been performed on a regular basis to determine the impact of the power plant on the temperature profile of the Danube River. During the period 1978-95, 12 research expeditions have been conducted by teams from the UACG. For the purposes of the 1999 EIA report on the Kozloduy NPP, the team that prepared the document, with the assistance of the Kozloduy NPP management, organised a research expedition along the Danube River on August 4 and 5, 1999.

The report analysed and summarised the main results of the research expeditions and the known publications on issues pertaining to the thermal characteristics and their influence on the thermal field of the Danube River.

The water temperature of the Danube River is a hydrological element/indicator, for which the monitoring regime began relatively late – after 1941. There are few publications of studies on the temperature regime of the Danube River.

The distribution of the water temperature across the width of the river depends on the amount of water in it, the season and the hydraulic characteristics of the river section. The maximum measured differences along the river width reach 0.2˚C – 0.4˚C and are highest in the early morning hours. During the warm season the river is virtually isothermal along its cross-section.

At the depth of the stream, the water temperature, especially in the central part of the river bed, is equal. Infrequent differences in the 0.2 – 0.4°C range are observed in the midstream area. Due to the intensive turbulence-induced displacement and the inertia of the thermal processes in the open streams, in the event of relatively rapid changes of the ambient air temperature, the variations of the water temperature at different depths remain within the 0.2 – 0.4 C range.

The water temperatures 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 seasonal pattern is outlined with peaks in the summer months.

The changes in the average daily water temperatures for the period 1941-1985, as well as their extremes under the natural regime of the river, without taking into account the impact of the Kozloduy NPP, have shown that in some months the average monthly temperatures tend to differ in some months by more than 3˚C, i.e. the amplitude of the variations of the monthly average water temperatures of the Danube River is compatible to the acceptable normative difference of 3˚C. (Pursuant to Regulation 7/1986, cancelled during the preparation of this assignment)

Based on 10-year observations (1975 – 1985) at Lom and Oryahovo and the data from the operation of the Kozloduy NPP, a correlation has been derived from 120 observation points, based on which the natural temperature of the water at Oryahovo has been determined, considering the impact of the hot (outlet) channel of the Kozloduy NPP at ^{km}686,4:

$$T_{Or.\,Nat.} = T_{Or.} - 1.126*dT_{NPP}*((Q_{Lom}*T_{Lom})/Q_{NPP}*(T_{Lom}+dT_{NPP}))^{-0.445}$$ (Modev St.),

where:

- → $T_{Or.Nat.}$ – water temperature at Oryahovo under natural conditions;
- → $T_{Or.}$– water temperature at Oryahovo after the commissioning of the Kozloduy NPP;
- → Q_{Lom} and T_{Lom} – water quantity of the Danube in m^3/s and water temperature in ˚C for Lom;
- → Q_{NPP} – water quantity for the cold (intake) channel of the Kozloduy NPP in m^3/s;
- → dT_{NPP}- temperature difference between the water in the discharge and intake canals in the area of the river Bank Pump Station (BPS) in ˚C.

This correlation has allowed for an easy and representative assessment of the impact of the water discharged by the power plant into the Danube River.

The observations on the variations of the water temperatures at different points of the Danube, although limited, cover different days and seasons and cover the annual cycle. The data analysis showed that the smallest daily amplitudes of the water temperatures occur during the months April-May and October-November. Thus, the daily variations in the water temperature rarely exceed 0.5˚C – 1.2˚C. The biggest daily fluctuations in the water temperature occur during the coldest and the warmest months of the year (for the water) – January and August. In August the daily fluctuations in the water temperature reach 1.6˚C – 2.2˚C.

Of essential significance for the thermal field assessment as influenced by Kozloduy NPP is the heat balance of the section of km687 (SPS) to km678 (Oryahovo).

To assess the degree of the possible thermal impact of the Kozloduy NPP on the Danube River, the elements of the heat balance of the section from ^{km}687 (BPS) to ^{km}678

(Oryahovo) have been compared to the heat from the Kozloduy NPP discharged into the Danube River.

The analysis of these results by the expert team developing the document showed that the hydrodynamic characteristics of the mixing zone of the two currents plays a significant role for the redistribution of the heated water in the Danube River, discharged via the hot (outlet) water channel.

Earlier studies demonstrated that the operating water quantity of the BPS has been changed from 6.0 m^3/s to 5.5 m^3/s. The analysis of the results from previous studies demonstrates that at the full capacity of the then operational six units, the expected discharge from the Kozloduy NPP to the Danube River via the existing discharge channel was about 180 m^3/s of warmed-up water with a temperature 10˚C higher than the natural temperature of the river water.

The change of the river temperature profile caused by the discharging of warmed-up water from the Kozloduy NPP is a specific form of pollution. According to the norms[127] applicable in Bulgaria, the thermal pollution of open streams should be assessed on the basis of the minimum average monthly water volume (in a year with 95% provision) and the natural temperature of the open stream – based on the average temperature in the warmest and coldest months of the year. The norm does not take into account the probability of combinations with water quantity with 95 % provision and average water temperature for the last 10 years, and whether this temperature is representative of the natural temperature profile of the open stream.

In order to determine the thermally polluted area downstream after the Kozloduy NPP, in 1978-91 the UACG conducted research expeditions – water flow of the Danube before the BPS, water quantity taken in for the cooling system of the power plant, temperature difference between the water taken in and discharged into the river and geometric characteristics of the section of the Danube River – average width and average depth.

Along with model studies for the development of measures to minimise the entry of floating objects into the forechambers of BPS 1, -2 and -3, in 1991 the UACG conducted a study of the thermal pollution to the Danube River by the NPP. Some of the more important results demonstrated that:

- The temperature of the water in the hot (outlet) channel before the discharge into the river follows a natural rise of the water temperature in the Danube River before the BPS on an hourly basis during the day, with a temperature difference of 7.5-8.5°C, during normal operational conditions;
- The heat stratification along the river at the zone of the thermal plume only occurs up to about 600 m after the discharge of the Hot (Outlet) Channel (HC). The maximum vertical stratification (about 4˚C) is observed at about 200 m

[127] During the preparation of the present assignment, Regulation 7/1986 has been cancelled by a Regulation for the repeal of Regulation 7/1986 prom. SG 22/05.03.2013

after the discharge and at about 80-100 m into the cross-section to the waterway (midstream) of the river;

→ The "thermal pollution" strain in the Danube River (with ΔT = 3˚C) is then manifested at about 1700 m after the discharge of the HC, with a maximum width of about 80 до130 m.

In order to determine certain current characteristics of the thermal effects of the Kozloduy NPP on the Danube for the purposes of the 1999 EIA, experts from the team and the NIMH – BAS, with the support of the management and using a motor boat provided by the power plant, carried out expeditionary studies on August 4 and 5, 1999 along the Danube River from the port of Kozloduy to the village of Ostrov.

The conclusion of the experts is that the results of the examination of the isotherm +3˚C (temperature field with a temperature 3˚C higher than the natural one fir the Danube River) from the previous studies and from this experiment, represent a sufficient reason to assume that there is a reconciliation of the results of the different studies.

The impact of the plant was more pronounced during the dry years. Due to the fact that before the experiment for the purposes of the 1999 EIA no expeditionary measurements and observations had been conducted at a very low outflow of the Danube River (close to the an outflow with 95% provision) data had been taken for the observed water temperatures in the section Lom – Oryahovo in 1983 – one of the dry years, for which there is detailed data on the water temperature at Oryahovo and at the BPS, as well as on the plant operation. The calculation results showed that for some periods the observed water temperature difference for the "Oryahovo – Lom" section of the Danube River was too high. The analysis also showed that the average monthly water temperatures at Oryahovo, after the commissioning of the NPP, were higher by 1.8˚C and the annual temperature was 1.9˚C higher than the natural one.

3.9.4.2 FORECAST OF IMPACT

Using the established dependencies, the team made calculations in order to determine the amount of the heat-influenced area from the Danube River after the discharge of the hot channel, under average monthly water quantities and with a 95% provision. The calculations have been made for two isotherms: +3 and +5˚C. The results obtained showed that during the operation of 4 units, with a total quantity of heated water of 104 m^3/s to a temperature 10˚C above the temperature of the Danube River, the heat-influenced area, at a 5 % probability to not exceed the value, and a temperature of + 3°C above the natural one, varies during the individual months of the year in the section from ^{km}684.3 to ^{km}676.1, forming near the Bulgarian bank and having a maximum width in the zone from 100 m to 185 m.

The size of the heat-influenced area is typically the largest in October, with 4 reactors in operation.

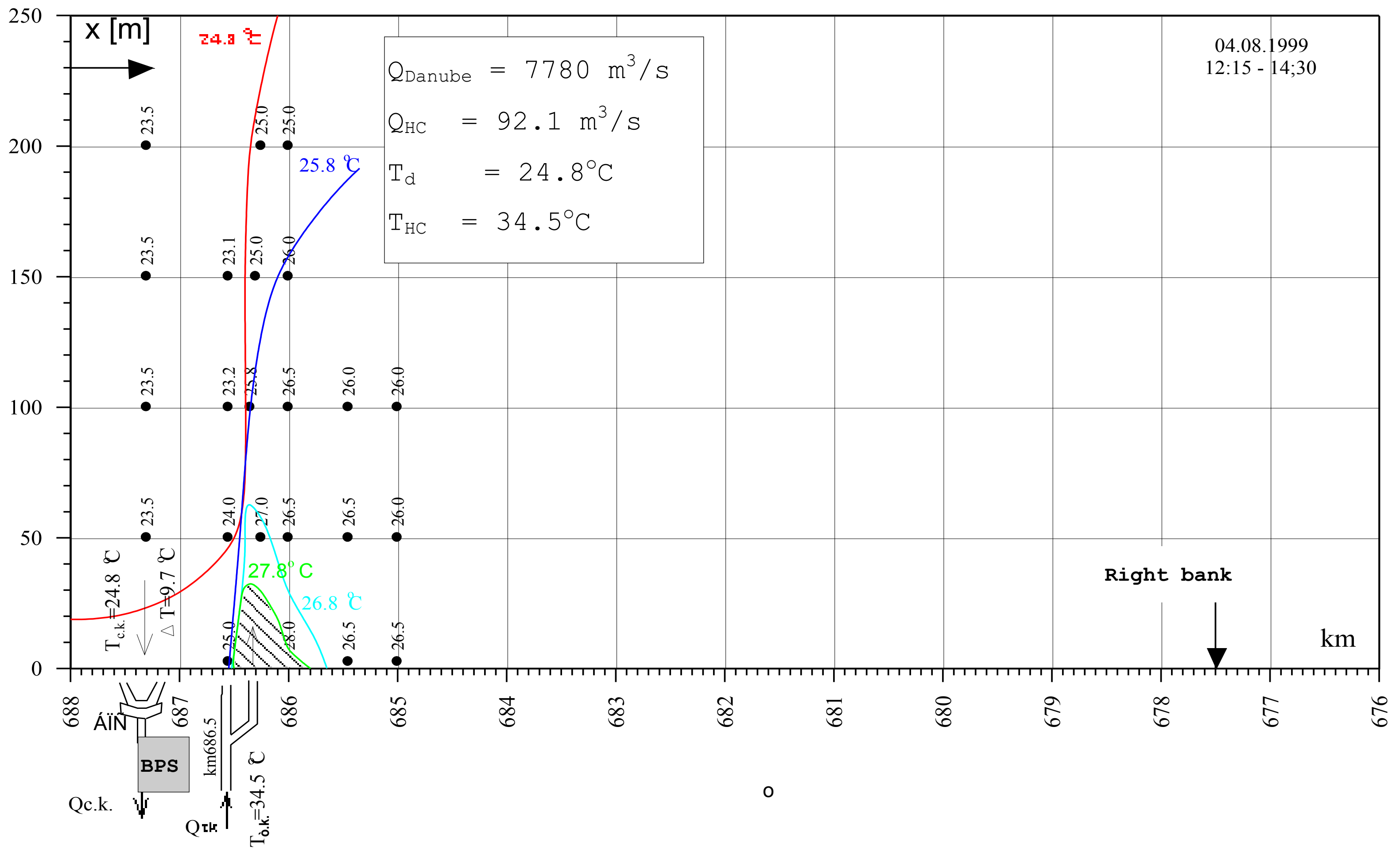

FIGURE 3.9-1: ISOTHERMAL OUTLINE AND RESULTS FROM MEASUREMENTS ON THE HEAT-INFLUENCED AREA OF THE DANUBE RIVER ON 04.08.1999

It is important to note that the national regulations only limit the admissible excess (less than 3°C) above the water temperature under natural conditions, without envisaging an upper limit of the temperature, pursuant to the currently effective Regulation №7/86, unlike most other countries.

The EIA Report will analyse and estimate the current and expected impact of the implementation of the new nuclear unit on the temperature regime of the Danube River.

3.10 HEALTH AND SANITARY ASPECTS OF THE ENVIRONMENT

3.10.1 CURRENT STATUS

The EIA report will examine the conditions at four alternative sites and select the one with the most favourable indicators according to the defined criteria for the construction and installation of a NNU, including the health and hygiene aspects of the environment and the risk on human health, according to a document of the MEB with Ref. No. EIAR 220 from 9.01.2013.

The purpose of this part of the ToR will be to identify the potential impacts in terms of the health and hygiene aspects of the environment and the risk on human health, considering the current capacities at the Kozloduy NPP site and the implementation of the NNU.

The radiological impact of the NPP on the environment and the population will be studied within two zones: a Precautionary Action Zone (PAZ) – 2 km, and an Urgent Protective Action Planning Zone (UPAPZ) – 30 km around the NPP. The investment proposal (IP) determines the various existing nuclear and non-nuclear power capacities and facilities at the production site of the NPP, which will be reviewed and assessed as possible factors for adverse impact on the personnel and the population of the settlements in Bulgaria and Romania, within the defined impact zones when the IP is implemented.

The available data on the population of the Vratsa region shows that the diseases of the circulatory system, the elevated level of malignant neoplasms, and the diseases of the respiratory system continue to play a prominent role, especially against the background of a demographic collapse. It should be noted that the above-background radiation, although negligible in terms of health risks and the health status of the population within the 30 km zone, is mainly due to the presence of gases and aerosols in the ground atmospheric layer, discharged by the NPP. The method for the assessment of the environmental condition at the NPP site and the impact areas (primarily the 30 km one) is based on the regulations approved by the Ministry of Health, developed by the NCPH and the NCRRP in accordance with the EU directives and the developments of the US EPA [128], [129]. The essence of the method consists of 4 individual steps:

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[128] United States Environmental Protection Agency: Integrated Risk Information System. Accessible at: http://www.epa.gov/

- Determination of the hazard;
- Determination of the exposure level – dose – response;
- Assessment of the exposure in terms of impact on the population and the personnel of the Kozloduy NPP;
- Estimates of the level of impact on the health of the population and the personnel.

For the implementation of the assessment method, data from the scheduled medical examinations conducted for the Kozloduy NPP personnel will be used. The results of the preventive medical examinations allow us to identify the "health situation" and the health condition of workers with different professions. The reasons will be analysed for the cases of temporary disability of the personnel and also the cases of radiation exposure for various production reasons, in accordance with the letter of the MH with Ref. number 26-00-2370/ 11.01.2013 and the letter from the Vratsa Regional Health Inspectorate with Ref. number КД-04-35-13/ 09.01.2013.

The EIAR section "Health and sanitary aspects" will analyse the **demographic and health status** of the personnel and the population during the construction, the operation and the decommissioning of the new nuclear unit. Current data will be used from the Medical Service of the power plant regarding the regular examinations and the other medical examinations.

For the purposes of the EIA report, a comparative analysis will be conducted on the morbidity of the population by disease classes, based on examinations conducted during a preceding period of 5-10 years, as well as on current examinations. The prevalence of paediatric diseases and malignant neoplasms will be presented and analysed in detail. The annual health and demographic analyses of the Vratsa RHI will form the basis of the EIAR study.

The probability for the occurrence of a harmful effect on human health and the assessment of its severity determine the term **"damage"**. The main components of the damage are the following stochastic variables:

- Probability of lethal cancer;
- Probability of non-lethal cancer;
- Probability of severe hereditary effects and reduced life expectancy if the damage is manifested.

In the study, the values of the so-called **nominal ecological factors**[130], [131] of the variability of stochastic effects will be determined for the personnel working in an ionizing radiation environment.

[129] Council Directive 96/29/Euratom of 13 May 1996, Council Directive 97/43/Euratom of 30 June 1997
[130] New nuclear power source of the Temelin NPP: Effects on public health, EIA, 2010

The EIA report will consider the principles of radiation protection and its main goal – reducing the radiation-induced cancer to a minimum.

The EIA report will pay particular attention to the analysis of the radiation exposure **of the personnel**, reporting the persons who have received doses above the threshold of the individual dosimeter (1 mSv) and the average annual effective dose.

In the EIA Report the radiation exposure **of the population** in the area of the Kozloduy NPP will be determined using a mathematical model for assessment of the spread of radioactive substances in the air for the purpose of the evaluating the morbidity of children and adults.

Previous studies present data and analyses on the effects of harmful physical non-radiation factors on the environment. The EIA report will update the studies in terms of the effects of harmful physical factors on the health of the personnel and the population. The thermal impact of Kozloduy NPP in its current capacity, with a forecast on the impact of the future nuclear capacities, is considered the most dangerous non-radiation factor, followed by the electromagnetic fields around the substations and the high voltage power lines. The importance of noise, vibrations and lighting for the working environment and to a certain degree for the population, should also be added as non-radiation factors.

The analysis of the impact of various harmful physical factors at the territories of the new unit on the environment and the population will be conducted at the different stages of the Report – construction, operation and decommissioning.

For the purpose of the IP and its implementation, the climatic and landscape conditions in the area of the Kozloduy NPP and the territory of the Kozloduy Municipality will be explored in terms of health protection, taking into account the specifics of the 30 km and the 100 km zones of impact around nuclear power plants.

For this specific estimate study, the best practices of the Czech Republic will be used for the calculation of the total effective doses and partial effective "Sv" doses from separate sources for the next years, as well as the probability of health problems. The EIA Report will determine the risk levels with a leading start of releases into the atmospheric air and the water.

As a result of the objective data presented in the IP, the extent of the possible cumulative effect on the population of the Republic of Bulgaria and the Republic of Romania will be assessed.

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[131] Glazunov I. S., et. al. Radiation medicine. Guide to practitioners and students. 1960

3.10.2 FORECAST OF IMPACT

There are five Bulgarian municipalities within a radius of 30 km from the UPAPZ around the Kozloduy NPP site. According to the 2011[132] census, the municipality of Kozloduy, including the town of Kozloduy and 4 villages: Harlets, Butan, Glozhene and Kriva Bara, has a total of 21 180 residents; the Municipality of Oryahovo has 11 522 residents; the Municipality of Mizia -7 570 residents; the Municipality of Vaulchedram – 9 900 residents; Municipality Hayredin – 5 001 residents. This zone includes some settlements from the municipalities Lom, Byala Slatina, Boychinovtsi, Krivodol and Borovan.

During the construction and the future operation of the plant, the spread of the different quality and quantities of specific air pollutants will predominantly follow the characteristic directions of the wind rose in the region – north-west/west and north-east/east. These fixed factors will be addressed by the EIA report with the assessment of the possible adverse effects on the health of the population within the 30 km Urgent Protective Action Planning Zone (UPAPZ).

In the EIA report, based on analysis of the current data available, an estimate and a comprehensive assessment will be carried out on:

- → The sanitary characteristics of the physical, chemical, radiological or mechanical agents used during the operation;
- → The health and sanitary analysis on the potential pathways of impact of the investment project on the health of the personnel, the population and the environment;
- → Establishing the potentially affected population and the sites with specific hygienic-protection status;
- → Identifying the risk factors for the health of the personnel working at the site;
- → The possibilities for combined, complex, cumulative and remote impact of the established factors;
- → The assessment of the risk for human health and adequate protection measures.

The EIA report will assess the **exposure dose to the population** and examine the pathways for the entry of artificial radionuclides in environmental sites on both the Bulgarian and the Romanian territory (MEF, Republic of Romania, outgoing № 3672 RP 18.10.2012) via the release of gases and aerosols in the ground atmospheric air and via liquid radioactive releases.

The EIA Report will also **evaluate the level of pollution of other major ecological environments, such as air, surface and ground water, soils, etc.** from the specific activity of the NPP during the implementation and the operation of the investment

[132] Population as of 01.02.2011 by regions, municipalities and settlements http://www.nsi.bg/census2011/PDOCS2/Census2011_Age.xls

proposal, connected directly to and having special importance for the determination of the potential impacts on the health and sanitary aspects of the environment and respectively the risk for human health.

The EIA Report will assess the impact of the activity on the health and sanitary conditions of the nearby settlements and the other sites **subject to health protection** against air pollution with Fine Dust Particles – $FDP_{2.5}$ and FDP_{10}, pollution with harmful exhaust emissions and noise, ionizing radiation and radioactive materials, while the preliminary estimates on health positions, based on studies of similar sites, are that the above hazards will be practically absent or will be within the specified Limit Admissible Values (LAV).

The EIA report will examine all health risk factors in the working environment by type. The health assessment will be consistent with the requirements of **Regulation 13/2003** on the protection of the workers against risks related to exposure to chemical agents at work (SG 8/2004, am. SG 71/2006, am. SG 67/2007)

Considering the characteristics of the individual factors in terms of their impact on the health of the personnel and the public, these will be classified and treated under the health and sanitary requirements as follows:

- Chemical factors;
- Physical factors;
- Radiation factors;
- Non-ionizing radiation, etc.;
- Psycho-sensory factors;
- Social factors.

Based on the examined indicators, the health risk will be assessed, with **discussion of the health protection measures** and the effective risk management.

Based on studies and analysis, the EIA report will estimate the possible effects on the health and sanitary aspects of the environment and the risk to human health resulting from the construction of the NNU, in accordance with the requirements of Appendix I of the Commission Recommendation from 11 October 2010 on the application of Article 37 of the Euratom Treaty. Upon identification of the potential impacts, adequate measures will be suggested for the prevention of the health risk to the personnel and the population.

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

3.11.1 CURRENT STATUS

3.11.1.1 DOSES FROM GASEOUS AND AEROSOL RELEASES

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

Over the past 5 years, the maximum individual effective dose for the population varies within 4÷7 μSv/a, which is below the statutory effective dose for the population – 1 mSv/a, under BNRP-2012.

For 2012 the maximum individual effective annual dose within the 30 km zone from gaseous and aerosol releases (RNG+LLA+^{131}I+^{3}H+^{14}C) by the Kozloduy NPP has been estimated at 1.33 mSv/a. The maximum values are calculated in the south-southeast direction at a 1.3 km distance for the age group 7-12 years. This is due to the wind rose for the region.

The collective effective annual dose for 2012 was estimated at 2.65×10^{-2} manSv/a. The statutory collective effective annual dose to the population living within the 30-km zone due to gaseous and aerosol emissions amounts to 1.47×10^{-2} manSv/GW.a.

3.11.1.2 DOSES FROM LIQUID RELEASES

The low values of the releases of treated water from the Kozloduy NPP in 2012 and the previous years determine the low exposure levels for the population in the area. The released tritium activity in 2012 was 24.1 TBq and represents 13 % of the permissible level and 93 % of the control level for the period. The total activity (excluding tritium) of the liquid releases is 411 MBq, which is only 0.28% of the control level limit allowed by the Bulgarian NRA for the period.

The collective dose for the population within the 30 km zone from liquid radioactive releases in 2012 was estimated at 4.7×10^{-3} man.Sv/a. The statutory collective dose per unit of produced electricity amounts to 2.61×10^{-3} man.Sv/(GW.a). This exposure is only 13% of the average value for PWR reactors in the world: 2×10^{-2} man.Sv/GW.a. (UNSCEAR'2000).

The maximum individual effective dose for the 30 km zone is set at 6.37×10^{-7} Sv/a, and for a representative of the critical group of the population living along the Danube River (the town of Oryahovo and the villages of Leskovets, Ostrov and Gorni Vadin) it is respectively) it is respectively 4.49×10^{-6} Sv/a. This exposure is negligible and represents less than 0.5% of the annual effective dose limit of 1 mSv (BNRP-2012).

Compared to the limit exposure 0.25 mSv/a from radioactive releases from the NPP (Regulation on ensuring the safety of nuclear power plants, 2004), the maximum dose is only 1.7%, and compared to the quota on liquid releases 0.05 mSv/a – 8.5%.

The completed assessments on the dose impact of the releases from the Kozloduy NPP are completely comparable with the global practice, according to official UN data (UNSCEAR-2000). It should be noted that since then the international best practice shows a continuous improvement in the control of the releases, and respectively lower emissions and actual reporting, resulting in lower dose estimates for the population in the areas of the NPP. Since the comparison is made on the basis of the collective dose, in the assessments on the Kozloduy NPP the relatively small population density in the area, compared to many other NPPs worldwide, also positively affects the assessment.

The low values of the radioactive releases from the Kozloduy NPP determine the values for the radiation exposure with a negligible radiation risk to the population in the area of the power plant. The additional radiation exposure of the population in the 30 km zone averages about 500 times lower than the natural background radiation (2400 µSv).

The collective dose to the population within the 30 km UPAPZ around the Kozloduy NPP is 2.65×10^{-2} man.Sv for the population in that area amounting to 65994 residents.

3.11.2 FORECAST OF IMPACT

3.11.2.1 DOSES FROM GASEOUS AND AEROSOL RELEASES

The main exposure pathways with regard to people are the following: external exposure from a radioactive cloud, external exposure from the ground surface, internal exposure due to radionuclides entering the body through inhalation (inhalation exposure pathway) and internal exposure due to radionuclides entering the body through the food chain (oral exposure pathway).

The assessment of the external and the internal exposure of the population in the area of the NPP will consider the following impact pathways:

- ✓ External exposure to a radioactive cloud;
- ✓ External exposure to depositions on the ground surface;
- ✓ Internal exposure by inhalation;
- ✓ Internal exposure due to consumption of radioactively contaminated foodstuffs.

The assessment of the radiation exposure of the population will include:

- ✓ Assessment of the maximum individual effective dose for the population and estimated collective effective annual dose.
- ✓ Analysis and conclusions about the radiobiological effects and the radiation risk for the population within the 30 km zone around the Kozloduy NPP.

The estimates of the radiation risk will have the following scope:

1) Risk of radiation-induced cancer for the general population and the persons of employable age;

2) Risk of hereditary diseases for the general population and the persons of employable age;
3) Risks and damage to certain tissues for the general population;
4) Risk of hereditary diseases for the first generation and for two generations;
5) Risks of hereditary diseases for the reproductive part of the population, estimated for two generations when the first generation is exposed before the second one;
6) Risks of hereditary diseases for the reproductive part of the population, estimated for the first generation after the exposure.

The assessment of the exposure to radiation will consider both the external and the internal impact of the radioactive releases and the annual individual effective dose, the annual individual equivalent dose and the dose for the critical group, and the collective dose for the population per age groups will also be assessed.

The input data will be from the radiation monitoring at the source – radioactive releases into the atmosphere and the hydrosphere, actual meteorological and hydrological data, statistical demographic data, data about the consumption of food produced in the region for the period of the assessment. The radioactive releases may be directed into the atmosphere or into an aquatic environment, and the models should describe the transfer of radionuclides through different parts of the biosphere to humans.

A conservative approach will be used for comparison to the annual administrative limits to releases, by components for the whole site at 1200 MW operating power. The limits will be defined in such a way that when approached the control level for the individual effective dose for the population – 50 μSv/a is not exceeded.

3.11.2.2 DOSES FROM LIQUID RELEASES

The liquid radioactive releases into the Danube River are diffused due to the basic water movement and the precipitation processes. 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, utilisation of the river water for drinking purposes, consumption of foods from crops and pastures irrigated with river water.

The EIA report will address each of these pathways. It will take into account the physical movement and the dispersion of the water masses together with the radioactive decay of the radionuclides. The resulting concentration of radioactive substances in the water and in the bottom sediments forms the input for the calculation of the uptake by humans through contact with the environment and the uptake and the subsequent individual and collective doses.

The input data will be the radionuclide distribution and the activity of the releases into the treated water discharges. In 2011 a total of 38 800 m^3 treated water was discharged into the Danube River.

The hydrological data needed to assess the radiation exposure is the following: average speed of the river, average depth, distance, average width of the river; location and capacity of the recipient water body – the river.

Statistical data on the consumption habits of the population. Demographic data on the population by age group.

3.11.3 MODELS AND SOFTWARE PRODUCTS FOR ASSESSMENT OF THE RADIOBIOLOGICAL EFFECTS AND THE RADIATION RISK FOR THE REFERENCE INDIVIDUAL AND FOR ASSESSMENT OF THE DOSES FOR THE POPULATION FROM LIQUID AND GASEOUS RELEASES INTO THE ENVIRONMENT

The assessment of the radiobiological effects and the radiation risk to a reference individual due to radioactive releases from the Kozloduy NPP will be carried out using the programme HeConEmpPop (Health consequences for employees and population). The modelling programme formalises the methodology for assessment of the radiobiological effects and the radiation risk according to ICRP Publication 103, The 2007 Recommendations of the International Commission on Radiological Protection.

Such quantitative estimates are extremely important to define the whole possible range of harmful effects, favourable and unfavourable times for discharge during maintenance and other activities, specify the resources and intervention criteria set out in the emergency plan, evaluate the extreme impacts in case of an unfavourable combination of various factors, optimise the radiation control, etc.

Depending on the technological and meteorological parameters, the concentration and the exposure dose in the environment vary within a very wide range. Even when the technological parameters are fixed, the mentioned range is very wide due to meteorological reasons.

The main meteorological elements are:

- ✓ wind;
- ✓ classes of atmospheric stability (Pasquill-Turner);
- ✓ specific humidity;
- ✓ atmospheric pressure;
- ✓ temperature;
- ✓ precipitation.

The meteorological data processing is performed in compliance with the international standards adopted in Bulgaria – American National Standard for determining meteorological information at nuclear power sites ANSI/Ans 2-5-1974 and Commission for instruments and methods of observation WMO Brussels 1989.

The complex meteorological parameters obtained as a final result provide climatic information that is unique to the area, taking into account its specific local meteorological characteristics. That information is used to devise detailed solutions to a wide range of environmental tasks related to the spreading of radionuclides and determining the exposure doses in different scenarios, the concentration for emergency planning, etc. Thus, when certain region-specific meteorological parameters are used, this enables us to solve the task to determine the aggregate exposure dose of the facility throughout the period of operation (subject to various scenarios), which is an important integral regulatory parameter.

The resulting frequency distributions – the information on the annual recurrence of the distribution of the wind speed, the stability class of the atmosphere and the wind direction – are presented by the wind roses:

- ✓ of the wind;
- ✓ of atmospheric stability;
- ✓ combined;
- ✓ precipitation.

The wind rose shall be prepared for the entire period for which data are available from weather stations, per seasons, annual and day/night.

The roses presenting the wind, the stability classes and the precipitation allow us to determine a four-component distribution "wind direction – wind speed – stability class – precipitation", which represents meteorological pre-processing that is unique to the area, and is required for solving a wide range of tasks related to the environmental status of the power plant.

The data will be presented in the format required by the "SHIELD Normal Operation" programme used for the calculation of the doses from gaseous releases, developed by "Eco Program" OOD. The data recorded in these tables is input data for the modelling programme developed on the basis of the model CREAM (Consequences of Releases to the Environment Assessment Methodology) Radiation Protection 72 –Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment.

Impact on human health is possible during the operation of the new nuclear unit, and therefore the EIA report will assess the biological impact of ionizing radiation.

The biological impact of ionizing radiation is considered in terms of four aspects: physical, physical and chemical, chemical and biological. The biological effect of the ionizing radiation on the human body depends on many factors, the most important of which are: type of radiation, uptake dose and its potency, size and localization of the exposure, reactivity of the organism and exposure duration. As a result of all the processes at the molecular, cellular, tissue and organ level, the ionizing radiation in the body causes the following radiation damage:

3.11.3.1 DETERMINISTIC (NON-STOCHASTIC) EFFECTS

Early somatic effects. These are also called deterministic, since the severity of the damage is proportional to the dose rate after a certain threshold for clinical expression is exceeded. The presence of a threshold dose for the expression of a certain effect is explained by the fact that the damage from ionizing radiation in small sub-threshold doses in the body triggers healing processes, which compensate for the damage. At doses exceeding the threshold, the severity of the damage is increased in proportion to the uptake dose due to the fast cell destruction rate, compared with the cell reproduction rate. For a single whole-body brief exposure of humans, the threshold dose is 0.2-0.3 Sv. At this dose, the irradiated individual does not feel sick, but there are disturbances in the functioning of many radiosensitive organs (red bone marrow, lymph nodes, spleen, gonads, mucous membranes of the digestive tract and the respiratory system, etc.). The threshold dose for an early damage in humans is defined by the reduction of the number of leukocytes. The systems for restoration of the body are able to compensate for this damage resulting from exposure to low doses (0.3 Sv). However, at higher doses, these compensatory capacities are limited. In humans this occurs at doses of 1 Sv, where symptoms of acute radiation sickness are observed. At doses of about 4 Sv /called LD_{50}/ about 50 % of exposed individuals die. Doses above 6-7 Sv /LD_{100}/ are lethal in most cases.

The occurrence of deterministic effects in different individuals is different. They depend on the characteristics of the radiation and the dose of radiation and also on the physiological condition of the body.

The deterministic effects are: acute radiation sickness – threshold 0.25Gy; visual impairment – threshold 0.5 Gy; permanent infertility in women – threshold 2.5-6 Gy; temporary sterility in men – threshold 0.15 Gy. These effects are totally dependent on the dose and therefore no permissible dose limits can be discussed.

3.11.3.2 STOCHASTIC EFFECTS

The stochastic effects (non-threshold) are effects for which the probability of occurrence (rather than their severity) is a function of the **dose.**

→ ***Somatic (cancer):***
  - Late somatic effects – these occur years and decades after the exposure.

→ ***Genetic (hereditary)*** – affecting the descendants of the exposed individual.

These include the late somatic effects and the genetic effects. There, a modification of the normal cells under the influence of low doses of ionizing radiation is observed, but these cells retain their ability to reproduce. These effects are not dose-determined and no threshold can be discussed, the exceeding of which would lead to their occurrence. In terms of the dose-effect relation, a stochastic (probabilistic) distribution of cases occurs, i.e. the increase of the dose increases the probability for disease and not its weight, like with the deterministic effects. That is why for these effects we talk about a *radiation risk*. The stochastic effects are random in nature and their occurrence depends on the physiological specifics of the organism. Since the modified cells retain their reproductive capacity, they are able to create their own population. This population can be destroyed by the body's defence mechanisms. But when this does not happen due to a number of reasons, the stochastic effect occurs after a latency period. The probability of its occurrence depends on the number of modified cells, which appeared after the irradiation and the larger their number, the higher the probability of their survival.

3.11.3.2.1 Late somatic effects:

These include malignant neoplasms (various forms of carcinomas and leukoses). It is typical of such stochastic effects that they occur after a long latency period – from several years to decades. The mechanisms of malignancy are not known. The decisive role is played by the occurrence of an inherited variation in the genetic apparatus of the cell. The assessment of the carcinogenic risk is very difficult due to the high incidence of spontaneous tumours and its annual fluctuations. The establishment of carcinogenic diseases due to the effects of ionizing radiation is possible if their number is greater than the average fluctuation. The risk assessment is carried out by monitoring the groups receiving higher doses, because only in these groups an increased incidence of malignant neoplasms has been found after years of research. The results of these observations allow us to create models of the relation “dose-additional risk” that can be extrapolated to low doses. At high doses, the relation dose-risk is linear, non-threshold, i.e. the additional risk is proportional to the dose. For the more common lethal malignant diseases, the hazard ratio is determined, taking into account the risk due to exposure to a determined single dose for the rest of the life of the irradiated person (lifetime risk factor). At very high doses and irradiation potencies, the relation dose-risk is linear-quadratic, i.e. the additional risk decreases more rapidly with the reduction of the dose.

3.11.3.2.2 Genetic effects:

These are due to the exposure of germ cells before or during the reproductive age, resulting in additional mutations that are transmitted to the offspring. The ionizing radiation is a powerful mutagen and the most common genetic damages caused by it are gene mutations and chromosomal aberrations. The assessment of the genetic risk from exposure to ionizing radiation is very difficult due to the high spontaneous incidence of genetic damage. The linear non-threshold relation typical for the dose-genetic risk relation applies here as well. The genetic risk assessment is carried out in two ways: In the first, the genetic risk is expressed by the frequency of the genetic damage per dose unit. In the second, the genetic risk is expressed by the dose that doubles the natural mutation rate.

Recently, there has been an increase of the doses doubling the spontaneous mutation, meaning that the genetic risk has decreased in comparison with the past. The risk of serious lethal genetic damage for the first 10 generations is 1 case per 125 persons irradiated with a dose of 1 Sv.

The term "genetic risk" means the probability for adverse genetic effects occurring in the offspring of the population exposed to radiation. The assessment treats the problem in relation to three main factors:

- → capacity of the ionizing radiation to induce mutations;
- → capacity for transfer of the induced mutations;

- gene mutations and chromosomal aberrations occurring spontaneously and becoming a reason for the hereditary pathology.

These effects are expressed upon exceeding of the background incidence of genetic diseases in the population per unit of radiation dose with low LET (***linear energy transfer***) upon chronic exposure to low doses.

The programme will give the risk ratios for the reproductive part of the population and for the total population estimated for two generations, as well as the risk ratios only for the first generation after the irradiation.

3.12 CULTURAL HERITAGE

3.12.1 CURRENT STATUS

No archaeological survey or observation has been conducted for the territory of the present NPP during the construction and subsequent reconstructions of the Kozloduy NPP, laying of communications in the area, etc., nor is there any information regarding archaeological findings and sites discovered or registered in the area of the power plant.

Opinion № 4800-2/15.01.2013 of the NIICH and Letter № 33-HH-81/19.02.2013 generally mention about 300 archaeological and construction, historical and archaeological sites within the territories of the municipalities around the power plant.

The Archive of the National Institute of Immovable Cultural Heritage (NIICH) includes 2 historical sites (the Kozloduyski Bryag area and the Mateev Geran area) and 2 archaeological sites (the ancient fortress Chetate and ancient fortress Regiana, situated in the Magura Piatra area). In the automated information system "Archaeological Map of Bulgaria" (AIS-AMB)[133] there are registration cards for 18 sites within the municipality. Most of them are on the land of the village of Harlets, situated to the east of the mouth of the Ogosta River, and are associated with the Roman camp and the city of Augustae, which has been studied via archaeological excavations (and declared "a national antiquity" as early as 1927 (SG issue 69/1927) and "an archaeological reserve of national importance"[134]). 4 sites situated in the western end of the territory of the town have also been recorded.

A letter of the Vratsa Regional Museum of History (Outgoing № 135/27.12.2012) mention mound necropolises near sites 1 and 2, as well as another necropolis in the vicinity of site 3. A part of these mounds has been recorded on the map of the area in M 1:25 000[135].

Out of them, there is potential danger for the "Regiana Roman Fortress" and its accompanying structures (a road, necropolises, a production facility, residential

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

[134] Decision of the Bureau of the Council of Ministers No. 14 from 25.06.1984

[135] D. Dimitrova Archaeological monuments in the Vratsa region. Sofia. 1985. (№ 101).

facilities), situated on a terrain with unspecified area between Site № 3 and the borders of the current town[136].

For Site 4, situated entirely within the construction limits of the Kozloduy NPP, no preserved archaeological structures are expected (irreversibly damaged during the construction and the operation of the power plant).

In the event that the implementation of the investment proposal (mostly for Sites 1, 2, 3) potentially threatens previously unknown archaeological sites (immovable cultural heritage as defined in the Cultural Heritage Act), the provisions of Art. 161 of that Act will become applicable.

3.12.2 FORECAST OF IMPACT

The excavation works and the disturbance of the original surface and natural soil deposits threaten irreversibly any remains of life from various historical periods, archaeological structures and artefacts contained in them. This is also valid for embankment works. This is applicable to both the specific sites and for new passages and communications.

In order to limit the destructive effect on the immovable cultural heritage (archaeological sites and structures), the provisions of Art. 161 of the CHA are applicable: field studies for the registration and the performance of rescue archaeological excavations to the ones directly endangered by the construction works (Regulation H-00-0001/14.02.2011). If during the construction the presence of unregistered cultural monuments is established, the subsequent actions must conform with the Cultural Heritage Act (CHA). The excavation works must be conducted under monitoring by a specialist-archaeologist.

The absence of any targeted search for immovable cultural heritage (archaeological sites) at the present NPP site, as well as the adjacent terrains require the purposeful gathering of information from archive sources, scientific publications, museum collections. It is imperative to conduct a visit and inspection of the terrain in order to update already available and presented information.

[136] Declared as immovable cultural heritage in State Gazette (issue 90/1965) with the status of a monument "of national significance". No boundaries or regimes have been defined.

4 SIGNIFICANCE OF IMPACT ON THE ENVIRONMENT, DETERMINING THE INEVITABLE AND LASTING IMPACTS ON ENVIRONMENT RESULTING FROM THE CONSTRUCTION, OPERATION AND DECOMMISSIONING OF THE INVESTMENT PROPOSAL SITE, WHICH MIGHT PROVE SIGNIFICANT AND WHICH HAVE TO BE DISCUSSED IN DETAILS IN THE EIA REPORT

4.1 IMPACT CHARACTERISTICS

In determining the impact a general approach will be applied taking into account both the Bulgarian legislation requirements and the good international practice for evaluation of impact on the environment and the risk for people's health by means of the following:

1. **Probability of impact occurence** – expected, not expected;
2. **Territorial coverage of impact** within the area of: the construction site of the IP, Kozloduy NPP site, the 30 km zone of urgent protection measures;
3. **Type of impact** – positive/negative and direct/indirect, primary and secondary;
4. **Degree (significance) of impact** in 5 levels: 1 – very low, 2 – low, 3 – medium, 4 – high, 5 – very high level;
5. **Characteristics of impact**:
6. **Frequency** – constant, temporary;
7. **Duration** – short-term, long-term;
8. **Cumulative effect** – impacts acting together and affecting one and the same component/factor of the environment.
9. **Reversibility of impact** – reversible, irreversible.

The impact on the components/factors of environment and human health with the IP realization will be determined in the EIA Report on the following basis:

- The data about the type and quantities of expected waste and emissions as a result of the IP realization;
- Current data about the condition of components/factors of the environment;
- Expected changes in the components and factors of the environment during the IP realization;
- Health and hygienic aspects of environment and the risk for human health.

Special attention will be paid to the measures for reducing, limiting or preventing the expected negative impacts on the components/factors of the environment and the risk for human health.

4.1.1 DURING CONSTRUCTION

Impact on the following components and factors of the environment is expected:

- **QUALITY OF AIR** – impact is expected during construction – temporary, negative, limited with observing the legislation requirements and envisaged measures, reversible after completion of this stage;
- **RADIOACTIVITY OF AIR –** not expected;
- Impacts are expected during operation;
- **SURFACE WATERS (non-radiation aspect) –** impact is probable to occur during construction for lack of treatment and organization of conveying the non-radioactive waters to the discharge point which is provisioned in compliance with the ecological legislation. Type of impact – direct, negative of low level of impact, limited at observing the legislation requirements and envisaged measures. Characteristics of the impact – temporary, short-term, without cumulative effect, with regional sensitivity. Reversible after this stage;
- **SURFACE WATERS (radiation aspect) –** no impact is expected;
- **GROUND WATERS** (**non-radiation aspect**) – impact during construction is expected as a result of excavation works, the mechanization used and accompanying activities on the territory of the selected site – direct, negative, low level of impact, limited at at observing the legislation requirements and envisaged measures. The impact will be temporary, short-term without cumulative effect and reversible after the end of this stage;
- **GROUND WATERS** (**radiation aspect**) – no impact is expected during construction;
- **BOWELS OF EARTH AND UNDERGROUND NATURAL RESOURCES –**with sites 2 and 4 no impact on bowels of the earth is expected during construction. With sites 1 and 3 unwatering will be necessary around the construction site. The impact is long-term, constant and irreversible for the ground waters level;
- **SOILS –** the soils both on the construction areas and the terrain will change their usage due to the direct earth works associated with the construction of buildings, servicing roads, canals, etc. Impact will be irreversible, direct, negative. The impact will be almost the same at any of the discussed sites, excluding site 4 where the greater part of the soils are sealed under pavement or are destroyed during previous construction works. The earth works will not be carried out on soils but on construction materials, foundations and geological base.

  During the construction of the NNU no impact on the soils is expected from radiation point of view as a result of construction works. This is valid for the four discussed sites.

→ **LANDSCAPE –** all investigations show that the landscape structure will change. The following landscape components will be affected: geological properties, soils and vegetation. As a result of the excavation works the geological properties will be directly affected. Impact is assessed as direct, irreversible, negative within the area of the discussed sites. The soils will be subjected to mechanical impact as a result of earth works, and the humus will be stored at a temporary depot at the selected site. The vegetation in these areas will be destroyed. The impact on the landscape components soils and vegetation is assessed as direct, negative, reversible and local.

→ **VEGETATION AND ANIMAL WORLD** – the potential impact on the four discussed sites will be as follows:

Site 1:

Direct impact – annihilation is possible of some species, dwelling places of vertebrae fauna, changes in the natural characteristics of hunting places, places of rest and nutrition base at partial or total destruction of vegetation at the sites;

Indirect impact – worsening is possible of the condition of dwelling places and dwelling places of some species, invasion and spreading of invasive species of the flora and fauna;

Secondary impact – not expected.

Site 2:

Direct impact – annihilation is possible of some species, dwelling places of species, changes in the natural characteristics of dwelling places;

Indirect impact – worsening is possible of the condition of dwelling places and dwelling places of some species, invasion and spreading of invasive species of the flora and fauna;

Secondary impact – not expected.

Site 3:

Direct impact – annihilation is possible of some species, dwelling places of of species, dwelling places of vertebrae fauna, changes in the natural characteristics of hunting places, places of rest and nutrition base, also worsening of the water ecosystems' ecological condition;

Indirect impact – worsening is possible of dwelling places and dwelling places of some species, invasion and spreading of invasive species;

Secondary impact – not expected.

Site 4:

Direct impact – not expected;

Indirect impact – not expected;

Secondary impact – not expected.

- **WASTE (non-radioactive) –** expected is direct, local, periodical, low-level impact because at this stage the construction and hazardous waste will be delivered for further treatment to persons possessing permits, complex permit or registration document as per the terms of the Waste Management Act (WMA), or persons possessing organizations for utilization of waste, having permits under Art. 35 of the Water Management Act. Separate collection of domestic waste will be envisaged as per. Art. 33, par.4 of the WMA;
- **WASTE (radioactive) –** no impact is expected;
- **HAZARDOUS SUBSTANCES –** the main types of hazardous substances to be used at this stage are fuels and lubricants. Their impact is expected to be insignificant at their environment-friendly management;
- **HARMFUL PHYSICAL FACTORS** – physical factors' impact is short-term and reversible. The impact level is limited by the usage of personal transport;
- **NOISE** – impact is limited at observing the legislative requirements and envisaged measures, reversible after the construction stage is over. Construction works at the site of the NNU will not be a source of noise for the populated areas in the region due to the great distances from it. The noise of construction machines will affect the NPP industrial zone. The noise of servicing transport machines will affect the populated areas in the region through which they will run and also the NPP site when running through it. The expected noise impact on the territories with rated noise regime can be determined as follows: territorial scope – the NPP and NNU sites; type – negative, direct, primary; level – low to medium (expected exceeding of hygienic norms); characteristics – temporary (during daytime only), short-term (by the end of construction works), cumulative (summed up), reversible;
- **HEALTH AND HYGIENIC ASPECTS –** the expected impact is negative (within the area of construction site), direct, primary, temporary, short-term (during daytime only by the end of construction works) without cumulative effect, reversible;
- **CULTURAL HERITAGE** – impact is expected only in case rescue excavations are necessary.

The EIA Report will study in details the scope of impact on the environment and the risk to human health, taking into account the stage and specific character of the IP.

4.1.2 DURING OPERATION

- **QUALITY OF THE AIR** – insignificant impact is expected during operation resulting from the diesel generating stations and transport to do with delivery of the necessary materials and raw materials for the NNU;
- **AIR RADIOACTIVITY** – impact is expected during operation. It will be described in details in the EIA Report;
- **SURFACE WATERS** (**non-radiation aspect**) – at the operation stage impact may occur only as a result of unforeseen accidents during collection, treatment and transportation of the non-radioactive waste waters to their discharge point, or eventual spilling from broken pipe line or damaged facilities for collection or storage. The expected impact on the selected site is direct, negative, medium level and limited at observing the legislation requirements and envisaged measures;
- **SURFACE WATERS** (**radiation aspect**) – at the operation stage impact may occur only as a result of unforeseen accidents during collection, treatment, transportation and conditioning of radioactive liquid waste, or eventual spilling from broken pipe line or damaged facilities for collection or storage. The expected impact on the territory of the selected site is direct, negative, medium level and limited at observing the legislation requirements and envisaged measures;
- **GROUND WATERS** (**non-radiation aspect**) – at the operation stage impact may occur only as a result of unforeseen accidents during collection, treatment, transportation and conditioning of non-radioactive waste, or eventual spilling from broken pipe line or damaged facilities for collection or storage. The expected impact on the territory of the selected site is direct, negative, medium level and limited at observing the legislation requirements and envisaged measures;
- **GROUND WATERS** (**radiation aspect**) – at the operation stage impact may occur only as a result of unforeseen accidents during collection, treatment, transportation and conditioning of radioactive waste, or eventual spillingfrom broken pipe line or damaged facilities for collection or storage. The expected impact at observing the legislation requirements and envisaged measures is limited to the territory of the selected site, it is direct, negative, medium level;
- **BOWELS OF EARTH AND UNDERGROUND NATURAL RESOURCES** – in principal, during operation migration of radionuclides in the ground waters is possible. At sites 2 and 4 migration is less probable due to the ground waters low level and to the expected construction of anti-sinking and anti-filtration soil and cement insulation. At sites 1 and 3 migration is possible in eventual leakage of radiation through the protection safeguards;

→ **SOILS** – during operation the negative impact on soils will be comparatively weaker versus that during construction. Smaller areas of natural soils have remained – green areas and protection zones. Impact is temporary – at trampling by the on-site transport machines, spilling of liquids, waste and other. Impact on soils at all sites is low level one. [137].

→ During the NNU normal operation and observation of all technological and engineering requirements, no significant impact associated with radiation pollution of soils is expected. Information will be presented about the monitoring on soils to be carried out after commissioning the new nuclear capacities, as per letter NoB2975/10.01.2013 of REEW– Vratsa;

→ **LANDSCAPE** – the operation stage is not associated with impact on the landscape components of the four discussed sites. No significant, negative and cumulative impact is expected;

→ **VEGETATION AND ANIMAL WORLD** – the potential impact on the four discussed sites will be as follows:

Site 1:

Direct impact – permanent change of dwelling places and hunting territories is possible;

Indirect impact – possible risk of radioactive pollution, fragmentation of habitats and habitats of species;

Cumulative impact – negative impact is possible on habitats and habitats of species;

Secondary impact – not expected.

Site 2:

Direct impact – permanent change in the natural characteristics of environment is possible;

Indirect impact – possible risk of radioactive pollution, negative cumulative impact on habitats and habitats of species is possible;

Secondary impact – not expected.

Cumulative impact – negative impact is possible on habitats and habitats of species;

Site 3:

Direct impact – permanent change in the natural characteristics of environment is possible;

[137] Vassilev, G., Radioecology, Sofia, Thita Consult, 2005, p. 574

Indirect impact – possible risk of radioactive pollution, fragmentation of habitats and habitats of species;

Cumulative impact – negative impact is possible on habitats and habitats of species;

Secondary impact – not expected.

Site 4:

Direct impact – not expected;

Indirect impact – not expected;

Secondary impact – not expected.

→ **WASTE (non-radioactive) –** expected is direct, local, recurrent, low-level impact because at this stage the construction and hazardous waste will be delivered for further treatment to persons possessing permits, complex permit or registration document as per the terms of the Waste Management Act (WMA), or persons possessing organizations for utilization of waste. For domestic waste separate collection of packaging will be envisaged as per. Art. 33, par.4 of the WMA and the remaining waste will be stored at the depot regulated to this purpose as follows: the waste from the ZPPM will be transported to the Depot for non-radioactive domestic industrial waste, the waste beyond this zone will be transported to the Regional Depot, the town of Oryahovo.

→ **WASTE (radioactive)** – the impact during operation is expected to be similar to that of the liquid and solid RAW generated by the operating at present NNU at the Kozloduy NPP site. These will be described in details in the EIA Report.

→ **HAZARDOUS SUBSTANCES –** the main types of hazardous substances used at this stage are fuels, lubricants, chemicals and compounds used as secondary raw materials in a series of preparation processes. Provided that the introduced in "Kozloduy NPP" EAD practice and the legislation requirements for environment-friendly waste management are observed, insignificant impact is expected;

→ **HARMFUL PHYSICAL FACTORS** – the impact from the exposure of the personnel to electromagnetic fields of industrial and radio frequencies is expected to be long-term one but of small significance at observing the legislative requirements. No impact on population is expected with regard to EMF with industrial frequency radiated from sources in Kozloduy NPP. No cumulative impact is expected;

→ **NOISE –** the character of the expected noise impact is similar to that at the construction stage but of much lower level (at the places affected no exceeding of hygienic noise norms is expected);

→ **HEALTH AND HYGIENIC ASPECTS –** the radiological impact on human health is expected to be of low significance on the basis of IRPC recommendations, without cumulative effect and reversible;

→ **CULTURAL HERITAGE** – no impact is expected.

4.1.3 DURING COMMISSIONING

In view of the legislative requirements, the process of decommissioning of a nuclear unit is based on a concept on which basis the justification and selection of an optimal and safe option for performance of the main actions and stages of their realization in the decommissioning period. The selected option for decommissioning of nuclear unit shall be worked out, justified and presented as part of the Plan for decommissioning of the nuclear unit.

The decommissioning duration is minimum 8-10 years, because the set of activities for decommissioning requires firstly carrying out of wide-scope assessment of safety, also the development of other specific strategies, as for example such related to the requirements to the radioactive waste management.

Impact is expected on the following components and factors of environment:

→ **AIR (non-radiation aspect)** – impact during decommissioning is expected to be similar to that during construction but of much lower level of significance;

→ **AIR (radiation aspect)** – impact during decommissioning is expected to be similar to that during operation but of much lower level of significance;

→ **SURFACE WATERS (non-radiation aspect)** – impact during decommissioning is only possible in case of unforeseen accidents or natural calamities. The impact on the selected site will be direct, negative, of low level, limited at observing the legislative requirements and envisaged measures and reversible;

→ **SURFACE WATERS (radiation aspect)** – impact during decommissioning is expected to be similar to that during operation, of low level of significance at observing the legislative requirements;

→ **GROUND WATERS (non-radiation aspect)** – having in mind the legislative requirements, the selected option for decommissioning of the nuclear unit is optimal and safe at observing the requirements. No negative impact is expected on ground waters. Impact during decommissioning is only possible in case of unforeseen accidents or natural calamities. The impact on the selected site will be direct, negative, of low level and reversible;

→ **GROUND WATERS (radiation aspect) –** impact during decommissioning is only possible in case of unforeseen accidents or natural calamities. The impact on the selected site territory will be direct, negative, of low level, limited at observing the legislative requirements and envisaged measures and reversible;

- **BOWELS OF EARTH AND UNDERGROUND NATURAL RESOURCES –** during decommissioning no significant impact on the bowels of earth is expected.
- **SOILS** – impact on soils during decommissioning is the same as at decommissioning of any other industrial enterprise – demolishing of buildings, removing waste to the RAW depot, sealing of lands and carrying out soils monitoring. The level of impact will be low to medium;
- **LANDSCAPE** – the stage of the investment proposal decommissioning includes activities not related to the impact on landscape components;
- **VEGETATION AND ANIMAL WORLD** – the impact on biodiversity during decommissioning of the nuclear unit is expected to be similar to that during construction and refers to the four discussed sites;
- **WASTE (non-radioactive)** – direct, local, recurring impact is expected, of low level of significance. All construction, industrial non-hazardous and hazardous waste from that stage will be delivered for further treatment to persons possessing permits, complex permit or registration document as per the terms of the Waste Management Act (WMA), or persons possessing organizations for utilization of waste, companies possessing permits as per Art. 35 of the WMA. For domestic waste separate collection of packaging will be envisaged as per. Art. 33, par.4 of the WMA and the remaining waste will be stored at the depot regulated to this purpose;
- **WASTE (radioactive)** – similar impact is expected like that during the operation stage but of much lower level of significance;
- **HAZARDOUS SUBSTANCES** – provided that the practice introduced in "Kozloduy NPP" EOD and the legislation requirements for their environment-friendly management are observed, insignificant impact is expected;
- **HARMFUL PHYSICAL FACTORS** – impact will be similar to that during construction but of very lower level of significance;
- **NOISE** – the decommissioning stage is connected with the construction of new buildings, rehabilitation of old ones, dismantling of equipment and activities related to waste treatment and transportation. The machines used for the different activities will be the source of noise. An assessment will be made in the EIA Report of the noise emissions in environment and the impact on the zones with rated noise regime in the region based on information about the type of used machines and the noise characteristics; at that stage the noise impact in its character will be similar to that at the construction stage;
- **HEALTH AND HYGIENIC ASPECTS** – the expected impact will be similar to that during construction – negative (within the area of construction site), direct. Primary, temporary, short-term (only at daytime by completion of decommissioning activities), without cumulative effect, reversible;

→ **CULTURAL HERITAGE –** no impact is expected.

Part of the operator's responsibility is to observe the IAEA requirements, Decommissioning of Facilities Using Radioactive Material, IAEA Safety Standards Series No. WS-R-5, Vienna (2006) and the Regulation on safety during decommissioning of nuclear facilities (2004) concerning all aspects of safety and environment protection during all stages of decommissioning.

Impacts during this long period are manageable and are expected to be insignificant.

4.2 ASSESSMENT OF POTENTIAL IMPACT

In the EIA Report an assessment will be made of the potential impact on each of the components of the environment and human health in accordance with ***Table 4.2-1****: Matrix of potential impact assessment at realization of the investment proposal*

TABLE 4.2-1: MATRIX OF POTENTIAL IMPACT ASSESSMENT AT REALIZATION OF THE INVESTMENT PROPOSAL

Component/ factor	Stage	Probability of impact occurrence[1]	Territorial coverage of impact[2]	Type of impact			Level of impact[3]	Characteristics of the impact			Reversibility[7]
				positive/ negative	direct/ indirect	secondary		frequency[4]	duration[5]	cumulative effect[6]	
SITE 1, 2, 3 and 4											
1.1. Air	Construction										
	Operation										
	Decommissioning										
1.2. Surface waters	Construction										
	Operation										
	Decommissioning										
1.3. Ground waters	Construction										
	Operation										
	Decommissioning										
1.4. Bowels of earth	Construction										
	Operation										
	Decommissioning										
1.5. Soils	Construction										
	Operation										
	Decommissioning										
1.6. Landscape	Construction										
	Operation										
	Decommissioning										
1.7. Non-radioactive solid waste and hazardous substances	Construction										
	Operation										
	Decommissioning										
1.8. Solid and liquid RAW	Construction										
	Operation										
	Decommissioning										
1.9. Vegetation	Construction										
	Operation										
	Decommissioning										
1.10. Animal world	Construction										
	Operation										
	Decommissioning										

Component/ factor	Stage	Probability of impact occurrence[1]	Territorial coverage of impact[2]	Type of impact			Level of impact[3]	Characteristics of the impact			Reversibility[7]
				positive/ negative	direct/ indirect	secondary		frequency[4]	duration[5]	cumulative effect[6]	
1.11. Noise	Construction										
	Operation										
	Decommissioning										
1.12. Vibrations	Construction										
	Operation										
	Decommissioning										
1.13. Radiation	Construction										
	Operation										
	Decommissioning										
1.14. Personnel	Construction										
	Decommissioning										
	Decommissioning										
1.15 Population	Construction										
	Operation										
	Decommissioning										
1.13. Cultural heritage	Construction										
	Decommissioning										
	Decommissioning										

[1] expected, not expected;

[2] the selected site, Kozloduy NPP site, servicing zone, local, transborder;

[3] **1** – very low, **2** – low, **3** – medium, **4** – high, **5** – very high;

[4] constant, temporary;

[5] short-term, medium-term or long-term;

[6] no/yes;

[7] reversible, irreversible.

Italic- matrix elements with positive impact.

<u>Underlined</u> – matrix elements from which no impact is expected or elements from which insignificant negative impact is expected.

Bold – matrix elements from which significant negative impact is expected.

5 CUMULATIVE EFFECT

In compliance with the MoEW recommendation stated in letter No EIA-220/09.01.2013 concerning the necessity of including a separate item "Cumulative effect" as part of the EIA Report, the present Chapter of the ToR aims at describing the *tasks, scope and approach* to be applied in the *assessment of the possible cumulative impact* of the Investment proposal realization.

5.1 MAIN TASK

The main task of the cumulative impact assessment as part of the EIA will be to present an analysis and judgement of the possible cumulative effect of the Investment proposal realization and the operation of other (present and future) facilities at the Kozloduy NPP site and beyond it, which might occur as a result of summing up the effect of realization and operation (operation of 5 and 6 units of the NPP with increased thermal power (104%), Depot for dry waste storage, Depot for storing spent fuel under water, decommissioning of units 1÷4, Specialized unit for decommissioning and the National Depot for RAW).

To meet this objective, **in the scope of the cumulative effect assessment** an analysis will be included of the possible cumulative impact with regard to the following:

- → Each of the discussed sites separately;
- → Each component (factor) of environment separately and in combination;
- → All established and studied past, present and forthcoming actions at the Kozloduy NPP site and in the 30 km zone of urgent preventive measures.

5.2 APPROACH

The approach to be applied for the cumulative impact assessment is based on a common methodological framework, presented in ***Table 5.2-1****: Methodological framework for assessment of the cummulative impact*.

TABLE 5.2-1: METHODOLOGICAL FRAMEWORK FOR ASSESSMENT OF THE CUMMULATIVE IMPACT

Main stages of cumulative impact assessment	**Tasks for the cumulative impact assessment at the individual stages**
Stage 1: Determining the scope of the cumulative impact assessment	• The components and factors of environment will be determined which could be affected by the cumulative impact; • Existing sites, approved sites or such in the process of approval and/development will be identified; • The potential impact on the identified sites will be established.
Stage 2: Analysis of the cumulative impact and determining its significance	• An assessment will be made of the cumulative impact of all identified existing, approved or in process of

Main stages of cumulative impact assessment	**Tasks for the cumulative impact assessment at the individual stages**
	approval and/development sites upon the individual components/factors of environment; • The possible cumulative impact significance will be assessed.
Stage 3: Identifying measures for reducing, limiting or preventing possible cumulative impact	• Concrete applicable measures will be recommended for reducing, limiting or preventing of the cumulative impact.
Stage 4: Identifying the need of follow up activities	• The necessity will be identified of expanding the scope of the monitoring being carried out.

The concrete approaches to be applied for the assessment of the cumulative impact from building of a NNU include:

Stage 1: Determining the scope of the cumulative impact assessment

The following approaches will be applied at this stage:

→ *Determining the components and factors of environment* which could be affected by the possible cumulative impact of the IP;

→ *Determining of the existing sites, approved sites or such in the process of approval and/development,* which includes the identification of all sites that have spacial, functional, technical, logistic etc. relation with the IP on the Kozloduy NPP territory and also in the 30 km zone of urgent preventive measures.

→ *Establishing the potential impact of the ifentified sites on each individual component/factor of the environment.* This assessment will be based on analysis on the following:

- ✓ Location and characteristics of existing, approved or in the process of approval sites (occupied territory, production process and technologies, operation mode, pollutants, etc.);
- ✓ Main and additional infrastructure (roads, railway lines, water transport, etc.);
- ✓ Operation life and sites status – investigation, construction, operation, latest designs for modernization or expansion, decommissioning, etc.;
- ✓ Operation mode permit.

The following will present the sources of information for establishing the potential impact of the sites:

- ✓ Territory structure plans, regional and local development plans;

- ✓ Conducted written consultations with the legal persons at the sites, with representatives of regulatory bodies, local authorities, etc.;
- ✓ Expert valuation, reports, conclusions and other information.

Stage 2: Analysis of the cumulative impact and determining its significance

At this stage an assessment will be made of the potential cumulative impact of existing, approved or in the process of approvaland/or development sites on the components/factors of environment by analysisng:

- → Effects with accumulation – the total impact of different effects on each separate component/factor of environment;
- → Effects with superimposing:
  - ✓ accumulation of **the same** impacts which may lead to a new significant impact;
  - ✓ accumulation of **different** impacts which may lead to a new significant impact;
- → Time effects – assessment of possible impacts which would occur at the different stages of the sites realization (construction, operation, decommissioning), which may lead to a new significant impact.

The assessment of the cumulative impact and its significance will be made at taking into consideration the level of impact on components/factors of environment.

5.3 VALUE OF CUMULATIVE IMPACT

The value of impact will be expressed by using the matrix approach – ***Table 5.3-1****: Matrix of assessment of the cumulative impact of building a NNU at the Kozloduy NPP site*

For the needs of cumulative impact assessment a 5-grade rating for the impact significance will be applied, defined in three main groups:

- → red colour is a marker for impacts of great significance (i.e., inadmissible high level of impacts);
- → green colour is a marker for impacts of medium significance (i.e., impacts affecting the respective component/factor without damaging it). Measures will be proposed for these impacts for reducing, limiting or preventing the cumulative impact;
- → yellow colour is a marker for impacts of small significance. Measures will be proposed also for these impacts for reducing, limiting or preventing the cumulative impact.

TABLE 5.3-1: MATRIX OF ASSESSMENT OF THE CUMULATIVE IMPACT OF BUILDING A NNU AT THE KOZLODUY NPP SITE

SIGNIFICANCE of impact	LEVEL OF IMPACT				
	Very low (VL)	Low (L)	Medium (M)	High (H)	Very high (VH)
Very low (1)					
Low (2)					
Medium (3)					
High (4)					
Very high (5)					

Stage 3: Identifying measures for reducing, limiting or preventing the possible cumulative impact

At this stage of assessment of the IP cumulative impact, measures and ways will be proposed for prevention of the possible impacts. When this is impossible, measures for reducing and/or limiting the possible cumulative impacts wil be proposed.

At identifying the measures an iterative approach will be applied which includes:

- → Making an assessment on the basis of the specific features of IP and all identified existing, approved or in the process of approval and/or development sites;
- → Assessment of the residual impacts after applying the proposed measures.

Stage 4: Identifying the need of follow up activities

Based on the results and conclusions from previous stages, at this stage the necessity will be identified of expanding the scope of the monitoring being carried out.

As far as soils are concerned, the following criteria will be followed at cumulative impact assessment:

- → During an accident the limit of releasing Cesium-137 to the atmosphere, when no long-term restrictions are imposed on using soils and water in the monitored zone is 30 TBq. The combined release of other radionuclides, different from the Cesium isotopes, must not cause in the long-term plan (beginning 3 months after the accident) greater risk than the one set for the Cesium release within the indicated limits;
- → The frequency of greater releases to environment, when urgent preventive measures have to be undertaken for the population, shall not exceed 10^{-6} events of the nuclear station annually.

With regard to waste, by means of comparative analysis the cumulative impact will be established of the generated waste and expected waste from the NNU. As for RAW, on the basis of comparative analysis of the expected RAW at the IP realization and the present generated flows of waste, an estimated assessment will be made in the EIA Report of the expected impact on environment, including the cumulative impact. Concrete measures will be proposed for limiting and minimizing these impacts. The assessment will cover the impact of the ways of RAW treatment on the territory of "Kozloduy NPP" EAD, as well as the capacity of the available depots and facilities for storage and treatment, included will be also an analysis of the necessity of building new ones.

The assessment of the cumulative impact on environment from radionuclides pollution at normal operation will be made by software based on the accepted by the EU methodology CREAM (Consequences of Releases to the Environment Assessment Methodology) Radiation Protection 72 – Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment.

- → To assess the dose load on the population from liquid releases, the DARR-CM programme will be used. It is adapted to the hydrology of Kozloduy NPP region, applying conservative approach-assessment of the dose radiation of the critical group of population;
- → To assess the dose load on the population within the 30 km zone of urgent preventive measures (ZUPM) due to gas-earosole releases, LEDA-CM programme, "Shield Normal operation" will be used. The programme is adapted to the geographical and meteorological characteristics of the Kozloduy NPP region. The methodology measures both the external and internal impact of radioactive releases and assesses the annual individual effective dose, the annual individual equivalent dose and the dose for critical group, as well as the collective dose for the population by age groups.

The model programmes used for the assessment of individual and collective effective doses of the population from radioactive releases to environment are verified and validated.

In modeling the following input data will be used:

- → Demographic information about the Kozloduy NPP region;
- → Meteorological information;
- → Emissions in the atmosphere;
- → Emissions in waters.

With air emissions the following will be used:

- → At normal NPP operation: radioactive rare gases (RARG); Long-lived aerosols (LLA) I-131 (Iodine-131); H-3 total (Tritium); C-14 total (Carbon-14);
- → Average annual values in the period of decommissioning of units 1÷4: Long-lived aerosols (LLA); Co-60; Sr-90; Cs-134; Cs-137; Pu-239, 240; Am-241;

→ Average annual values in the atmosphere from the incinerator: Mn-54; Co-58; Fe-59; Co-60; Nb-95; Ag-110m; Cs-134; Cs-137.

With emissions for liquid releases to the Danube River the following elements will be used:

→ At normal Kozloduy NPP operation: nuclides (excluding H-3); Tritium (H-3);

→ Average annual values in the period of decommissioning of units 1÷4: nuclides (excluding H-3); Tritium (H-3).

After preparation of the models and their analysis, the output data will be obtained for the annual effective doses of the population for the 30 km zone around Kozloduy NPP.

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.

Assessment of the impact of environmental risks as a result of the investment project implementation will be made in respect of:

- ✓ ***Design-based accident*** – according to the REGULATION on Ensuring the Safety of Nuclear Power Plants (2004) this is an accident which a nuclear power plant is designed to withstand according to established design limits, including the degree of damage to the fuel and the release of radioactive substances into the environment. Safety systems are designed to manage the events of this category;
- ✓ ***Major accident –*** according to the REGULATION on Ensuring the Safety of Nuclear Power Plants (2004) this is an accident that causes significant damage to the core.

This chapter shall discuss radiation and non-radiation risks associated with the operation of the new nuclear unit. For the purposes of the Environmental Impact Assessment Report (EIAR) it will study and analyse information and data submitted by the Contracting Authority with regard to the following:

- ✓ Analysis of the sustainability of the project in case of events associated with ultimate loss of heat sink and complete loss of external power supply, taking into account the requirements of ENSREG to stress-tests in light of the Fukushima events;

- ✓ Evaluation of the probability of core damage (the frequency of significant core damage of the new reactor being lower than 10^{-5} events per nuclear power plant per year);
- ✓ Assessment of the probability of large radioactive release (the frequency of large radioactive releases being lower than 10^{-6} events per nuclear power plant per year);
- ✓ Evaluation of unit behaviour in case of a major accident so that for all design-based accidents and major accidents reviewed the changes in core geometry shall be limited in such a way as to ensure conditions for long-term fuel cooling;
- ✓ Description of the technical measures in accident management;
- ✓ Comparative analysis of proposed site in terms of nuclear safety and radiation protection:
- ✓ Analysis of proposed sites in terms of nuclear safety and radiation protection taking into account the following:
    - Influence of factors of technogenic and natural origin on the safety of the facility;
    - Radiological impact of the nuclear power facility on the population and the environment;
    - The specific characteristics of the site that are important for the migration and accumulation of radioactive substances;
    - Capacity to implement measures to protect the public in case of an accident at the nuclear power facility;
    - Change to the size of the emergency planning zones.

6.1 RADIATION RISKS DUE TO ACCIDENTS AND INCIDENTS

6.1.1 NORMAL AND ABNORMAL OPERATIONS

In the process of normal and abnormal operation of the new nuclear unit the threshold dose for a total release of radioactive substances according to BNRP-2012 should not be exceeded as regards the critical group of the population.

6.1.2 EMERGENCY SITUATIONS

The assessment of emergency situations includes assessment of design-based accidents and major accidents. These two types of emergency situations differ not only in their probability of occurrence, but also in terms of their development and severity.

The potential severity of the radiological consequences of accidents is related to the level of activity of radioactive fission products inside the reactor and the level of damage to the barriers designed to ensure safety and prevent release of radioactive substances into the environment. The products of fission are located in the cooling system of the primary circuit. The total activity of the fission products in the core during operations of the reactor depends primarily on the amount of fuel in the combustion zone and the timing of the accident. In the cooling system, including the products of fission, mostly isotopes of noble gases, iodine and cesium are to be found, but their activity in the cooling system is one hundred thousand times lower than that in the fuel. Other isotopes, for example of Sr, Te, La, Ce, Ba, etc., are found in the cooling system in trace amounts. Therefore, the severity of radiation effects depends on the type of accident.

Design-based accidents can lead to release of radioactive substances from the cooling system of the primary loop, but activity is negligible compared to the total list of radioactive materials contained in the core. Therefore, the possible consequences of design-based accidents, compared with the consequences of major accidents, are much lower. Under the INES scale (see below) they are classified as level 3 and 4.

Major accidents result in serious damage to the reactor core. In water-pressurised reactors it denotes the occurrence of an accident, which leads to melting of nuclear fuel, and, hence, to release of radioactive substances from the reactor core into the containment, and subsequently, into the environment. On the international INES scale these accidents are rated as levels 5 to 7.

The requirements applicable to the design of NPPs with reactors of Generation III and III+ significantly differ from the ones for reactor projects of older generation by providing expanded use of passive and special protective equipment for prevention of major accidents and dealing with their consequences, including a corium capture concept. A major accident is only possible after repeated collapse of the power plant systems at various independent levels of protection, for example, failure of the primary cooling system and subsequent prolonged failure of the external and then internal sources of electricity. New nuclear plants are designed in such a way that the probability of major accidents should be lower than 10^{-5} per reactor per year. The containment system is designed in such a way that during operational states and in accident conditions involving the release of radio nuclides, including major accidents, to reduce these releases to the environment, so that the radiation effects remain within acceptable limits. Due to their design and the reactor containment systems, the primary loop and all related equipment that are relevant to the nuclear and radiation safety and are located in the containment to be protected against external events, the occurrence of which cannot be excluded with sufficient probability. The containment system also acts as a biological shielding.

A widely recognised international standard for limiting significant release of radioactive substances into the environment is that the probability of such circumstances should be less than every one million years, i.e. 10^{-6} per reactor per year, which for the types of reactors concerned is secured by at least a tenfold margin.

Possible radiological consequences of a major accident are limited by safety requirements for new nuclear power sources in such a way that the leak of radioactive substances should not cause any serious radiation or health damage to the population in the immediate vicinity of the nuclear power plant, and should not lead to the emergence of long-term and large-area effects on food chains, in the use of land or water areas. Limiting radiological consequences should lead to a situation where even in case of a major accident there will not be a need for evacuation from the area of specific protection measures and for implementation of other emergency protective measures (shelters, iodine prophylaxis) outside the emergency planning zones of the nuclear power plant.

6.1.3 CHARACTERISTICS OF EVENTS ACCORDING TO THE INTERNATIONAL NUCLEAR EVENTS SCALE INES

The International Nuclear Events Scale (INES) was introduced in 1990 by the International Atomic Energy Agency (IAEA) to facilitate reporting of the safety information in case of nuclear accidents.

The scale has 7 levels (degrees) of danger and a zero level meaning no danger. The scale (***Table 6.1-1:*** *INES International Nuclear Events Scale*) is logarithmic, like the Richter scale, and each level indicates an accident approximately 10 times more severe than the previous (lower) level.

TABLE 6.1-1: ***INES INTERNATIONAL NUCLEAR EVENTS SCALE***

Level	Risk Assessment Criteria		
	People and the Environment	**Radiological Barriers and Controls**	**Defence-in-Depth**
Level 7 ***Major Accident***	Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures.		
Level 6 ***Serious Accident***	Significant release of radioactive material to the environment likely to require implementation of planned countermeasures.		
Level 5 ***Accident with Wider Consequences***	Limited release of radioactive material likely to require implementation of some planned countermeasures. Several deaths from radiation.	Severe damage to reactor core. Release of large quantities of radioactive material within an installation with a high probability of significant public exposure.	

Level	Risk Assessment Criteria		
	People and the Environment	Radiological Barriers and Controls	Defence-in-Depth
Level 4 ***Accident with Local Consequences***	Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls. At least one death from radiation.	Fuel melt or damage to fuel resulting in more than 0.1% release of core inventory. Release of significant quantities of radioactive material within an installation with a high probability of significant public exposure.	
Level 3 ***Serious Incident***	Exposure in excess of ten times the statutory annual limit for workers. Non-lethal deterministic health effect (e.g., burns) from radiation).	Exposure rates of more than 1 Sv/h in an operating area. Severe contamination in an area not expected by design, with a low probability of significant public exposure.	Near accident at a nuclear power plant with no safety provisions remaining. Lost or stolen highly radioactive sealed source. Misdelivered highly radioactive sealed source without adequate procedures in place to handle it.
Level 2 ***Incident***	Exposure of a member of the public in excess of 10 mSv. Exposure of a worker in excess of the statutory annual limits.	Radiation levels in an operating area of more than 50 mSv/h. Significant contamination within the facility into an area not expected by design.	Significant failures in safety provisions but with no actual consequences. Found highly radioactive sealed orphan source, device or transport package with safety provisions intact. Inadequate packaging of a highly radioactive sealed source.
Level 1 ***Anomaly***			Overexposure of a member of the public in excess of statutory annual limits. Minor problems with safety components with significant defence-in-depth remaining. Low-activity lost or stolen radioactive source, device or transport package.
Level 0 ***Out-of Scale Event***	No safety significance.		

By March 2011 there has been one registered Level 7 accident (Chernobyl) and one Level 6 accident (the accident at Nuclear Complex Mayak). On 12 April 2011 the Japanese Nuclear and Industrial Safety Agency declared "provisionally" that the Fukushima accident is Level 7.

Herein below ***Figure 6.1-1:*** *Events on the INES Scale that occurred at Kozloduy NPP and were reported to the Nuclear Regulation Agency* shows the number of events for the 2007-2011 period.

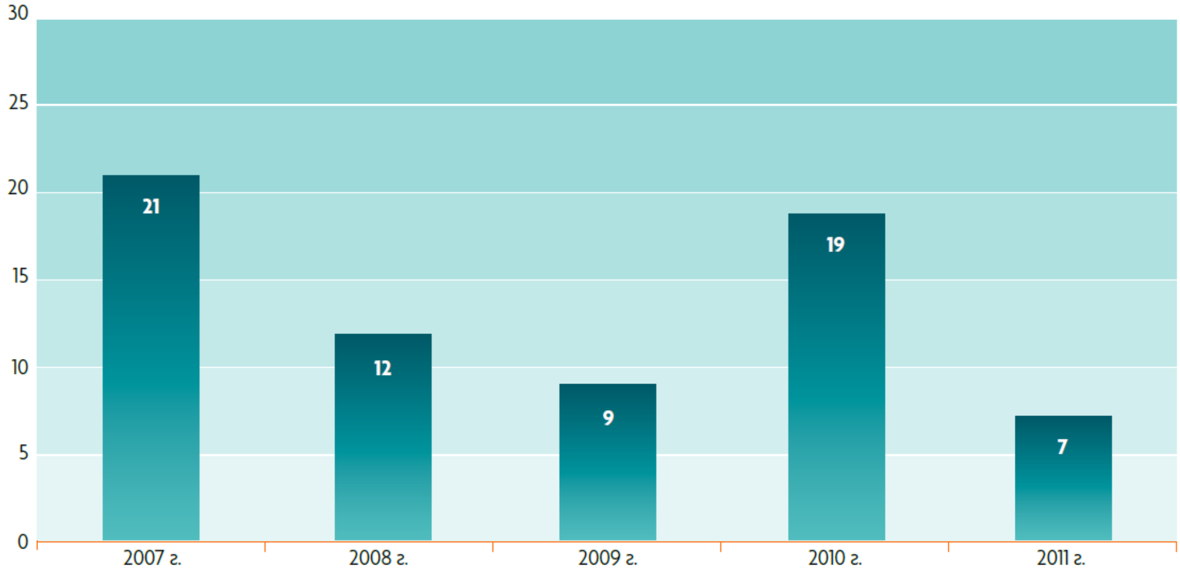


FIGURE 6.1-1: EVENTS ON THE INES SCALE THAT OCCURRED AT KOZLODUY NPP AND WERE REPORTED TO THE NUCLEAR REGULATION AGENCY[138]

These events are as follows:

- ✓ In 2011 all seven events pertain to level "0" – Out of scale;
- ✓ In 2010 all 19 events pertain to level "0" – Out of scale;
- ✓ In 2009 there were nine operational events, including 7 reported at "0" (tolerance), out of the INES scale, and 2 events off the scale. No events listed at "1" (anomaly) or higher on the INES scale;
- ✓ In 2008 – one of the 12 reported operating events is estimated as "Off the International nuclear events scale INES" and 11 were classified as level "0" (tolerance) – out of the INES scale;

[138] Annual reports of Kozloduy NPP EAD for 2007, 2008, 2009, 2010 and 2011.

- ✓ In 2007 – a total of 21 operational events were registered, two were rated "off" scale and 19 were classified as level "0" (tolerance) – out of the INES scale.

For the entire period of operation of the existing facilities (about 150 reactor / years) at Kozloduy NPP no events have been registered higher than level 2 on the INES scale. Generally, the recorded and reported events total 52 Level 1 events and two Level 2 events. No additional radiological impacts off-site Kozloduy NPP have been established for all these events.

6.1.4 CHARACTERISTICS OF THE RADIATION RISK TO THE ENVIRONMENT

Upon release of radioactive material from a nuclear power facility the population is directly threatened by the moving cloud of leaked radioactive gases and aerosols. The cloud is the source of both external and internal radiation, the latter as a result of inhaling radioactive substances.

The movement of the cloud leads to gradual deposition of radioactive aerosols and topsoil contamination. The extent of topsoil contamination also depends on whether during the cloud movement there is rain. Contamination of surface aerosol radio nuclides has the potential to cause long-term contamination of the environment. In terms of risk to public health, the probability of transfer of nuclear activity in the food chain should be taken into account, resulting in internal radiation through the so-called ingestion – i.e. primarily through consumption of contaminated agricultural products.

The risk associated with the possible consequences of a radiation event (i.e. the event has the effect of uncontrolled release of radioactive substances into the environment) can be assessed judging on the scope of the necessary measures to protect the endangered population and the degree of contamination in the affected environment.

Limitation of human and environmental exposure in the event of an emergency radiological situation is achieved through the provision of protective measures, such as:

- ✓ immediate protective measures, including the use of shelters, iodine prophylaxis and evacuation;
- ✓ further protective measures, including evacuation, limiting the use of contaminated food, water and forage.

Urgent protective measures should always be considered justified if the assumed exposure of an individual may lead to imminent danger for his health.

The actions planned for the Kozloduy NPP site are included in the emergency response plan of the plant.

The Environmental Impact Assessment Report (EIAR) shall assess the extent of required Emergency Plan update as a results of the construction of a new nuclear facility.

6.1.5 ACCIDENT EVALUATION METHODS

The methodology of accidents evaluation consists of the steps listed below – determination of the source of radiation and analysis of the spread and impact of radioactive substances on environmental components and factors. Data and information required for this assessment will be provided by the Contracting Authority.

6.1.5.1 SOURCE ELEMENT

For the purpose of safety analyses, the common conservative approach requires that the source element is defined so that the radiological consequences will have a sufficient safety margin. For the purposes of the Environmental Impact Assessment Report (EIAR) the assumption of radiological consequences can be more general, given that it would be done with an adequate margin and a detailed evaluation of the specific design solution will be made in the Preliminary Safety Report.

6.1.5.2 QUALITATIVE DETECTION

Based on the results of international studies of accidents where the proportion of individual radio nuclides in radiological consequences is estimated, the following main groups of decay products should be taken into account:

- noble gases (mainly Xe-133 with half-life of 5.2 days) – a source of external human exposure resulting from the spread of the radioactive substances cloud; this exposure is not so significant;
- iodine (mostly I-131 with half-life of 8.0 days) – enters the body through breathing, deposited mainly in the thyroid gland and its share is significant in terms of short- and medium-term effects of the accident, unless its deposition in the thyroid gland is blocked by the timely intake of potassium iodine;
- cesium (mainly Cs-137 with half-life time of 30 years) – it is the main long-term source of external and internal exposure of persons involved in accidents as a result of contamination of the ground and the other environmental elements (water, flora), and contamination of certain foods from the food chain;
- other products of radioactive decay (especially Te, Sr, La, Ce, Ba) and actinides in smaller quantities are negligible in design-based accidents, and, in case of major accidents, they are less relevant than cesium; yet, especially during the first year after the accident, their share in the exposure of persons and environmental elements and food should be taken into account.

Given the above, it can be concluded that it is important for the comprehensive assessment of the immediate threat to human health in the vicinity of the nuclear power facility to add to the source element representatives of all groups of radio nuclides, such as: Xe-133, I-131, Cs-137, Te-131m, Sr-90, La-140, Ce-141 and Ba-140. Calculations made will render it possible to assess the radiological consequences of potential accidents for a given source and region.

For the characterisation of environmental risk in terms of long-term environmental burden, particularly in the case of a design-based accident, a suitable simple source element is formed only by the following radio nuclides: I-131, Cs- 137, possibly Sr-90 as well.

The source element in this case is based on the extraction of decay products and activation products from nuclear reactions in the fuel with UO_2, enriched with U-235, which is used in all PWR reactors. The presence and proportions of various important radio nuclides is determined by objective laws of physics and are independent of the particular design of the reactor or its suppliers. This is why it is possible, before the completion of the selection procedure for a specific model for the new nuclear unit, to determine the radionuclide groups whose presence in the source will be decisive for safety analysis results. This will allow sufficient accuracy in assessing the radiological consequences of the entire list of radio nuclides released into the environment as a result of the accident.

The release of decay products from molten fuel in case of a major accident depends mostly on their chemical and physical form. It is assumed that in the high temperature of the molten fuel in the containment, the fuel will release up to 75 – 100% of noble gases, iodine and cesium (in design-based accidents – from 1,000 to 100 times lower), while for other radio nuclides – the release is 10,000 to 1000 times lower. Only a fraction of the activity of the fuel decay products may be released in the environment in case of a major accident with intact containment, depending on a number of factors (technical, structural).

The total amount of radioactive substances that could leak into the environment depends on the quality of individual engineering barriers and their current status at the time of the event.

With all units surveyed the containment is equipped with special systems which prevent loss of integrity, even in major accidents. Core cooling and heat removal from the containment is taken care of so that the containment remains intact during the accident and for hours afterwards.

6.1.6 POSITION RELATIVE TO THE EXISTING EMERGENCY PLANNING ZONES

The investment project for the construction of the new nuclear unit provides for PWR units of Generation III and III+, with a degree of safety barriers that in the event of a radiation accident, which may occur with probability of 10^{-6}/year, the possible release of radioactive substances at a distance greater than 800 meters from the reactor does not require evacuation of the population

The specific conditions in the area of Kozloduy NPP are such that the closest populated area significantly exceeds the perimeter of 800 meters from the future reactor building and, depending on the final siting, distances reach about 3 kilometres. Hence, the area where the greatest threat could reach is not populated. Within the territory of Kozloduy NPP there are zones for emergency planning (exposure dose), which are defined and supported by procedures and measures in the emergency action plan of the Plant. In addition, the analysis of the operational experience of Kozloduy NPP indicates that the Plant has achieved a high administrative capacity, including its response to accidents and incidents. Documents have been produced by Kozloduy NPP to provide for procedures and reporting responsibilities, analysis of operational events, and for assigning and monitoring the implementation of corrective measures in compliance with the rights, duties and responsibilities of Kozloduy NPP arising from the Safe Use of Nuclear Energy Act (SUNEA), the Regulation issued by the Nuclear Regulation Agency (NRA) concerning the terms and procedures for notification of NRA of events at nuclear facilities and sites with sources of ionizing radiation (hereafter referred to as the Regulation), and as a "nuclear operator" and "license holder for the operation of nuclear facilities." Procedures for the use and dissemination of operating experience have been developed and implemented to regulate the terms of:

- dissemination and use of information from internal and external operating experience (OE);
- informing the nuclear community of events occurring at Kozloduy NPP through the World Association of Nuclear Operators (WANO).

The Environmental Impact Assessment Report (EIAR), based on the analyses conducted, will assess whether it is necessary to make changes to the boundaries of the precautionary and protective action zones.

6.1.7 Radiation hazards during investment project preparation and implementation

Construction and structural activities during the preparation and implementation of the investment project for the new nuclear unit are of a different nature than radiation activity proper.

The Environmental Impact Assessment Report (EIAR) shall assess whether the nuclear safety of the current units of the Plant will not be affected in the course of building and structural works.

6.1.8 Radiation hazards during decommissioning of the new nuclear unit

With the decommissioning of the new nuclear unit the nuclear fuel will first be shifted to the reactor pool. The systems will be gradually cooled and released from pressure, dried and decontaminated, which will limit the potential sources of risk from radiation contamination. Activities carried out during decommissioning will take place in such a way as to ensure nuclear safety, radiation protection, emergency preparedness and physical protection, based on the relevant / valid at the time permits and applicable laws. In this regard, the risk to the environment and human health, compared to the previous operation of the new nuclear unit, is expected to be significantly lower.

6.2 NON-RADIATION RISKS FROM ACCIDENTS AND INCIDENTS

6.2.1 NON-RADIATION RISKS DURING THE OPERATION OF THE NEW NUCLEAR UNIT

Operations of the new nuclear unit after the extension of the nuclear power plant are not a risk factor in the probability of emergency occurrence that could have significant negative consequences on the environment and the population.

In connection with the operation of the new nuclear unit, certain emergency situations related to leakage of polluted waste water (in case of a damage of the sewerage sealing, or disfunction of the treatment plants and equipment), leakage of stored substances (chemicals, combustible materials, lubricants, cleaners and the like) from the tanks or pipelines for transport, should not be excluded. There is a risk of fire incidents as well.

The above mentioned risks for the occurrence of emergency situations are characterised by low probability of impact. Nevertheless, the Environmental Impact Assessment Report (EIAR) will assess the need for the implementation of specific preventive or recovery measures beyond those which are customary or specified by the relevant construction, safety, fire, transportation or other regulations.

6.2.2 NON-RADIATION RISKS DURING THE NEW NUCLEAR UNIT OPERATIONS PHASE

The above described risks during the operations phase of the new nuclear unit (NNU) may also relate to the period of preparation and implementation of the investment project. Standard risks in the performance of construction works, respectively, structural works, are eliminated by such means and by compliance with requirements considered typical of this type of activities.

6.2.3 NON-RADIATION RISKS DURING THE NCC DECOMMISSIONING PHASE

Risks during the decommissioning of the new nuclear unit will not outweigh the risks during the preparation and implementation of the investment project, and in this case it should not be deemed necessary to apply measures different than the usual.

7 MONITORING

Monitoring (surveillance) as a mechanism is directly related to the management, development and decision-making as part of running the business of each economic entity. Environmental monitoring as part of other governance and management programmes is a proven tool in the modern understanding of good planning and effective operation of any production.

7.1 NON-RADIATION MONITORING

Kozloduy NPP has introduced and successfully operates its own non-radiation monitoring, radio-ecological monitoring, and in-house environmental control monitoring. The purpose of the non-radiation monitoring is to maintain compliance with legislative requirements and the conditions listed in the permits issued by the Ministry of Environment (MoEW) and Water, Environment Executive Agency (EEA), and Basin Directorate for Water Management Danube Region (BDWMDR) and the Regional Inspectorate for Environment and Water (RIEW) in Vratsa. Kozloduy NPP developed and established its own programme to control non-radiation monitoring. It covers 20 indices for the quality of waste water discharged from the Plant as per the international environmental standards, also stated in the permits issued by the Basin Directorate, as well as indicators for groundwater. The results show that there is no upward trend in the values of the controlled parameters and no significant excesses were registered above the permissible limits. Values are comparable in recent years. Annual reports are available in the Environment Executive Agency (EEA) and the Regional Inspectorate for Environment and Water (RIEW) in the town of Vratsa. Corporate control is undertaken through regular inspections and internal controls. In-house control of non-radiation monitoring is performed throughout the year by authorities of the MoEW, the BDWMDR and the RIEW in Vratsa.

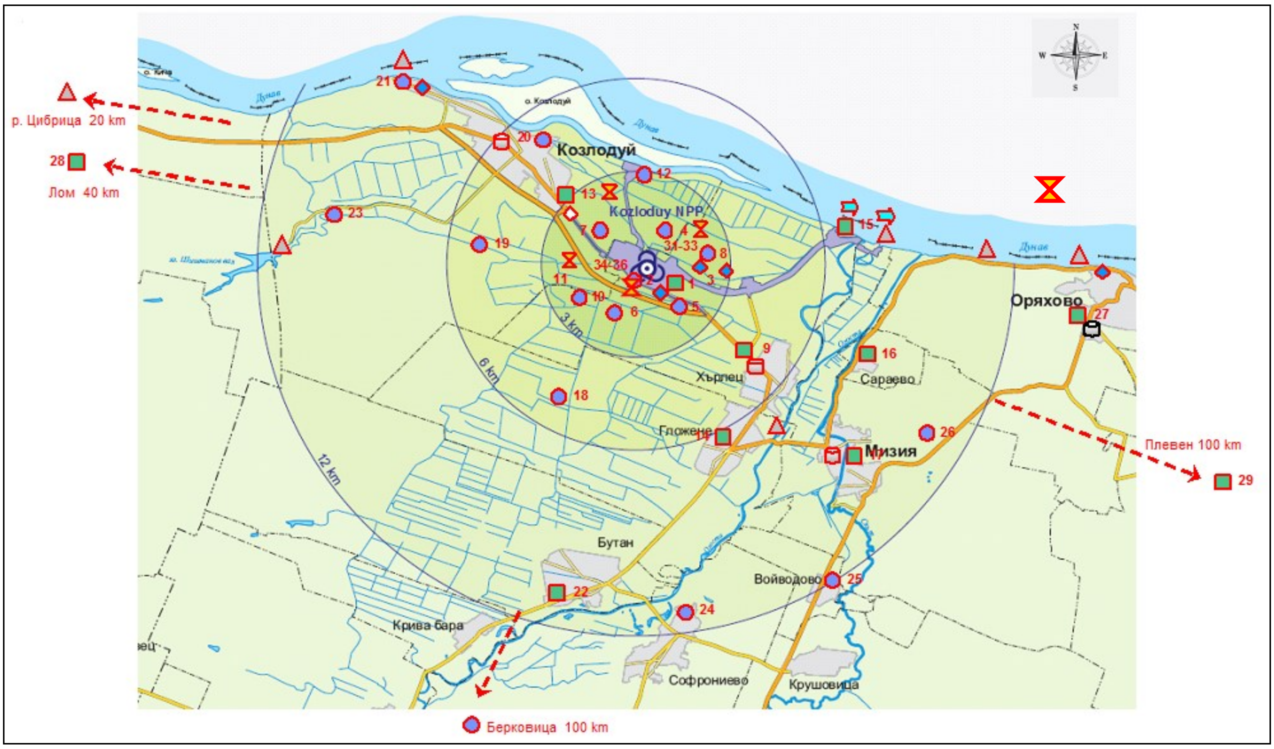
Under a schedule approved by the Ministry of Environment and Water for automatic mobile stations (MAS) for further measurements in areas where there is none or a limited number of fixed points the Pleven Regional Laboratory takes measurements for air quality monitoring in the North / Danube Ambient Air Quality Evalution and Management Area (ROUKAV) within Kozloduy Municipality every few years – the latest measurements were taken in 2008 and in 2011.

7.2 RADIATION MONITORING

The radioecological monitoring performed by Kozloduy NPP EAD covers all environmental components – air, water, topsoil, vegetation, crops, typical foods produced in the area, etc.

European requirements for the application of Article 35 of the Euratom Treaty for monitoring levels of radioactivity in the environment for the assessment of dose exposure of the population as a whole is regulated by European Commission Recommendation 2000/473/Euratom, dated 8th June 2000, as this recommendation is essential to standardise and unify the applied practices of radioecological monitoring in EU member states. It defines the terms and general requirements, as well as the types of monitoring, monitoring networks and sampling (dense and diluted), the frequency of testing, monitoring volume and requirements for sampling and analysis of the main elements of the controlled environment. It also contains provisions on the volume of the supporting information going with the sample, the management and communication of monitoring data.

The in-house radiation monitoring of the environment is governed by the long-term environmental radiation monitoring programme of Kozloduy NPP EAD. The programme is based on the legal requirements in this sector, as well as on international best practice and the operational experience of the Radiation Monitoring Department. The programme is agreed with the Ministry of Environment and Water (MoEW), the Ministry of Health (MH) and the Nuclear Regulation Agency (NRA), and is in line with international recommendations in the field, namely Article 35 of the Euratom Treaty and Recommendation 2000/473/EURATOM. To ensure independent control, radiation monitoring programmes are implemented by the control authorities of the Environment Executive Agency, the Ministry of Environment and Water (MoEW) and the National Centre of Radiobiology and Radiation Protection (NCRRP) / the Ministry of Health.



Description:
– outpost type "A": aerosols, atmospheric deposition, topsoil, vegetation, gamma background (TLD) – 11 units
– outpost type "B": atmospheric deposition, topsoil, vegetation, gamma background (TLD) – 15 units
- outpost type "C": water, sediments, algae, gamma background – 7 unit
food chain products: – drinking water; – milk; – fish; – cereals

FIGURE 7.2-1: LAYOUT OF RADIATION MONITORING OUTPOSTS AROUND KOZLODUY NPP

To locate and assess the possible impact of Kozloduy NPP on the environment and the population around the Plant there are two distinct zones of control with different radii: Precautionary Protective Action Planning Zone – the area of specific protection measures (2 km); and Surveillance Zone (30 km). The monitoring covers also the industrial site itself. Sampling and measurements are carried out for comparison at benchmark posts (stations) within up to 100 km around Kozloduy NPP, where no influence of the Plant's operations is expected. Laboratory and automated control is performed on the environmental components.

In the 30-km surveillance zone there are 36 control outposts for the terrestrial ecosystem and 7 stations for the water ecosystem, where the sampling for laboratory analysis and measurement of the activity of technogenic radio nuclides in the samples take place. Samples of the air, topsoil, vegetation, water and bottom sediments are analysed and the background gamma radiationis measured. Beyond those stations, samples of drinking water, milk, fish, agricultural grain crops and forage crops in the region are analysed. The location and type of control outposts is given in ***Figure 7.2-1****: Layout of radiation monitoring outposts around Kozloduy NPP.*

Besides radioecological monitoring within the 100-km zone around the nuclear power plant radiation measurements are carried out on the industrial site. Subject to control are the background gamma radiation, groundwater, air, atmospheric deposits, vegetation and topsoil.

Water samples from more than 115 boreholes are analysed four times a year for total beta activity and tritium content.

The frequency of sampling is consistent with the design requirements and the long years of experience in radio-ecological monitoring at Kozloduy NPP, as well as the international practice of other countries.

The surveyed benchmark radio nuclides are fission products and activated corrosion products whose ingestion through the ambient air, drinking water and food or entry into objects of the environment (the food chain) would cause additional internal exposure of the population.

The methods used are standardised methods validated by practice, such as gamma spectrometry, low background radiometry of total beta activity and radio chemically isolated radiostrontium, liquid scintillation spectrometry of tritium and alpha spectrometry of trans-uranium elements. Generally, these are methods well-tested in practice, organised in analytical procedures for environmental samples used by leading laboratories worldwide and recommended by IAEA.

Practice shows that the results of radioecological monitoring have values significantly lower than those fixed in the regulations. For this reason, the current results are compared against those obtained from previous years of operation, and the results measured before the commissioning of the nuclear power plant. This approach allows recording and analysing even the smallest change in the trends of radiation background.

The implementation of the radiation monitoring programme has been verified by self-assessment criteria – meeting the pre-set volume requirement, with guaranteed reproducibility and accuracy of results. The accuracy of the analysis is verified repeatedly in national and international prestigious laboratory comparisons made by the World Health Organisation (WHO), the Federal Office for Radiation Protection of Germany (BfS), the International Atomic Energy Agency (IAEA) and the National Physical Laboratory in the UK (NPL). The results from the in-house radiation monitoring are annually verified through independent research and by the National Centre of Radiobiology and Radiation Protection (NCRRP) under the umbrella of the Ministry of Health (MH). The main findings are published for the general public.

In pursuance of the provisions of Article 15 of the Regulation for the Conditions and Procedure for Establishing of Special-Statutory areas around Nuclear Facilities and Facilities with Sources of Ionizing Radiation, approved by Council of Ministers' Decree № 187 of 28.07.2004, Kozloduy NPP has built an automated information system for radiation monitoring (AISRM) of settlements within the 30-km zone of the Plant. The system covers 13 villages and, at appropriate public places, stationary information boards are placed to show the real-time dose rate of local gamma background. Local measuring stations (LMS) are located in urban areas: the town of Kozloduy, the village of Harlets, the village of Glozhene, the village of Butan, the town of Mizia, the village of Oryahovo, the village of Selanovtsi, the village of Tarnava, the village of Hayredin, the village of Mihaylovo, the town of Valchedrum, the village of Zlatiya and the village of Stanevo. The data is automatically transmitted via a GPRS channel to the server at Kozloduy NPP, which manages and archives information and provides access for visualisation and references at the NPP (Radiation Monitoring Department) and to the Environment Executive Agency (EEA) under the Ministry of Environment and Water (MoEW).

The results derived by the automated information system radiation monitoring (AISRM) of urban settlements within the 30-km surveillance zone around the Plant indicate a gamma background in the normal range of natural background radiation for the region. Pooled results for the settlements located nearest to Kozloduy NPP for 2011 are given in ***Table 7.2-1:*** *Data from the AISRM on the background gamma radiationwithin the 30-km zone for 2011*.

Table 7.2-1: Data from the AISRM on the background gamma radiationwithin the 30-km zone for 2011

Background gamma radiationin μSv/h

Period	Kozloduy Local Monitoring Station	Harlets Local Monitoring Station	Glozhene Local Monitoring Station	Butan Local Monitoring Station	Mizia Local Monitoring Station
I quarter 2011	0.098	0.099	0.076	0.104	0.081
II quarter 2011	0.098	0.097	0.075	0.103	0.078
III quarter 2011	0.097	0.097	0.074	0.103	0.075
IV quarter 2011	0.098	0.098	0.075	0.103	0.080
2011, min- max	0.07 ÷ 0.13	0.07 ÷ 0.14	0.05 ÷ 0.12	0.07 ÷ 0.13	0.05 ÷ 0.12

In conclusion, it can be said that the results from measurements of the radiation background in the control outposts and urban settlements within the 30-km area is within the natural radiation background range for this geographic area – 0.05 ÷ 0.15 μSv/h.

The Ministry of Environment and Water performs a supra-institutional radiological monitoring in the 30-km area around Kozloduy NPP. The radiological monitoring consists of continuous and periodic monitoring of the following indicators:

- Background gamma radiation;
- Atmospheric radioactivity;
- Content of technogenic radio nuclides in uncultivated topsoil;
- Radiological indicators in surface waters in the 30-km surveillance zone around Kozloduy NPP and treated water discharges from the Plant;
- Content of technogenic radio nuclides in bottom sediments.

7.2.1 Continuous measurement of the background gamma radiation

Background radiation data are obtained in real time from local monitoring stations of the National Automated Information System for continuous monitoring of background gamma radiation.

The system has integrated 8 automatic stations from the external dose measurement monitoring of Kozloduy NPP, located within a radius of 1.8 km from the Plant, thus ensuring continuous monitoring of the background radiation levels in the area.

The monitoring effected by stations within the 30-km zone: Hayredin, Valchedram, Oryahovo and stations within the 100-km zone of Vratsa, Montana and Knezha, shows that the average monthly values of the dose rate in 2009 ranged from 67 nGy/h (Oryahovo) to 99 nGy/h (Vratsa) and did not exceed the background levels typical for the stations.

The radiation situation in the area is stable and unchanged as regards impact from Kozloduy NPP.

7.2.2 Atmospheric radioactivity specification

The Ministry of Environment and Water measures twice a month aerosol samples (of volume> 900 m3) obtained by way of automatic sampling in Vratsa and Montana to analyse the specific radioactivity of long-lived radio nuclides (LLA).

The analysis of data from automatic stations **has not found** above-background rates of measured radionuclide values typical of the surface air in this geographical area, while the technogenic data for ^{137}Cs are within the minimal detectable activity (MDA). No presence of other anthropogenic radio nuclides has been indicated.

The Environment Executive Agency also receives monthly reports from Kozloduy NPP as an output of the ongoing in-house monitoring of gaseous releases into the environment.

The in-house aerosol monitoring undertaken by Kozloduy NPP includes a study of radioactivity in the ambient air twice a month in 11 outposts within the 100-km zone around the nuclear power plant and 3 control outposts on the industrial site. Radioactivity of the ambient air is controlled by a new generation of high-tech devices for continuous high-capacity aerosol sampling (80÷100 m3/h), with digital control and data storage. For comparability, results are translated to standard atmospheric conditions. Analysed aerosol filters for large volumes of the ambient air (10,000 ÷ 20,000 m^3) show results well below the established standards (BNRP Regulation of 2012). Technogenic radioactivity of ^{137}Cs in aerosols at control outposts within the 100-km area is at background values, below the minimum detectable activity (MDA) – an average of 2.8 μBq/m3. Registered radioactivity of ^{137}Cs in the ambient air is about 105 ÷ 106 times lower than the reference values (the annual average equilibrium equivalent concentrations for ^{137}Cs according to BNRP-2012 is 3.2 Bq/m3). Until April 2009 the total beta activity of aerosol samples had been surveyed too. For 2009 the average total beta activity in long-lived aerosols for the various posts was in the range of 0.50 ÷ 0.68 mBq/m^3. The results are consistent in a narrow range over the years.

Radioactivity of atmospheric deposition (sludge) is examined monthly at 33 control outposts within the 100-km zone around the Plant. In 2011 the total beta radioactivity of atmospheric deposition for all 33 stations ranged in the 0.058 ÷ 1.96 $Bq/(m^2.d)$ internval, the average being 0.43 $Bq/(m^2.d)$. The measured values by sector and at the benchmark posts within the 100-km zone are very low, in the range of 0.1 x 1.8 $mBq/(m^2.d)$ versus the average of 0.7 $mBq/(m^2.d)$ for all 33 outposts. The gamma spectrometric measurements show values for background levels of radioactivity of ^{137}Cs up to 0.024 $Bq/(m^2.d)$.

As a whole, the radioactivity of ambient air (aerosols and deposition) within the 30-km surveillance zone and the 100-km zones is at normal background levels.

7.2.3 RADIOLOGICAL MONITORING OF TOPSOIL

The Ministry of Environment and Water (MoEW) has been examining the surface, uncultivated topsoil layer (0 ÷ 5 cm) at quarterly intervals to determine the specific activity of natural and technogenic radio nuclides in the 26 control outposts of the surveillance zone of the nuclear plant. The measured specific activity of the technogenic radionuclide ^{137}Cs in the surface layer at these points ranged from 0.5 Bq/kg (Mizia) to 51.2 Bq/kg (at the village of Selanovtsi) and is believed to be the result of the global deposition after the Chernobyl accident. Throughout the year there has been no presence of other technogenic radio nuclides.

A comparative analysis with observations from previous years and outposts from other regions of the country found that no impact on the radiation status of topsoil has been reported resulting from the operations of the Kozloduy Nuclear Power Plant.

Radioactivity of the topsoil in the vicinity of Kozloduy NPP is subject to detailed and systematic studies since the Plant's commissioning in 1974. Under the In-House Radio-Ecological Monitoring Programme sampling is carried out within the 100-km zone and analysis is performed on topsoil taken from 36 control outposts. Sampling is done in the immediate vicinity of control outposts, possibly from non-arable/uncultivated land, from the 5-cm surface layer. It examines the contents of long-lived technogenic radio nuclides typical for WWER reactors – ^{90}Sr, ^{134}Cs, ^{137}Cs and others, of air-dry weight (a.d.w.).

For 2011 the results for ^{90}Sr are within the range of 0.22 ÷ 3.97 Bq/kg a.d.w., while the annual average content for all 36 control outposts was 1.33 Bq/kg a.d.w. The activity of ^{137}Cs in the studied topsoil ranged from 1.55 to 45.4 Bq/kg a.d.w., the average value for 2011 was 13.1 Bq/kg a.d.w. It is observed that in some of the stations, the ^{137}Cs content is significantly lower than the average. This occurs when the land is partially or fully cultivated. The registered technogenic activity in the environment within the 100-km zone is of trans-boundary origin due to the global depositions and is relatively low compared to other regions in the country. It is the result of the natural self-cleansing of the atmosphere following nuclear weapons tests and the nuclear accident at Chernobyl NPP.

7.2.4 RADIOLOGICAL MONITORING OF VEGETATION

Vegetation (grass) is examined four times a year in the outposts in the town of Kozloduy, and the villages of Harlets and Oryahovo (gamma spectrometry and ^{90}Sr), twice a year at the plant site (gamma spectrometry) and in the stations in Lom, Pleven and Berkovitsa (gamma spectrometry, ^{90}Sr once a year). Sampling is done very close to the places where topsoil samples are taken. Samples are analysed on air-dry weight (a.d.w.).

In 2011 the results obtained for the ^{90}Sr content in vegetation are within the range of 0.23 ÷ 1.15 Bq/kg a.d.w., with an average of 0.54 Bq/kg a.d.w. The activity of ^{137}Cs in vegetation in 2011 was within the range of 0.78 <MDA <2.55 Bq/kg a.d.w. Radioactivity in samples is within the normal range for these flora species.

7.2.5 RADIOLOGICAL MONITORING OF SURFACE WATER

The in-house radioecological monitoring examines the radioactivity of water along the Danube river and the inland rivers and ponds near the nuclear power plant – Ogosta river, Tsibritsa river and Kozloduy dam. As a recipient of the liquid releases from the nuclear power plant, particular attention is paid to the Danube river, along the course of which there are 4 control outposts – one upstream and 3 downstream from the nuclear plant.

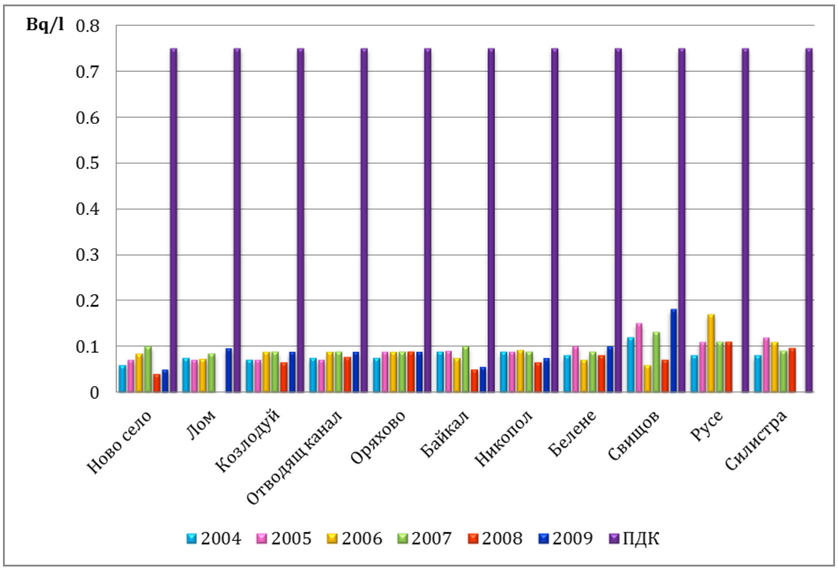
Weekly sampling of water is done from the three control outposts along the water intake of the Danube river, then pooled monthly samples are analysed. Samples from the locality of Batatovets along the Danube river are taken twice a year and from inland waters – once a year.

The results are within the normal limits typical of natural water reservoirs: total beta activity <0.012 ÷ 0.15 Bq/l, annual average – 0.056 Bq/l, activity of ^{90}Sr – 0.9 ÷ 3.9 mBq/l, annual average – 1.8 mBq/l, activity of ^{3}H – <4.0 ÷ 22.3 Bq/l, annual average – 7.2 Bq/l, activity of ^{137}Cs – <0.3 ÷ 1.1 mBq/l, annual average – 0.6 mBq/l. The total beta activity measured in the open water reservoirs is only 30% of the control level (0.5 Bq/l, Regulation № N-4/2012). For the Danube river the maximum measured value is 0.087 Bq/l.

The operations of Kozloduy NPP have had no perceptible impact on the radioecological status of the water of the Danube river and other water basins in the area. The results are within normal limits for natural water bodies, many times below the established norms.

The Ministry of Environment and Water monitors the radiological parameters of the water of the following rivers: Danube, Osam, Iskar, Leva, Ogosta, Timok, Tsibritsa flowing within the 100-km zone of the Plant.

Data analysis on the total beta activity of water from the Danube river (from Novo Selo to Silistra), compared with the results of the outlet channel of Kozloduy NPP in the period 2004-2009 (***Figure 7.2-2:*** *Total beta activity of the Danube River in the period 2004 – 2009, Bq/l*), showed values significantly below the limit specified in the regulations for the quality of surface water (0.750 Bq/l). This conclusion applies also to the other monitored rivers in the area.



Source: Environment Executive Agency

FIGURE 7.2-2: TOTAL BETA ACTIVITY OF THE DANUBE RIVER IN THE PERIOD 2004 – 2009, BQ/L

In addition, subject to monthly control are the treated water discharges from Units 5 and 6 – clean and radiologically controlled area, the treated water discharges from Units 1÷4, water from the intake and outlet cannels, water from the old "Valyata" cannel, the new "Valyata" cannel, and water from the Danube river, upstream and downstream from the Plant – at the ports of Kozloduy and Oryahovo, respectively.

The Environment Executive Agency receives monthly reports on the size and activities of treated water discharges as a result of the Plant's in-house ongoing radiological monitoring.

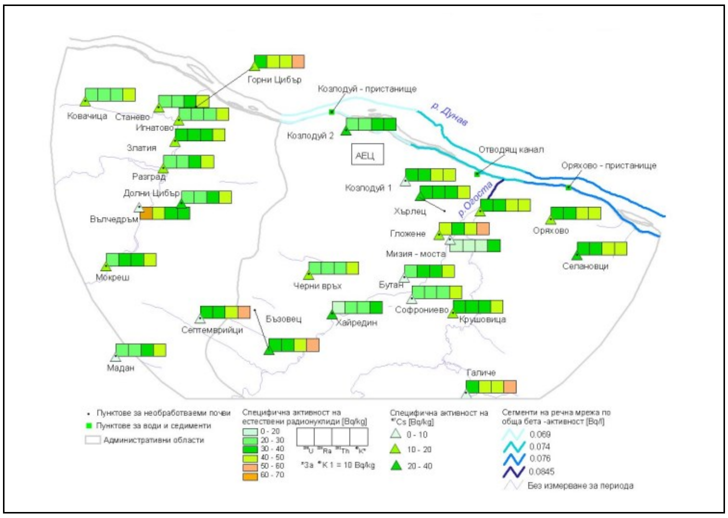
Analysis results are commensurate with data reported in previous years and show no change in the radiological characteristics of the Danube river on Bulgarian territory due to the activity of Kozloduy NPP.

7.2.6 RADIOLOGICAL MONITORING OF SEDIMENTS

Specific activities of natural and artificial radio nuclides in sediments are identified every three months at outposts located along the Danube river – from Novo Selo to Silistra, including the "outlet" channel of the NPP – at the locality of "Batatovets." The measured values of the specific activity of the technogenic ^{137}Cs in these samples throughout the year range from 0.46 Bq/kg (Baykal) to 12.3 Bq/kg (Oryahovo).

During the year there was no presence of other anthropogenic radio nuclides in sediments.

The radiological monitoring performed by the Ministry of Environment and Water (MoEW) in 2009 within the 30-km surveillance zone of Kozloduy NPP is indicative of the overall status of the radiation environment in the region (***Figure 7.2-3***: *Radiological status of the environment within the 30-km surveillance area of Kozloduy NPP for 2009*).



Source: Environment Executive Agency

FIGURE 7.2-3: RADIOLOGICAL STATUS OF THE ENVIRONMENT WITHIN THE 30-KM SURVEILLANCE AREA OF KOZLODUY NPP FOR 2009

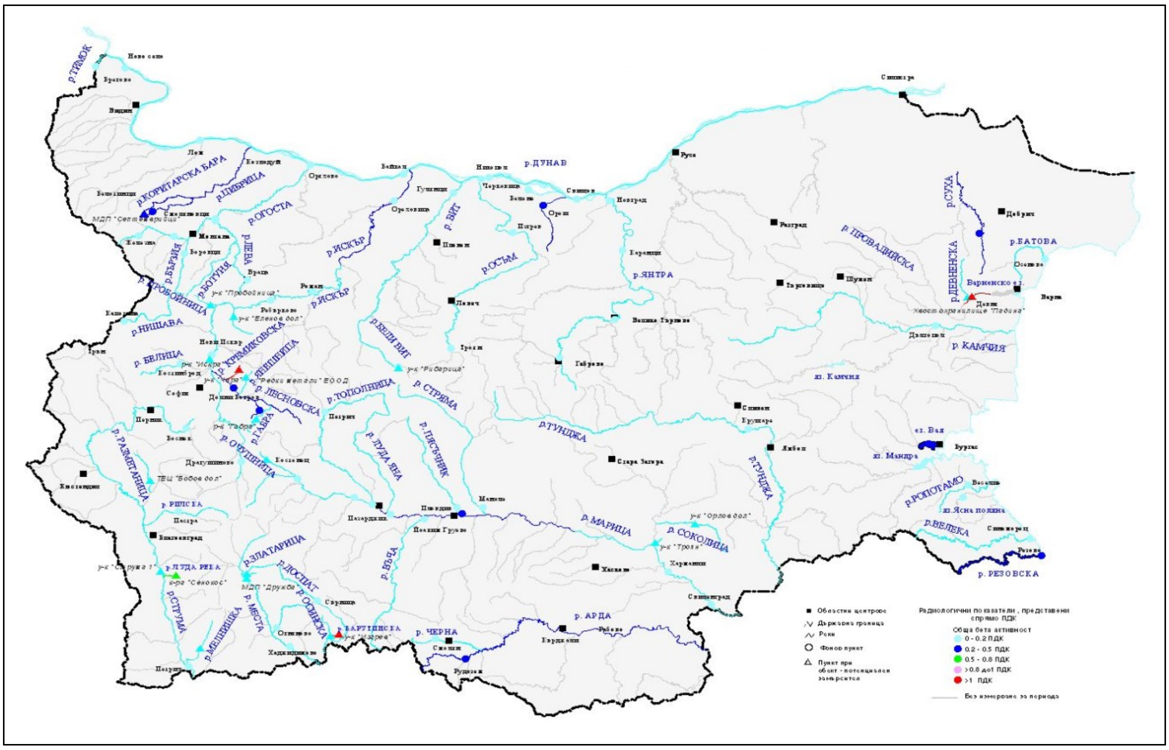
Data for 2009, compared with the radiological monitoring outcomes from previous years, showed no adverse trends in the radiation and environmental status resulting from the Plant's operations.

In 2010 systematic monitoring of the radiation situation was carried out in 84 outposts in the basins of major rivers and other water bodies in the country and in eight outposts along the Danube river.

Data analysis on total beta activity of water in the Danube river and other major rivers, dams and lakes found values significantly below the maximum permissible concentration (MAC) (Regulation № 7/1986 on the Indicators and Standards for Determining the Quality of Running Surface Water MAC-0.75 Bq/l).

The trend shows that radiological indicators, as compared against those in previous years, have preserved their values specific to the particular monitoring station in the country. This is indicative of the lack of contamination of this environmental component.

Data on radiological parameters of surface water, derived from the ongoing radiological monitoring carried out by the Environment Executive Agency in 2010, are presented in ***Figure 7.2-4***: *Total beta activity in surface waters in 2010, Bq/l.*



Source: Environment Executive Agency

FIGURE 7.2-4: TOTAL BETA ACTIVITY IN SURFACE WATERS IN 2010, BQ/L

Analysis results are commensurate with data reported for previous years and show no change in the radiological characteristics of the Danube river on Bulgarian territory due to the activity of Kozloduy NPP.

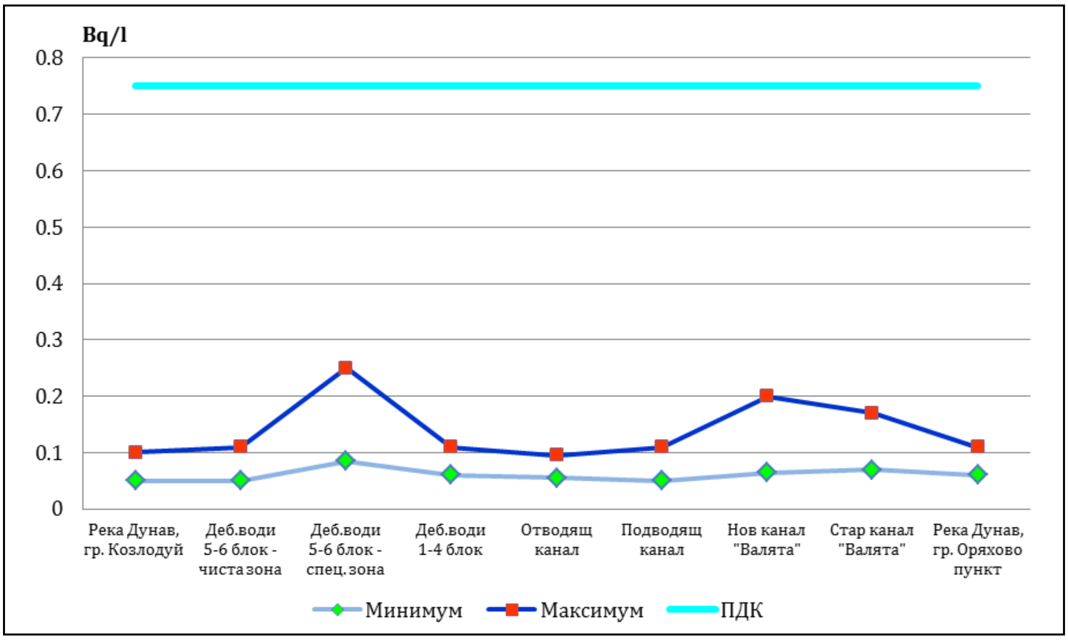
In 2010 no presence of other technogenic radio nuclides in sediments was observed.

7.2.7 GASEOUS RADIOACTIVE AEROSOL RELEASES

To assess the impact of gaseous releases some elements of the terrestrial ecosystem and the inland river ecosystem in the region of Kozloduy NPP are monitored. During the whole period of observation no noticeable qualitative changes in the radioecological status have been recorded as a result of gaseous radioactive releases from the Plant. Technogenic radioactivity of environmental objects is due to the presence of ^{90}Sr and ^{137}Cs in concentrations typical of the natural background, due to global atmospheric deposition and contamination of the environment as a result of the Chernobyl accident.

7.2.8 LIQUID RADIOACTIVE RELEASES

All the deviations from the normal radiation status observed have been negligible in absolute terms and an upward trend was not reported. In 2010 no presence of technogenic radio nuclides of reactor origin was registered – **Figure 7.2-5**: *Total beta activity of treated water discharges from Kozloduy NPP for 2010, Bq/l*.



Source: Environment Executive Agency

FIGURE 7.2-5*: TOTAL BETA ACTIVITY OF TREATED WATER DISCHARGES FROM KOZLODUY NPP FOR 2010, BQ/L*

7.2.9 RADIOLOGICAL MONITORING OF AGRICULTURAL PRODUCTION

The in-house monitoring at Kozloduy NPP covers surveying of major types of grain forage crops produced within the 3-km zone, including barley, wheat, corn, sunflower, etc. All samples are subject to separate analyses of grain and straw (heads, cobs). The analysis methodology is similar to that used in the analysis of vegetation. The total beta activity dominates in straw (heads, cobs) and varies within the normal range – 98.7 Bq/kg a.d.w. in maize grain to 1083.0 Bq/kg a.d.w. in sunflower heads. The higher values measured in silage (straw, heads, cobs) than in the grain core of the analysed products is explained with the distribution of radio nuclides in different parts of the crops.

The results of the gamma spectrometric measurements show that the registered total beta activity in samples is almost entirely due to natural ^{40}K – 550 Bq/kg a.d.w. on average. In 2011, as in previous years, excessive background activity of ^{137}Cs, or of other anthropogenic radio nuclides (for ^{137}Ss norms are 0.23 <MDA <1.75 Bq/kg a.d.w.), was not reported. The registered activity of ^{90}Sr is in the range 0.073 ÷ 1.54 Bq/kg a.d.w. The results for 2011 are consistent with data from previous years for the same types of crops.

7.2.10 RADIOLOGICAL MONITORING OF MILK, MEAT AND FISH

Milk as a typical food product is an indicator of a possible radioactivity uptake in the food chain. The in-house radio-ecological monitoring programme in 2011 surveyed the monthly radioactivity of cow's milk from three farms in the area of Kozloduy NPP –in the town of Kozloduy, the village of Harlets and the town of Mizia. Samples were analysed for total beta activity and gamma-spectrometrically for radionuclide content.

The total beta activity in the cow's milk samples varied within the range of 20 ÷ 55 Bq/l, with an average content of 37.8 Bq/l. With an average potassium content per litre of cow's milk at 1.3 g/l, the specific activity of ^{40}K is about 40 Bq/l. Results show that virtually all measured total beta activity is due to the natural isotope ^{40}K.

Gamma-spectrometric measurements of milk in 2011, like in previous years, indicated no activity of ^{137}Cs, with the results varying in the following range (0.048 <MDA <0.13 Bq/l). In 2011 the activity of radiostrontium varied in the range of 4.6 ÷ 18 mBq/l, the average level being 8.9 mBq/l.

Pork samples were analysed at the local pig-breeding farm in the town of Kozloduy over the 1993-1999 period. Afterwards, due to the farm's closure, analysis of this kind of sampling was suspended. Samples were gamma-spectrometry-identified per fresh weight (f.w.). Technogenic radioactivity ranged within MDA (^{137}Cs: 0.06 ÷ 1.04 Bq/kg f.w., average 0.42 Bq/kg f.w.).

Sampling was carried out on ichthyofauna in the region of the BPS (bank pumping station). Catches were taken at the access point of the intake cannel (before the NPP) and at the outlet of the outlet cannell (after the NPP) along the Danube river. The aim is to analyse the impact of liquid releases from Kozloduy NPP on fish in the area. Fish bones and meat are analysed separately, while in meat sub-samples gamma spectrometric radiocesium is defined and bone sub-samples are analysed for ^{90}Sr. The analysed samples of fish in 2011 showed radiocesium activity in meat respectively: ^{137}Cs in the range of 0.09 ÷ 0.29 Bq/kg fw with an average of 0.15 Bq/kg fw, and ^{134}Cs below

MDA (<0.07 ÷ <0.17 Bq/kg fw). The activity of ^{90}Sr in bones varied in the range of 0.42 ÷ 0.84 Bq/kg fw.

Therefore, radioactivity proved to be at low background levels in the food chain.

7.2.11 ADDITIONAL EXPOSURE DOSE OF THE POPULATION WITHIN THE 30-KM SURVEILLANCE ZONE AROUND KOZLODUY NPP

To estimate the additional public exposure dose caused by radioactive emissions from nuclear power plants in the environment, verified and validated model evaluation programmes are used on the basis of the EU-approved CREAM methodology adapted to the geographical and hydrological characteristics of the area of Kozloduy NPP.

For 2011 the overall assessment of the maximum individual effective dose of the population critical group, received from liquid releases and gaseous releases into the atmosphere, taking into account the contribution of ^{14}C and ^{3}H, was 7 μSv/a, which is negligible compared to the population norm per year (1,000 μSv) according to BNRP-2012. The collective dose to the population within the 30-km surveillance zone around Kozloduy NPP is 0.039 manSv. The statutory collective dose at 0.022 manSv/GW.a is comparable to the average indicators for PWR reactors worldwide. Over the past five years the value of the maximum individual effective dose to the population has ranged within the 4 ÷ 7 μSv/a interval, which is below the control margin of 10 μSv/a under BNRP-2012. Additional radiation exposure of the population in the 30-km surveillance area is on average 500 times lower than that received from natural background radiation (2400 μSv).

In the Environmental Impact Assessment Report (EIAR) the developed and functioning monitoring system in all its aspects will be analysed in detail and evaluated with regard to the investment project, the specific requirements for nuclear facilities and the need for its development and improvement.

7.2.12 NOISE

In the operations phase noise monitoring will be carried out in compliance with the requirements in the Methodology for determining the total sound power emitted into the environment by the industrial enterprise and for determining the noise level at the site of impact, issued by the Ministry of Environment and Water (MoEW) in 2012.

8 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 Conditions and Procedures for the Performance of 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 Conditions and Procedures for the Performance of EIA (RCPPEIA).

Art. 24 of RCPPEIA identifies the Minister of Environment and Water, as competent authority for the EIA in a Transboundary Context.

Art. 25 of RTPEIA describes the steps of the EIA in a transboundary context, when Bulgaria is a country of origin, as is the present case.

In addition, the competent authority – the Minister of Environment and Water, should consider whether the investment proposal might have expected significant impact on the environment in another country/countries. In this case, the investment proposal falls within Annex I, paragraph 2 of the Espoo Convention and is in the category of investment proposals, where national law requires mandatory EIA – paragraph 2.2 of Annex 1 to Art. 92, item 1 of the EPA. At the time of development of these Terms of Reference, the competent authority has appointed the Republic of Romania, being the affected party, and accounting for the fact that the location of the investment proposal is on the Danube River, which is the border in the Republic of Bulgaria with the Republic of Romania. Deciding to notify other parties is entirely the prerogative of the Minister of Environment and Water – Art. 3 of the Espoo Convention.

In order to provide the relevant information to the competent authority for the expected transboundary impact of the investment proposal on the environment, this chapter presents data and information on the operation of the facilities of the Kozloduy NPP.

8.1 Preliminary Assessment of the Potential Transboundary Impact

As described in Chapter 1 of the Terms of Reference: Description of the investment proposal, 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 WWER-440, and units 5 and 6 – WWER-1000. The main features of the six units are presented in ***Table 8.1-1.***

TABLE 8.1-1: *MAIN FEATURES OF THE SIX UNITS*

Unit		Reactor type – output in MW	Year of inclusion to the energy system	Fuel campaigns	Decommission of units
Unit 1		WWER -440	1974	23	31.12.2002
Unit 2		WWER -440	1975	24	31.12.2002
Unit 3		WWER -440	1980	22	31.12.2006
Unit 4		WWER -440	1982	21	31.12.2006
Unit 5	Life service 2017*	WWER -1000	1987	18	not applicable
Unit 6	Lifespan 2021*	WWER -1000	1991	17	not applicable

** in the event that the program to extend the life service of these units is not realized.*

During the operational years of the Kozloduy NPP, as outlined in Chapter 9 of the Terms of Reference – Monitoring, 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 Monitored Zone to radioactive gaseous, aerosol and liquid emissions from the Kozloduy NPP[139] is also subject to ongoing assessment.

The results from the measurements on the radiation for the period 1998-2002, when units 1÷6 are operational as well as all other nuclear facilities at the site (SFS and SERAW facilities), according to the main control components, are shown in ***Table 8.1-2:*** *Data from the radiation monitoring for the period 1998 – 2002 and* 2011 and 2012. In order to provide information for comparison the results for 2011 are also shown. Units 1÷4 are decommissioned. In order to make a sufficiently reliable analysis of the actual impact, the table includes the normative limitation and the results of the pre-commissioning measurements in the region of the Kozloduy NPP during the period 1972-1974. The NCRRP (previously SIRRH) has prepared a summary of these results from the published expert report by the BTUC in 1993 [140].

[139] Results from the radiation environmental control for the period 1998-2002, 2011 and 2012 – ERC-008/009/010/011/012.

[140] Marinov B. et all, - Impact of the Kozloduy NPP on the environment and the working environment and the health of the population and the employees. Expert report by the BTUC, city of Sofia, 1993, Vasilev G., Bliznakov V., Impact of the Kozloduy NPP on the radiology, exposure and health of the population and the employees, BalBok, city of Sofia, 1994.

Table 8.1-2: Data from the radiation monitoring for the period 1998 – 2002 and 2011 and 2012 [141]

Component	Norm as per standard	Reference values 1972-1974	1998-2002 min-max	2011 min-max	2012 min-max
Radiation gamma background in the 100 km zone, µSv/h	0.3(1)	0.06 – 0.17 *(natural radiation background)*	0.05 – 0.26	0.05 – 0.15	0.05 – 0.14
Air - ^{137}Cs, [mBq/m³]	3200(2)	-	0.0003 – 0.031	<0.0008 – 0.010	0.0008 – 0.011
Natural water					
-total beta-activity, [Bq/l]	0.5(3)	0.25 ± 0.070	0.026 – 0.44	0.012-0.15	<0.018 – 0.084
- tritium, [Bq/l]	-	-	<6.9 – 62.3	<4.0 – 22.3	<3.3 -33.0
- ^{90}Sr , [Bq/l]	-	0.012 ± 0.002	0.0016 – 0.015	0.0009 – 0.0039	0.0009 – 0.0084
- ^{137}Cs, [Bq/l]	-	0.0040 ± 0.0012	<0.0004 – <0.013	<0.0003 – 0.0011	0.0002 – 0.0009
Drinking water					
-total beta-activity, [Bq/l]	1(4)		0.034 – 0.69	0.024 – 0.088	0.031 – 0.075
- tritium, [Bq/l]	100(4)	-	<6.9 – <11.4	<3.9-8.3	<3.9 – <6.4
-^{137}Cs, [Bq/l]	11(5)		0.0007- 0.0027	<0.0004 – <0.0011	<0.0004 – <0.0008
-^{90}Sr, [Bq/l]	1.9(5)		<0.0006 – 0.014	<0.0008 – 0.0023	<0.0008 – 0.0026
Soil					
-^{90}Sr, [Bq/kg a.d.w.]	-	5.0 ± 0.4	0.91 – 5.81 (*)	0.22 – 3.97 (*)	0.33 – 3.84 (*)
-^{137}Cs, [Bq/kg a.d.w.]	-	7.6 ± 0.6	< 0.42 – 103*	1.55 – 45.4*	0.42 – 48.1*
Milk					
-^{134}Cs +^{137}Cs, [Bq/l]	370(6)	0.13 ± 0.011	<0.052 – 0.17	<0.048 – <0.13	<0.049 – <0.13
-^{90}Sr, [Bq/l]	-	0.11 ± 0.015	0.003 – 0.055	0.0046 – 0.018	0.0055 – 0.018

[141] Annual reports for radiation monitoring for the Kozloduy NPP

Component	Norm as per standard	Reference values 1972-1974	1998-2002 min-max	2011 min-max	2012 min-max
Agricultural products crops and fodder -^{90}Sr, [Bq/kg a.d.w.] -^{134}Cs +^{137}Cs, [Bq/kg a.d.w.]	- 600(6)	0.15 ± 0.01 0.25 ± 0.02	<0.030 – 2.16 < 0.50 – <4.03	0.073 – 1.54 <0.23 – <1.75	0.089 – 1.72 <0.31 – <4.82
Emission dose impact **Liquid and gaseous**, IED [Sv] (% from the limit $1x10^{-3}$ Sv)	$1x10^{-3}$	-	3.17 – $4.29x10^{-6}$ (0.32 – 0.43%)	$6.98x10^{-6}$ (**) (0.7%)	$5.82x10^{-6}$ (**)

(1) Regulation No. 1 of 15.11.1999 on the norms and objectives of the radiation protection and safety for the liquidation of the uranium industry consequences in the Republic of Bulgaria, SG, issue No. 101/23.11.1999.

(2) AAVAA for air, Regulation for BNRP, SG, issue No. 76/05.10.2012.

(3) Regulation No. H-4 of 14.09.2012 for description of the surface water, SG, issue No. 22/05.03.2013.

(4) Regulation No. 9 of 16.03.2001 for the water quality, intended for drinking-household purposes, SG, issue No. 30/28.03.2001.

(5) AAVAA for drinking water, Regulation for BNRP, SG, issue No.. 76/05.10.2012.

(6) Regulation No. 10 of 18.04.2002 for the maximum admissible radioactive pollution for import of agricultural production after the Chernobyl nuclear power plant accident, SG, issue No. 44/29.04.2002. (Values are in Bq/kg)

* the pollution from tests with nuclear arms and the Chernobyl NPP accident is also reported for these values.

** the higher value for the maximum individual effective doses (IED) is due to the reporting the contribution of ^{14}C and ^{3}H in the gas-aerosol emissions and the greater conservatism of the assessments, received with the newly introduced software “Shield – normal operation”, using the adopted contemporary CREAM methodology in the European union.

Data from the two periods – with six units in operation (1998-2002) and with two units in operation (2011 and 2012) – has been analyzed 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 4 ÷ 7 μSv/a, which is no more than 0.7 % 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.
- ✓ Radiobiological effects and radiation risk data[142].

a. Deterministic effects

There is no risk of development of deterministic effects for the population in the monitored area (100 km) of the Kozloduy NPP.

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[142] Results from the radiation environmental control for 2011 - 12.РМ.ДОК.111, 2012 – 13.РМ.ДОК.112

The maximum individual dose for a person from a critical group of the population is 6.98×10^{-6} Sv. Individual doses of gas-aerosol emissions are in the range of 1.22×10^{-8} – 2.72×10^{-6} Sv. (These doses are much lower than the threshold set under Art. 10 of the BNRP for the limit for annual effective dose, which is 1 mSv per capita).

On this basis, we claim that there is no risk of deterministic effects on the population in the monitoring zone of the NPP.

b. Stochastic effects

The risk of stochastic effects is negligible.

The possibility of radiation-induced cancer in the whole population is 2.65×10^{-8} and the possibility of hereditary diseases is 9.64×10^{-10}.

In support of these findings, for the purposes of assessing the impact of the operation of the Kozloduy NPP on the population near the plant, an independent expert assessment of the content of the technogenic radionuclides in the bodies of 150 children living near the plant was carried out. The study was conducted in 2003 by the Laboratory for Radiation measurements, internal dosimetry and expertise with the NCRRP. The results clearly show that there is no indication of the presence of technogenic radionuclides in the body of the tested individuals, and ^{131}I in the thyroid gland. [143]

The following conclusions and summaries can be drawn from the results of the **internal non-radiation monitoring** conducted at the Kozloduy NPP during the period 2007 – 2012 г.[144]

- ✓ Water supply and the use of water bodies for the discharge of waste water is done in compliance with the annual limits defined in the respective permits;
- ✓ Extracted ground waters comply with the quality standard envisaged in Annex No. 1 of Regulation No. 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 canal 1 and hot canal 2, and the quantity of the discharged waste water was smaller than the permitted quantity;
- ✓ With regard to surface waters, at the Kozloduy NPP site only isolated and occasional cases were observed of exceeded norms for some indicators beyond

[143] Independent expert assessment of the content of the technogenic radionuclides in the bodies of 150 children living near the Kozloduy NPP, NCRRP, 2003.

[144] Annual reports on the results from the own non-radiation monitoring on the environment around the Kozloduy NPP - 2007, 2008, 2009, 2010 and 2012.

the quality standard values, regulated by the Regulation on the study, use and protection of ground waters;

- ✓ All registered values of discharged water through the trapezoidal canal (TC), CDC and Ø1000 are under the individual emission limits set for these flows in the permit for discharge of waste waters, with the exception of the results for the indicator for borium;
- ✓ Taking into account the results of the analysis, it can be summarized that only in the waste water discharged into the main discharge canal (MDC) there are registered small values for the indicator for Borium, but they are within the values reported in the drinking water of the own of Kozloduy;
- ✓ With regard to surface waters, 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 Non-Radiation Household and Industrial Waste Depot (NRHIWD) was used predominantly for household and unusable industrial waste;
- ✓ As a result of the predominant quantity of household waste and the higher compaction factor than the design basis capacity, the NRHIWD 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 NRHIWD;
- ✓ 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 NRHIWD and are observed mostly in the hot summer months when there is strong sunlight.

The analysis on the operational experience of the Kozloduy NPP EAD shows that the power plant has accumulated a high administrative capacity, including such related to appropriate response to accidents and incidents.

Kozloduy NPP EAD has prepared documents which regulate the procedure and responsibilities for reporting, analysis of operational events, assigning and control of the implementation of corrective measures in accordance with the rights, duties and responsibilities of Kozloduy NPP EAD arising pursuant to the Safe use of Nuclear Energy Act (SUNEA), the NRA Regulation on the procedures for notifying the NRA for events at nuclear facilities and sites with sources of ionizing radiation (the Regulation) and in its capacity as a "nuclear operator" and "holder of licenses for the operation of nuclear facilities."

Below are the principles serving as the basis for the setting of final objectives related to reporting and analyzing 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 to compromise;
- ✓ constantly improving the level, quality and culture of safety by introducing, analyzing 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 the ratification of international conventions and treaties by the Republic of Bulgaria.

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[145] scale 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.

Expected impact of the co-operation of the existing nuclear capacities and the ones planned to be commissioned at the Kozloduy NPP site and nearby[146].

Currently the following nuclear capacities are operational at the Kozloduy NPP site:

1. Industrial operation of units 5 and 6 with reactors "WWEP-1000" and total installed electrical capacity of 2000 MWe;

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[145] 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.

[146] Requirement of MoEW, as per letter with outgoing Ref. No. OBOC-220/09.01.2013.

2. A depot for the storage of SNF under water (a Wet Spent Fuel Storage Facility) (WSFSP);
3. RAW management facilities, operated by the SE RAW Kozloduy;
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 basis 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[147]. 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.

[147] 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 depot 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.

Conclusion

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.

8.2 REQUIREMENTS FOR 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 Monitored Zone (within a 30 km radius around theKozloduy NPP site), encompassing a total of 18 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.

The environmental impact assessment in the transboundary context will follow the requirements of the Bulgarian, European and the international legislation regarding EIA in transboundary context and will be structured in such a way as to be in compliance with the main and specific requirements of the Republic of Romania, specified in letter with Outg. Ref. No. 3672/RP/18.10.2012. In this regard the EIA report will include:

8.2.1 MAIN REQUIREMENTS

No.	REQUIREMENTS	COMMENTS
1.	**The Environmental Impact Assessment Report (EIAR) shall include:**	
1.1.	Information on the characteristics of the sites that may have implications for	The main characteristics of the sites are described in detail in Chapter 1: Characteristics of the investment proposal, Section 1.6.: Description of the physical characteristics of the

No.	REQUIREMENTS	COMMENTS
	nuclear safety.	investment proposal and the areas needed as per this Terms of Reference (ToR). It presents four alternative locations and the existing infrastructure built on them. Additional information is provided in Chapter 2 of the Terms of Reference (ToR): Alternatives for the investment proposal 2.1.: Alternatives by location and 2.2.: Alternatives for supporting infrastructure during construction works and operations. Chapter 6 of the Terms of Reference (ToR): Description of the risks to environment in case of potential accidents and incidents, presents the selected approach for assessing the risk of accidents (internal impacts), accidents caused by human error, impacts caused by natural hazards, external impacts of human origin. The Environmental Impact Assessment Report (EIAR) will present in detail the characteristics of the site, which may be relevant to nuclear safety, as established in the applicable Bulgarian and European legislation (Annex 1). Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts, presents that part of the information which is relevant for the territory of the Republic of Romania, including the assessment of the environmental impact on the area.
1.2.	Information on accident analysis, including severe accidents (especially the probability and radiological consequences on Romanian territory). The source term in air and in the Danube River are required to be known, as well as the appropriate dose for each scenario.	Chapter 6 of the Terms of Reference (ToR): Description of the risks to environment in case of potential accidents and incidents, presents the selected approach for assessing the risk of accidents (internal impacts), accidents caused by human error, impacts caused by natural hazards, external impacts of human origin. Section 6 of the Environmental Impact Assessment Report (EIAR): Description of the risks for the environment for potential accidents and incidents, will provide information for the analysis of accidents, including major accidents. In Section 3.11 of the Terms of Reference (ToR): Radiation risk for the population for release during normal operation, there is a narrative of the current situation, and an outlook for the impact as well as models and software to evaluate the effects of radiobiological effects and radiation risk per reference individual and for the assessment of doses to the population of liquid and gaseous radioactive emissions into the environment. Section 4.11 of the Environmental Impact Assessment Report (EIAR): Radiation risk for the population in radioactive releases, will present the acceptable dose for every possible emergency scenario, in the air and water of the Danube river, under the applicable Bulgarian and European legislation (Annex 1). Chapter 11 of the Environmental Impact Assessment Report

No.	REQUIREMENTS	COMMENTS
		(EIAR): Transboundary impacts, will present that part of the information from the Environmental Impact Assessment (EIA), which refers to the territory of the Republic of Romania, including information on analysis of accidents, including major accidents (especially the probability of radiological consequences on Romanian territory) and the acceptable dose for every possible emergency scenario, in the air and water of the Danube river.
1.3.	Information regarding emissions in air and in the Danube during normal operation of the new unit	Section 1.8.2. of the Terms of Reference (ToR): Emissions – non-radioactive and radioactive, contains information about the type and amount of estimated emissions from the new nuclear unit during normal operation. Section 3.1 of the Terms of Reference (ToR): Climate and ambient air, and Section 3.2. of the Terms of Reference (ToR): Surface and groundwater, present the current situation and an outlook of the expected impact in the implementation and operation of the new nuclear unit. Section 3.9. of the Terms of Reference (ToR) presents the current situation and an outlook of the thermal impact on the Danube river from the implementation and operation of the new nuclear unit. Sections 3.1 and 3.2. will present the current situation in terms of emissions to air and water. Sections 4.1. and 4.2. of the Environmental Impact Assessment Report (EIAR) will present a narrative, analysis and evaluation of the likely significant effects on air and water in radiation and non-radiation aspect on Bulgarian territory as a result of the investment project and harmful emissions during normal operation and in emergency situations. Section 4.9.4 of the Environmental Impact Assessment (EIA) will reflect on the expected heat impact on the Danube river during the implementation, operation and decommissioning of the new nuclear unit. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts, will present that part of the information from the Environmental Impact Assessment (EIA), which refers to the territory of the Republic of Romania, including information on analysis of accidents, including information on emissions to air and water of the Danube River during normal operation of the new power facility.
2.	**On both banks of the Danube sector comprised around Kozloduy, there are Natura 2000 sites. On the Romanian bank there are the following Natura 2000 sites protected under the Habitats Directive and the Birds Directive**	
	ROSPA0010 Bistret river ROSPA0023 Jiu river-Danube River Confluences ROSCI0045 Corridor of Jiu River; ROSPA00135 Sands from Dabuleni	In terms of assessing the impact of the new nuclear unit on NATURA 2000 sites located within the territory of the Republic of Romania in the area of impact of the investment project (30 km zone) the potential impacts will be analysed in the following areas protected respectively by the Habitats Directive and the Birds Directive: ✓ ROSPA0010 Bistret river; ✓ ROSPA0023 Jiu river-Danube River Confluences;

No.	REQUIREMENTS	COMMENTS
		✓ ROSCI0045 Corridor of Jiu River; ✓ ROSPA00135 Sands from Dabuleni. The analysis will be based on studies carried out in accordance with the Regulation on the conditions and procedures for appropriate assessment of plans, programs, projects and investment projects with the subject and objectives of the protected areas conservation (adopted by Decree of the Council of Ministers No. 201 of 31.08.2007, promulgated in State Gazette, issue No. 73 of 11 September 2007). In a separate report (Annex 15.2. to the Environmental Impact Assessment (EIA)) there will be an evaluation of the potential adverse effects resulting from the investment project implementation on biodiversity and protected areas within the 30 km zone in the Republic of Romania and the Republic of Bulgaria, by type, probability, duration, territorial scope, frequency, cumulative effect.
3	**The Environmental Impact Assessment Report (EIAR) will include the following issues:**	
3.1.	Impact on biodiversity on both sides of the Danube river within the assessment of the environmental impact (30 km zone) outside protected areas of NATURA 2000.	Section 3.6. of the Terms of Reference (ToR): Biodiversity, provides information on the current situation in terms of flora and wildlife within the supervised zone (30 km) on Bulgarian territory. Section 3.6. of the Environmental Impact Assessment Report (EIAR) will present information regarding the current situation of biodiversity in the 30 km zone on the Bulgarian side, outside the Natura 2000 network. Section 4.6. of the Environmental Impact Assessment Report (EIAR) will present an analysis of the impact on biodiversity of the implementation, operation and decommissioning of the new nuclear unit. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts, will present the current situation in terms of biodiversity in the 30 km zone of the Romanian side, outside the Natura 2000 network. In addition to an analysis of the impact on biodiversity of Romanian territory of the implementation, operation and decommissioning of the new nuclear unit.
3.2.	The cumulative impact of other projects implemented at Kozloduy NPP and its surroundings, which can have harmful effects on the natural capital of both countries.	Chapter 5 of the of Reference (ToR): Cumulative effect, presents the approach of evaluation of the cumulative effects of all components and environmental factors, including biodiversity. Chapter 5 of the Environmental Impact Assessment Report (EIAR): Cumulative effect, will analyse and assess the possible cumulative effect of the implementation, operation and decommissioning of the new nuclear unit and other current and future facilities of Kozloduy NPP and elsewhere in the context of potential impacts, including on biodiversity. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impact, will make an assessment of the potential cumulative effect for the territory of Romania in the 30 km zone, including on biodiversity.
3.3.	Measures to mitigate the impact on biodiversity and impact	Based on the analysis, prediction and evaluation of impacts of the biodiversity issue within the 30 km zone of the

No.	REQUIREMENTS	COMMENTS
	assessment after their application	Environmental Impact Assessment Report (EIAR), Chapter 8: Description of the measures, envisages to prevent, reduce and wherever possible to offset any significant adverse effects in radiation and non-radiation environmental aspect, and the plan for the implementation of these measures will propose specific measures (technical, procedural and administrative measures) to reduce and/or prevent potential impacts both during construction works and during operations of the new nuclear unit. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts will present all the proposed measures, which relate to the territory of the Republic of Romania, including biodiversity.
4.	The names of geographical localities on maps should be written in the Latin alphabet and the maps must contain Romanian localities included in the assessment.	Chapter 11 of the Environmental Impact Assessment (EIA): Transboundary impacts will be developed and presented as a separate item in accordance with instructions given by letter of outgoing reference No. OBOC-220/09.01.2013 of the Ministry of Environment and Water. This chapter will be accompanied by maps and graphic material, providing in Latin alphabet the names of geographical objects and Romanian localities included in the assessment.
5.	Taking into account that in the influence area (30 km around Kozloduy NPP on Romanian territory) there is a resident population of 77 197 inhabitants in 18 settlements in the counties of Dolj and Olt, the environmental impact study must contain an assessment of the radiological impact on human health.	Chapter 1 Terms of Reference (ToR): Characteristics of the investment project, describes the existing nuclear facilities, and general plant facilities of Kozloduy NPP, while presenting the main characteristics of the production process of the new nuclear unit – technology, type and quantity of materials used, expected waste, emissions and harmful radiation. Chapter 3 Terms of Reference (ToR): Characteristics of the environment in which the investment project is implemented and outlook of the impact of key data and information on the expected impact factors and components. Sections 3.10. and 3.11. discuss the health and hygiene aspects and radiation risk for the population in case of radioactive releases during normal operation of the new nuclear unit. In addition, Chapters 5 and 6 of the Terms of Reference (ToR) also consider issues related to the assessment of human health risk in terms of cumulative effects, the risk of accidents and incidents. Given the complexity of the approach for assessing the risk to human health in an Environmental Impact Assessment (EIA), the same pattern of presentation of information will be followed, respectively, Chapter 1 of the Environmental Impact Assessment (EIA) will publish an abstract of the investment project for construction, activities and technologies, while Chapter 3 of the Environmental Impact Assessment (EIA) will provide a description and analysis of components and environmental factors, including as regards the health and hygiene aspects of the risk to the environment and human health (sections 3.10 and 3.11). In addition, chapters 5 and 6 of the Environmental Impact Assessment (EIA) will also consider issues related to the assessment of risk to human health in terms of cumulative effects, the risk of accidents and incidents.
6.	The assessment of impacts on human health must evaluate the excess risk generated by normal operation of the new nuclear unit, as well as in cases of accidents, based on the recommendations of the International Commission on Radiological Protection (ICRP 103/2007), for diseases associated with exposure to ionizing radiation (incidence and mortality rates from malignant disease, birth defects, developmental defects). These estimates should cover both the situation in normal operation of the plant and in the event of nuclear accident.	
7.	Taking into account the levels of contamination of the elements of the environment (air emissions, emissions in ground and surface water), it is necessary to study	

No.	REQUIREMENTS	COMMENTS
	the synergistic effect of their impact on the local population, both during the construction of the new power unit and during its operation.	Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts, will present all the information relating to the territory of the Republic of Romania in the Danube river within the 30 km zone of the assessment, including: ✓ Assessment of the radiological impact on human health; ✓ Assessment of impacts on human health in the event of accidents, based on the recommendations of the International Commission on Radiological Protection from diseases associated with exposure to ionizing radiation; ✓ Assessment of the health impact of the combined adverse effects during the construction works and operations of the facility; ✓ Estimates of the cumulative increase in risk to human health from the operation of all systems of the nuclear power plant; ✓ The evaluation will include the situation in the normal operation of the reactor and in case of emergencies. Given the levels of contamination in environmental media (air emissions, groundwater, surface water) as part of the scope of the Environmental Impact Assessment (EIA) in a Transboundary Context, it will assess the impact on the health of the local population, as well as synergistic effects, both during the construction of the new nuclear unit, and during its operation and decommissioning. The study of the health impact of Kozloduy NPP on the Romanian population will take into account the existence of the same site of the old units 1 ÷ 4 of Kozloduy NPP, which are currently in the process of decommissioning, and the radioactive waste to be generated in the future. Thus, the Environmental Impact Assessment (EIA) study will provide a cumulative effect on the Romanian population living in the zone of impact – the surveillance zone of 30 km.
8.	The study of the health impact of the Romanian population in the NPP Kozloduy area should take into account the existence at the same site of the old units 1-4 of Kozloduy NPP, currently in the process of decommissioning expected to generate nuclear waste in the future. This means that it is necessary to examine the cumulative effect on the Romanian population living in UPAZ.	
9.	It is necessary to calculate the cumulative excess risk to human health from the operation of these systems.	

8.2.2 SPECIFIC TECHNICAL REQUIREMENTS

No.	REQUIREMENTS	COMMENTS
1.	Presentation of the technological characteristics of the new nuclear unit which will be implemented at Kozloduy NPP, comparing them with the latest requirements for post-Fukushima nuclear safety, and the essential differences from the current technology, that give the project title "Nuclear Reactor of the Next Generation."	Chapter 1 Terms of Reference (ToR): Characteristics of the project, describes the existing nuclear and common nuclear facilities at the Kozloduy NPP site, presents the main characteristics of the production process of the new nuclear unit (NNU) – technology, type and quantity of raw materials used, expected waste, emissions and harmful radiation. Chapter 6 of the Terms of Reference (ToR): Description of the risks for the environment for potential accidents and incidents, presents the selected approach for assessing the risk of accidents (internal impacts), accidents caused by human error,
2.	Presentation of the design and	

No.	REQUIREMENTS	COMMENTS
	nuclear safety, which form and define the structural framework of the new nuclear unit integrated into a multiunit site (for example, safety concepts and principles, essential safety functions, regulatory requirements, integrated management)	impacts caused by natural disasters, external influences of human origin.
3.	Presentation of protective and support systems, including administrative measures designed to ensure the safety and security of nuclear units, including the justification of the specific requirements for nuclear safety.	In the relevant chapters of the Environmental Impact Assessment Report (EIAR) /see Chapter 9 of the Terms of Reference (ToR): Structure of the Environmental Impact Assessment Report (EIAR)/ the effects of the implementation, operation and decommissioning of the new nuclear unit will be analysed and evaluated, including in terms of nuclear safety: ✓ Systems embodied in the concept of defence in-depth in all operational modes; ✓ Basic safety functions – control of reactivity, heat removal from the reactor core, holding radioactive substances within the prescribed limits under all operating conditions and emergency conditions; ✓ Technical means to exclude human errors and/or limit their consequences; ✓ Degree of resistance to internal and external factors, including earthquakes, aircraft crashes, floods, etc.; ✓ Safety and control functions regarding the status of the power plant in the event of fire; ✓ Passive safety systems; ✓ Technical tools and solutions to manage the design basis accidents and minimize their effects; ✓ Additional solution to the corium capture concept; ✓ Burnable absorber to extend the nuclear fuel lifetime. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts will present a summary of the basic descriptions and analyses presented above, including: ✓ The technological characteristics of the new nuclear unit which will be implemented in Kozloduy NPP, comparing them with the latest requirements for nuclear safety after the Fukushima accident, and the essential differences with the current technology, resulting in a project entitled "NUCLEAR REACTOR OF NEXT GENERATION"; ✓ Design and nuclear safety, which form the structural framework and define a new nuclear unit (NNU) to be implemented at the site with several existing facilities (for example, concept and principles of safety, key safety features, regulatory requirements, Integrated Management); ✓ Protective and auxiliary systems, including administrative measures designed to ensure the safety and security of nuclear units, including the justification of specific nuclear safety requirements.
4.	Presentation of technical	In accordance with NS-G-2.2 "Operational Limits and Conditions

No.	REQUIREMENTS	COMMENTS
	specifications (known as Limiting Conditions for Operation – LCOs), highlighting their importance as supporting licensing documentation and during the nuclear unit operating modes.	and Operating Procedures for Nuclear Power Plants", OLCs are developed based on the results of safety analyses, whereas it is recommended that the initial development is jointly operated by the designer and the operator. For the purposes of the Environmental Impact Assessment Report (EIAR) thresholds of EUR will be used and the Bulgarian legislation and regulations, which shall be limiting to the new nuclear unit. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts, will present the above-described information.
5.	A brief but comprehensive presentation of the relationship between the essential requirements of European agreements or other international recommendations (for example, IAEA, US-NRC), ratified by Bulgaria, concerning nuclear safety, safe management of radioactive waste and spent nuclear fuel, environmental assessment in a transboundary context information, public participation in decisions, etc., and their coverage in the applicable Bulgarian laws, rules and standards.	In terms of the Environmental Impact Assessment (EIA) in a Transboundary Context it will be noted that the investment project for the construction of a new nuclear unit at Kozloduy NPP is entirely consistent with the requirements for nuclear safety to the observance of which Bulgaria is committed as an active participant in international cooperation in developing nuclear energy for peaceful purposes. Bulgaria is among the founders of the IAEA and its full-fledged member since 1957. In this regard, the country has participated in many international and regional initiatives and projects of the IAEA and the EU: ✓ INPRO – International Project on Innovative Nuclear Reactors and nuclear fuel cycle initiated by the IAEA. INPRO activities cover the following areas: methodology for evaluation of nuclear energy systems, sustainable nuclear energy, innovative nuclear technology, innovations in institution building. The results of INPRO activities are being used by all member states of the IAEA, including Bulgaria; ✓ WENRA – Participation in the development of benchmarks for safe management of radioactive waste (RAW) and Spent Nuclear Fuel; ✓ ERDO (European Organisation for the development of repositories for disposal of radioactive waste) This Working Group aims to reach a consensus on a uniform model of repository for radioactive waste (RAW), based on the current project SAPIERR for the development of European regional storage locations; ✓ EU nuclear Decommissioning Assistance Program (NDAPC) and the Kozloduy International Decommissioning Support Fund (KIDSF); ✓ IFNEC (International Framework for Nuclear Energy Cooperation). The main tasks are IFNEC development and use of modern technologies in the nuclear fuel cycle in order to significantly reduce nuclear waste, simplify storage and disposal and to reduce the amount of spent nuclear fuel from civilian applications in a safe and secure manner, protected from illegal proliferation of nuclear materials. Safe management of spent fuel and radioactive waste is a complicated and complex problem. Through exchange of information, experience and technologies, Bulgaria has been

No.	REQUIREMENTS	COMMENTS
		actively participating in international cooperation for improving the management of radioactive waste and spent nuclear fuel, which is performed on the basis of the EURATOM Treaty, Code rules for transportation of radioactive waste (IAEA) and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. It is this international experience, which forms the backbone of the investment project for the construction of a new nuclear unit at Kozloduy NPP. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts, will presented a list of international documents ratified by the Bulgarian state and their integration in the Bulgarian legislation. The same information will be presented in Annex 15.4. to the Environmental Impact Assessment Report (EIAR).
6.	Presentation of radioactive waste management system, including information on spent nuclear fuel, the classification of details on where and how they are transported, and the specification of transport containers.	Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impact Assessment, will explain in detail the "Strategy for spent nuclear fuel and radioactive waste" adopted in 2011. It will also present the system of radioactive waste management at Kozloduy NPP.
7.	Description of nuclear and radiological safety performance characteristics, in the context of the implementation of the Integrated Management System (safety management, quality management, safeguards and security, environmental protection, health and occupational safety, financial).	To achieve its objectives, "Kozloduy NPP" has developed and introduced a management system, which integrates all aspects of management and ensures consistency in the implementation of safety, health and safety, environmental, security, quality and economy so as to ensure the highest priority on safety. The management system of "Kozloduy NPP" is designed in accordance with GS-R-3 "System management facilities and activities" with regard to the requirements of BS EN ISO 9001 "Systems of quality management. Requirements.", ISO 14001:2004 "Systems for Environmental Management" and OHSAS 18001 "Systems for managing health and safety at work." Kozloduy NPP as an organisation operating nuclear facilities, has created conditions for the development and continuous improvement of safety culture in which safety has the highest priority. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts, will describe the nuclear and radiological characteristics in terms of safety of the plant, in the context of the implementation of the Integrated Management System (safety management, quality management, safeguards and security, environmental protection environment, health and safety at the workplace, financial agreement).
8.	Analysis of the results of the operational impact assessment	Chapter 5 Terms of Reference (ToR): Cumulative effect, presents the approach to evaluate the cumulative effects of all

No.	REQUIREMENTS	COMMENTS
	of the new nuclear unit on existing and functioning units (and vice versa) at the site of the nuclear power plant as a whole	components and environmental factors. Chapter 5 of the Environmental Impact Assessment Report (EIAR): Cumulative effect, will analyse and assess the possible cumulative effect of the implementation, operation and decommissioning of the new nuclear unit and other current and future facilities of Kozloduy NPP and beyond, in the context of potential impacts. The main task of assessing the cumulative impact as part of the Environmental Impact Assessment (EIA) will be the opportunity to provide an analysis and assessment of the potential cumulative effect of the investment project implementation and the operation of other facilities at Kozloduy NPP and off the site, that might arise resulting from the summation of the implementation and operation effects (operations at units 5 and 6 of Kozloduy NPP) decommissioning of units 1 ÷ 4, the DSF and the WSF, disposal and facilities operated by the State Enterprise Radioactive Waste. To achieve this objective, the assessment of the cumulative effects should include an analysis of potential cumulative impacts in terms of: ✓ Each of the sites being evaluated separately; ✓ Each component (factor) of the environment separately and in combination; ✓ All identified and studied past, present and future activities at the Kozloduy NPP site and within the 30 km surveillance zone.
9.	Presentation of the main aspects of the environmental monitoring in accordance with international, European and national nuclear regulations.	Chapter 7 of the Terms of Reference (ToR): Monitoring existing system, presents the existing system for radiation and non-radiation environmental monitoring, by components and factors. In Chapter 9 of the Environmental Impact Assessment Report (EIAR), the developed and functioning monitoring system in all its aspects will be analysed in detail and evaluated with regard to the investment project, the specific requirements of nuclear facilities and the need for its development and improvement. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts, will present the main aspects of the environmental monitoring in accordance with international, European and national nuclear regulations.
10.	Drawing up a detailed list of possible emergency scenarios, including Design Basis Accidents (DBA) and Beyond Design Basis Accidents (BDBA) plus severe	Chapter 6 of the Terms of Reference (ToR): Description of the risks for the environment for potential accidents and incidents, presents the selected approach for assessing the risk of accidents (internal impacts), accidents caused by human error, impacts caused by natural disasters, external impacts of human

No.	REQUIREMENTS	COMMENTS
	accidents (Beyond Design Basis Accidents – BDBA.	origin, including a classification of accidents – design and major. Chapter 6 of the Environmental Impact Assessment Report (EIAR): Description of the risks for the environment for potential accidents and incidents, will identify all events (design and severe), which may occur as a result of this project implementation. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts, will present a detailed list of possible emergency scenarios, including design basis accidents (Design Basis Accidents – DBA) and major accidents. As regards the assessment of beyond design basis accidents it should be stressed that at this early stage of project development (feasibility study) the survey does not include the full set of data required in terms of assessment in the context of specific technical requirements as set by the Republic of Romania – they will be available at a later stage, when the specific reactor model has been selected and when the relevant documents have been produced relating to the licensing of the investment project in accordance with harmonized legislation in the field of the safe use of nuclear energy for peaceful purposes. These documents include the Safety Analysis Report (SAR), Probabilistic Safety Analysis (PSA) and Technical Specifications (TP). They will be prepared at the level of technical design for the specific PWR model of the latest generation conforming to the particular conditions at the Kozloduy NPP site . In this regard, it will be stated that despite the limited information available at this stage of the project, there is sufficient information to evaluate the Transboundary impact of the cumulative effect of the operation of nuclear facilities of Kozloduy NPP.
11.	Analysis of the main results of the nuclear safety probabilistic assessment, with emphasis on beyond design basis accidents, BDBA postulated initiating events, and a description of severe accidents.	Chapter 6 of the Environmental Impact Assessment Report (EIAR): Description of the risks for the environment for potential accidents and incidents will provide for an assessment of the possible consequences of accidents, including: ✓ The extent to which the setting of passive and active design systems to bring the reactor of a certain type (as per selected alternatives for equipment) in the sub-critical condition with stable residual heat removal, with no release of radioactivity outside the containment spaces in the event of accidents; ✓ Analysis by types of accident regarding exposure dose limits and defined restrictive parameters for a particular type of reactor (under the chosen alternative equipment); ✓ The probability of a major accident with a major release as a key indicator for assessing the safety in terms of the environment and the population in the

No.	REQUIREMENTS	COMMENTS
		area around Kozloduy NPP; ✓ Capacity to update the existing emergency plan at Kozloduy NPP in view of the operation of a new nuclear unit. As regards the assessment of beyond design basis accidents it should be stressed that at this early stage of project development (feasibility study) the survey does not include the full set of data required in terms of assessment in the context of specific technical requirements as set by the Republic of Romania – they will be available at a later stage, when the specific reactor model has been selected and when the relevant documents have been produced relating to the licensing of the investment project in accordance with harmonized legislation in the field of the safe use of nuclear energy for peaceful purposes. These documents include the Safety Analysis Report (SAR), Probabilistic Safety Analysis (PSA) and Technical Specifications (TP). They will be prepared at the level of technical design for the specific PWR model of the latest generation conforming to the particular conditions at the Kozloduy NPP site. In this regard, it will be stated that despite the limited information available at this stage of the project, there is sufficient information to evaluate the Transboundary impact of the cumulative effect of the operation of nuclear facilities of Kozloduy NPP.
12.	Discussion of the main results of the hazard analysis of events such as earthquakes, floods, fires, explosions, extreme weather, missile, plane crashes, human activities in the vicinity of the plant, etc.	Chapter 6 of the Terms of Reference (ToR): Description of the risks for the environment for potential accidents and incidents, presents the selected approach for assessing the risk of accidents (internal impacts), accidents caused by human error, impacts caused by natural disasters, external influences of human origin. Chapter 6 of the Environmental Impact Assessment Report (EIA R): Description of the risks for the environment for potential accidents and incidents will assess and analyse the risk of events such as earthquakes, floods, fires, explosions, extreme weather, missile, plane crashes, human activities in the vicinity of the plant, etc. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impact will produce a summary of the results: ✓ hazard analysis of events such as earthquakes, floods, fires, explosions, extreme weather, missile, plane crashes, human activities in the vicinity of the plant, etc. ✓ assessment of the radiological impact on the Romanian territory, both during normal operation and in emergency situations, ✓ probabilistic assessment of nuclear safety, with an emphasis on design basis accidents (DBA) and the events causing them.

No.	REQUIREMENTS	COMMENTS
13.	Presentation of various dose limits (for example, individual, collective, annual, etc.) and the resulting emission levels of radioactive substances in the ambient air and water during normal operation and accidents compared to European standards, taking into account the impacts on the environment and the population in the Republic of Romania. Clarify the validity of the assumptions used in the calculations, the method of determining the resulting emission limits, definition of critical groups; scenarios and descriptions of exposure paths for the population.	Sections 3.11.1. and 3.11.2. of the Terms of Reference (ToR) present the current condition and expected impact of the new nuclear unit and the current doses of gas-aerosol and liquid releases. It also presents the projected scenarios leading to the exposure of the population. In addition, Section 3.11.3. of the Terms of Reference (ToR) describes the reliability of the assumptions used in the calculations, the method of determining the resulting emission limits, identification of critical scenarios for the populations and descriptions of routes of exposure of the population. In detail this information will be presented in section 3.11. and section 4.11. of the Environmental Impact Assessment Report (EIAR). Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impact, will provide information directly concerning the Romanian territory in the 30 km zone of the evaluation.
14.	Identification, presentation and analysis of environmental factors affected by the construction of a new nuclear unit.	Factors and components of the environment, which should be assessed in the Environmental Impact Assessment Report (EIAR), as defined by the Environmental Protection Act (EPA) (of 2002, last amended on 15.02.2013), and specified in the Regulation on the conditions and procedures for assessing the impact environmental (of 2003, last amended on 30.11.2012) and the instructions given by the Ministry of Environment and Water (MoEW) regarding the notification of the investment project (letter of outgoing reference No. OBOC-220/05.07.2012 of the Ministry of Environment and Water) and additional information on the notification letter of outgoing reference № OBOC-220/09.01.2013. The presentation and analysis of these environmental factors and components on the territory of the Republic of Romania, will be made in Chapter 11 of the Environmental Impact Assessment Report (EIAR).
15.	Summary (list) of the basic software (programs and software) used in the analysis of safety (deterministic and probabilistic) and referencing the methodologies and acceptance criteria of accidents consequences and probabilities analyses results.	The list of software (programs and software) used in the analysis of safety (deterministic and probabilistic) and a description of the methodologies and criteria for acceptance of the results of the analysis of the consequences and probabilities of accidents which will be used in the development of the Environmental Impact Assessment Report (EIAR) are presented in Annex 11.2. to the Terms of Reference. The final list will present the relevant components in the Environmental Impact Assessment Report (EIAR). Chapter 11 of the Environmental Impact Assessment Report

No.	REQUIREMENTS	COMMENTS
		(EIAR): Transboundary Impact, will summarise the models used for simulation and description of the authenticity of assumptions.
16.	Reporting on the use and management of toxic and hazardous non-radioactive chemicals in the plant, as well as information on how effective legislative requirements in force will be applied to reduce the environmental impact	Section 3.8. The Terms of Reference (ToR) describes the situation and the expected impact of the new nuclear unit on the use and management of toxic and radioactive chemicals in the plant, accompanied by safety data sheets, as per the Bulgarian legislation. To complete Sections 3.8. and 4.8. of the Environmental Impact Assessment Report (EIAR) detailed information on this issue will be submitted, while evaluating the impacts on the environment, workers and the population. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impact, will provide information on the potential impact on the Romanian territory in the 30 km zone, describe the requirements which are in force and will be applied to reduce their environmental impact.
17.	Presentation of the cumulative environmental effects of the plant in the short, medium and long run and how to change the emergency planning zone, which includes the Romanian territory.	Chapter 5 Terms of Reference (ToR): Cumulative effect, presents the selected approach to evaluate the cumulative effects of all components and environmental factors, including biodiversity. Chapter 5 of the Environmental Impact Assessment Report (EIAR): Cumulative effect, will analyse and assess the possible cumulative effect of the implementation, operation and decommissioning of the new nuclear unit and other current and future facilities on- and off-site Kozloduy NPP, in the context of potential impacts, including on biodiversity. Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impact, will include an assessment of the potential cumulative effect for the territory of Romania in the 30 km zone, including whether and how to change the emergency planning zone, which includes the Romanian territory.
18.	Description of the results of the radiological impact of the Romanian territory, both during normal and emergency operating modes: design and beyond design basis accidents, including severe accident.	See section 10 hereinabove.
19.	Description of the technical, procedural and administrative	See section 3.3. hereinabove.

No.	REQUIREMENTS	COMMENTS
	measures designed to reduce transboundary impacts both during construction works and during operation.	
20.	Modelling the spread (dispersion) of pollutants in the ambient air (Dispersion modelling study for air pollutants) under unfavourable weather conditions and the impact on Romanian territory.	See section 3.11 of the Terms of Reference: Models and software products of radiobiological effects and radiation risk per reference individual and for the assessment of doses to the population of liquid and gaseous radioactive emissions into the environment, present the modelling programs that are based on assessment methodologies for radiobiological effects and radiation risk, according to ICRP Publication 103, The 2007 Recommendations of the International Commission on Radiological Protection – model CREAM. These models are adapted to the Bulgarian conditions, using detailed weather data (for a period of more than 10 years) from the investment project area. The results of this modelling will be presented and analysed in section 4.11. of the Environmental Impact Assessment Report (EIAR). Chapter 11 of the Environmental Impact Assessment Report (EIAR): Transboundary impacts will present data and their analysis for the Romanian territory within the 30 km area of evaluation.

8.3 REQUIREMENTS OF THE FEDERAL MINISTRY OF AGRICULTURE, FORESTRY, ENVIRONMENT AND WATER MANAGEMENT OF (FMAFEWM) AUSTRIA

FMAFEWM has submitted a letter with Ref. No. 99-00-68/19.03.2013 to the MoEW, whereby Austria addresses a request to Bulgaria to submit information on the Investment proposal, in accordance with the Convention on EIA in a transboudanry context (Espoo Convention). Austria is willing to receive the Notification and the documentation related to the EIA scope, which should provide an opportunity to determine whether there is probability for significant unfavourable impacts on the environment in its territory. When the Austrian party submits any questions, they will be assessed and commented upon in the EIAR.

9 STRUCTURE OF THE EIA REPORT

CONTENT OF THE EIAR

Introduction

Information about the Client

1. **Annotation of the investment proposal for the construction, operation and technologies.**

   1.1. Necessity of the investment proposal;

   1.2. Description of the physical characteristics of the investment proposal and the required areas;

   1.3. Description of the basic characteristics of the production process.

2. **Alternative locations as assessed by the Client (with sketch and coordinates of the characteristic points in the approved coordinate system for the country) and/or alternative technologies and reasons for the choice made for study, with regard to the environmental impact, including zero alternative**

   2.1. Alternatives in terms of location

   2.2. Alternatives for associated infrastructure during the construction and operation phase;

   2.3. Alternative options for building the NNU

   2.4. The Zero alternative.

3. **Description and analysis of components and factors of the environment and cultural heritage that shall be largely affected by the investment proposal and the interaction between them.**

   3.1. Climate and atmospheric air

   3.2. Waters:

   3.2.1. Surface waters;

   3.2.2. Groundwaters.

   3.3. Lands and soils:

   3.3.1. Lands;

   3.3.2. Soils.

   3.4. Earth's interior and natural resources:

   3.4.1. Earth's interior;

   3.4.2. Natural resources.

3.5. Landscape

3.6. Biodiversity:

3.6.1. Flora;

3.6.2. Fauna;

3.6.3. Protected areas.

3.7. Waste:

3.7.1. Non-radioactive waste;

3.7.2. Radioactive waste.

3.8. Hazardous substances

3.9. Harmful physical factors:

3.9.1. Noise;

3.9.2. Vibrations;

3.9.3. Non-ionizing radiations;

3.9.4. Heat impact on the Danube River

3.10. Health and sanitary aspects of the environment and risk to human health:

3.10.1. Work environment;

3.10.2. Affected population.

3.11. Radiation risk to the population in the event of radioactive releases from the Kozloduy NPP

3.12. Cultural heritage

4. Description, analysis and evaluation of the potential significant radiation and non-radiation impact on the population and the environment resulting from the implementation of the investment proposal, the use of natural resources, the emissions of harmful substances during normal operation and in emergency situations, the generation of waste and the creation of discomfort.

4.1. Climate and atmospheric air:

4.1.1. During construction;

4.1.2. During operation;

4.1.3. During decommissioning.

4.2. Water:

4.2.1. Surface waters:

15.17.1.1. During construction;

15.17.1.2. During operation;

15.17.1.3. During decommissioning.

4.2.2. Groundwater:

15.17.1.4. During construction;

15.17.1.5. During operation;

15.17.1.6. During decommissioning.

4.3. Lands and soils:

4.3.1. Lands:

15.17.1.7. During construction;

15.17.1.8. During operation;

15.17.1.9. During decommissioning.

4.3.2. Soils:

15.17.1.10. During construction;

15.17.1.11. During operation;

15.17.1.12. During decommissioning.

4.4. Bowels of earth and underground natural resources:

4.4.1. Bowels of earth

15.17.1.13. During construction;

15.17.1.14. During operation;

15.17.1.15. During decommissioning.

4.4.2. Natural resources:

15.17.1.16. During construction;

15.17.1.17. During operation;

15.17.1.18. During decommissioning.

4.5. Landscape:

4.5.1. During construction;

4.5.2. During operation;

4.5.3. Impact during decommissioning.

4.6. Biodiversity:

4.6.1. Vegetation:

15.17.1.19. During construction;

15.17.1.20. During operation;

15.17.1.21. During decommissioning.

4.6.2. Animal kingdom:

15.17.1.22. During construction;

15.17.1.23. During operation;

15.17.1.24. During decommissioning.

4.6.3. Protected areas:

15.17.1.25. During construction;

15.17.1.26. During operation;

15.17.1.27. During decommissioning.

4.7. Waste:

4.7.1. Non-radioactive waste:

15.17.1.28. During construction;

15.17.1.29. During operation;

15.17.1.30. During decommissioning.

4.7.2. Radioactive waste:

15.17.1.31. During construction;

15.17.1.32. During operation;

15.17.1.33. During decommissioning.

4.8. Hazardous substances:

4.8.1. During construction;

4.8.2. During operation;

4.8.3. During decommissioning.

4.9. Harmful physical factors:

4.9.1. Noise:

15.17.1.34. During construction;

15.17.1.35. During operation;

15.17.1.36. During decommissioning.

4.9.2. Vibrations:

15.17.1.37. During construction;

15.17.1.38. During operation;

15.17.1.39. During decommissioning.

4.9.3. Non-ionnizing radiations:

15.17.1.40. During construction;

15.17.1.41. During operation;

15.17.1.42. During decommissioning.

4.9.4. Heat impact on the Danube River:

15.17.1.43. During construction;

15.17.1.44. During operation;

15.17.1.45. During decommissioning.

4.10. Health and hygienic aspects of the environment and risk to human health:

4.10.1. Impact in the work environment:

15.17.1.46. During construction;

15.17.1.47. During operation;

15.17.1.48. During decommissioning.

4.10.2. Impact on population:

15.17.1.49. During construction;

15.17.1.50. During operation;

15.17.1.51. During decommissioning.

4.11. Radiation risk to the population in the event of radioactive release

4.12. Cultural heritage:

4.12.1. During construction;

4.12.2. During operation;

4.12.3. During decommissioning.

5. Cumulative impacts

6. Characteristics of environmental from potential accidents and incidents

7. Information on the used environmentatl impact forecasting and assessment methods.

8. Description of the measures envisaged to prevent, mitigate, or, where possible offset any significant adverse impacts in radiation and non-radiation aspect on the environment, as well as a plan for the implementation of these measures

9. Monitoring

10. Position and opinions of the affected community, the competent decision-making authorities on the EIA or officials authorized by them, and other

specialized administrative bodies and states concerned in a transboundary context, as a result of consultations.

11. Transboundary impact

12. Conclusion of the team and the team leader, who have prepared the assessment.

13. An outline of the difficulties (technical reasons, insufficient data or lack of data) in the information gathering process for developing the Environmental Impact Assessment Report.

14. Other information at the discretion of the competent authority or its authorized officer.

15. Annexes

15.1. Annex 1: Non-technical summary;

15.2. Annex 2: Appropriate assessment under Art. 6 of the Habitats Directive of the investment proposal with the subject and objectives of protected area conservation;

15.3. Annex 3: Terms of Reference on the scope and content of the EIA Report;

15.4. Annex 4: Legislative Framework;

15.5. Annex 5: Team of Independent experts who Developed the Environmental Impact Assessment Report;

15.6. Annex 6: References

15.7. Annex 7: Consultations;

15.8. Annex 8: Input data;

15.9. Annex 9: Illustrative materials /tables, maps, diagrams etc./;

15.10. Others.

10 CONSULTATIONS

№	Consultations carried out (municipality, institution, control authority, other)	Description of the stated opinions/recommendations/notes	Accepted/ Rejected	Reasons
1.	**MoEW, ref. No OBOC-220 of 05.07.2012**	Conduct of the EIA procedures, Appropriate Assessment with the subject matter and conservation targets of the protected area, and the requirements of the Convention on the EIA in a transboundary context.	Accepted	The referenced letter is a mandatory element of the procedure and all recommendations and requirements will be fully taken into account in the EIA
2.	**MoEW, ref. No OBOC-220 of 09.01.2013**	Consultations for determining the EIA scope, specific recommendations were stated, such as creation of separate items of "Transboundary Impact" and "Cumulative Effect". It was recommended to expand the list of participants in the consultations	Accepted	The recommendations have been taken into account in the Terms of Reference
3.	**Ministry of the environment and forests (Romania) with ref. No 3672/RP/18.10.2012**	As regards the contents of the EIAR to be elaborated by the Client /through contractors/ as a formal document required for the analysis and impact on the environment in a transboundary context, the Romanian authorities consider important and needing special attention the following environmental aspects of nuclear safety and protection. **Basic requirements:** 1. The EIA report must also incorporate: • Information about the site characteristics, which may be relevant to nuclear safety; • Information about analysis of accidents, especially severe accidents (particularly the possibility of radiological effects on Romanian soil). The acceptable dose in the atmosphere and Danube river must also be identified for each possible accident scenario; • Information about the emissions into the air and the waters of Danube river during normal operation of the new facility.	Partially accepted	The analysis and assessment of the transboundary impact from construction of the new nuclear facility at the Kozloduy NPP site will be aligned to requirements defined in the Letter of the Ministry of the environment and forests of Republic of Romania, Ref. No 3672/RP/18.10.2012, whereas in regards of the specific technical requirements the entire information available at this early stage of the Project's elaboration (prefeasibility study stage) will be taken into account. It should be clarified that it does not contain the full volume of data required from the perspective of assessment in the context of the specific technical requirements put forward by Romania – these will be available at a later stage following selection of the particular reactor model and elaboration of the relevant documents associated with the Project's licensing according to the harmonized Bulgarian law in the area of safe use of nuclear energy for peaceful purposes. These

		2. There are NATURA 2000 areas on both Danube river banks around the town of Kozloduy. The following NATURA 2000 areas, which are respectively protected by the Natural Habitats Directive and the Birds Directive, are located on the Romanian bank: • ROSPA0010 Bistretriver; • ROSPA0023 Jiu River-Danube River Confluence; • ROSCI0045 Corridor of JiuRiver; • ROSPA00135 Sands from Dabuleni. It is mandatory to make the appropriate study for assessment of the natural capital in accordance with Art 63 of Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora. 3. EIAR must cover the following topics: • Impact on the fauna and flora on both Danube river banks, within the Project area, located both within and outside protected areas; • Cumulative impact combined with other projects implemented at the proposed site and its surroundings, which may be harmful for both countries' natural capital; • Measures to mitigate the effect on biodiversity and impact of residual effects following their application. 4. It is requested that names of geographic localities on the maps be written in Latin, with the maps containing the Romanian localities included in the assessment. 5. Considering the fact that the zone of impact (30 km around Kozloduy NPP on Romanian soil) contains a populace of 77 197 residents in 18 settlements of the Dozh and Olt counties, the environment impact assessment should contain an assessment of radiological impact on human health. 6. The human health impact assessment is required to assess the extra risk generated from normal operation of the new nuclear facility, as well as in cases of incidents, based on the recommendations of the		documents include a Report on the Safety Analysis (RSA), Probability Analysis of Safety (PAS) and Technology Regulation (TR) and will be elaborated at a technical design level for the particular latest generation PWR aligned to the particular conditions of the Kozloduy NPP site. In this context it will be clarified that regardless of the more limited information available at the current stage of project elaboration, its volume is sufficient to elaborate the assessment of transboundary impact from the cumulative effect of operating the nuclear facilities at the Kozloduy NPP site.

International Commission on Radiation Protection (ICRP 103/2007), as regards diseases associated with exposure to ionizing radiation (morbidity and mortality rate from malignant diseases, innate malformations, development defects). These assessments must cover both the situation in case of normal operation of the facilities as well as the cases of nuclear accidents.

7. Considering the levels of pollution of the environment's components (air emissions, groundwater, surface waters), it is necessary to carry out a study of the health impact from their synergic effect on the local populace during both construction and operation of the facility.
8. In addition, the health impact study for the Romanian populace in the area of Kozloduy NPP must take into account existence of the old site, of the old units 1-4 of Kozloduy NPP, which are currently being decommissioned and will generate nuclear waste in the future. This means that it is necessary to study the cumulative effect on the Romanian populace residing in the impact area.
9. It is necessary to calculate the cumulative increase of the risk to human health from the operation of all these systems.

Specific technical requirements:

1) Presentation of the new technologies applied in the new nuclear facility at Kozloduy NPP. comparing them to the new nuclear safety requirements following the Fukushima incident, as well as the significant differences to the current technologies, as a result whereof the Project is entitled "NEXT GENERATION nuclear reactor".
2) Presentation of the design and the nuclear safety objectives, which comprise and determine the new nuclear facility's structural framework integrated in a site of several capacities (such as concept and principles of safety, key safety functions, regulatory requirements, integrated management);
3) Presentation of the protective and ancillary

		systems, including the administrative measures intended to ensure the nuclear unit's safety and security, including justification of the specific nuclear safety requirements; 4) Presentation of the technical specifications (known as Limiting Conditions for Operation – LCOs), underscoring their significance as supporting licensing documentation and during the nuclear unit's operational modes; 5) Brief but comprehensive presentation of the link between the major requirements of European treaties or other international recommendations (such as IAEA, US-NRC), as ratified by Bulgaria, with regard to nuclear safety, safe management of nuclear waste and spent nuclear fuel, environmental assessments in a transboundary context, information about public participation in decision-making, etc., as well as their coverage by Bulgarian laws, regulations, and standards; 6) Identification and presentation of the radioactive waste management system, including information spent nuclear fuel, its/their classification, details of where and how these are transported and about the transport containers' characteristics; 7) Identification and specification of details relating to the processes and the nuclear and radiological characteristics in terms of the Plant's safety, in the context of application of the integrated management system (safety management, quality management, protective measures and security, environment protection, health and safety at work, financial arrangements); 8) Discussion on the outcome from the assessment of the impact from the operation of the new nuclear facility on top of the existing and operational facilities (and vice versa) and of the nuclear power plant as a whole; 9) Presentation of the main aspects of the environment monitoring system in the context of fulfillment of		

		regulatory requirements; 10) Elaboration of a detailed list of the potential accident scenarios, including Design Basis Accidents – DBA и and Beyond Design Basis Accidents – BDBA plus severe accidents); 11) Discussion of the main outcomes of the probability assessment of nuclear safety, focusing on Beyond Design Basis Accidents (BDBA), stipulating launch events and severe accidents; 12) Discussion of the main outcomes of the hazard event analysis, such as earthquakes, floods, fire, explosions, extreme weather, rockets, airplane crashes, human activity in proximity to the Plant, etc. 13) Presentation of the limits and restrictions of the doses, as well as restrictions on the derivative emissions for discharge of radioactive contamination in the exhaust air and wastewater during both normal operation and in accidents; comparison between such values and European levels, accounting for the effect on the environment and Romanian populace. Explanation of the statements used for calculation of the various assumption, clarification of the method of calculation of the restrictions on the derivative emissions, as well as identification of the critical groups, scenarios, and directions of radiation, are key for such a report; 14) Identification, presentation, and analysis of the environmental factors affected by the construction of the new nuclear facility; 15) Summary (list) of the underlying software code/programs used in the safety analysis (deterministic and probable ones) and reference to the methodologies and criteria for acceptance of the accident analysis' outcomes; 16) Brief presentation of information about the use and management of toxic and hazardous radioactive chemicals at the plant and information about		

		fulfillment of the effective requirements concerning their effect on the environment; 17) Presentation of considerations regarding the assessment of the plant's cumulative impact on the environment in the short-, mid-, and long-term, and regarding creation of emergency planning zones and incorporation of Romanian territories; 18) Description of the outcomes from the assessment of radiological effects on Romanian soil during both normal operation and emergency modes, as well as in accidents (Design Basis Accidents and Beyond Design Basis Accidents), including in severe accidents; 19) Details about the technical, procedural, and administrative measures intended to mitigate the transboundary impact during both construction and operation of the facility; 20) Considering the potential transboundary pollution, we request a dispersion modeling study for air pollutants under adverse conditions and their effect on Romania (considering all the weather factors).		
4.	**BDDR (Basin Directorate, Danube Region) Pleven – Ref. No 3804/06.2012**	The competent authority presents information about the water bodies within the IP's scope, as well as the measures stipulated in RBMP. A substantiated assessment of the impact from IP's implementation has been made that the latter will have no negative impact on the waters, water ecosystems, and is admissible from the viewpoint of environmental objectives and measures for achieving good water status, as stipulated in RBMP, provided that measures are taken not to allow direct and indirect pollution of waters. It is necessary to envisage monitoring of the radiation and non-radiation status of surface waters and groundwater in the area, as well as of groundwater, rainwater, and wastewater at the IP's site.	Accepted	The information provided by BDDR was used in elaboration of the ToR and plays leading role in determining the scope and contents of the sections "Surface Waters" and "Groundwater".
5.	**BDDR Pleven – 3804/08.01.2013**	EIA should pay special attention to the surface and ground water bodies and the zones for their protection in the event of potential effect by the linear infrastructure; comply with the measures to protect groundwater from pollution during construction; describe the need and	Accepted	The recommendations and requirements will be incorporated in the sections "Surface Waters" and "Groundwater" and EIA monitoring

		modes for water supply during all stages of IP implementation; envisage measures in compliance with RBMP and monitoring of the radiation and non-radiation status of surface waters and groundwater in the site's area		
6.	**Ministry of Agriculture and Foods, Regional Directorate Agriculture, city of Vratsa, 2457/08.01.2013**	The Regional Directorate does not object to IP's implementation since it is a facility of national significance. If site selection affects properties from the Government Land Fund, prior consent of the Minister of Agriculture and Foods is to be sought, and also, the relevant procedure for land use change is to be carried out	Accepted	The recommendations have been taken into account in the determination of the scope of EIA sections of "Land Use Parameters" and "Land and Soils"
7.	**Ministry of Health, National Center on Radiobiology and Radiation Protection, РД-02-08-17/04.01.2013**	Apart from Art 10, Para 3 of the Regulation on ensuring the safety of nuclear power plants (2004), ToR must also consider the requirements of Appendix I from a Commission Recommendation dated October 11, 2010 on the application of Art 37 of the EURATOM Treaty, by clarifying the extent of impact and risk to human health. EIA must determine site selection criteria in compliance with the Regulation on ensuring the safety of nuclear power plants.	Partially accepted	There is a dedicated site selection project under EU criteria. The requirements of Art 37 of the EURATOM Treaty regarding the requirements of Appendix I from a Commission Recommendation dated October 11, 2010 have been reflected in the ToR and will be taken into account in the elaboration of the EIAR for the extent of impact and risk to human health. Site selection is the subject matter of a related project implemented in parallel with this EIA of the NNF IP. Assessment in the EIAR will be made according to Art 25, Cl.1 of the Regulation on ensuring the safety of nuclear power plants (2004), which says that the sites favorable for placement of nuclear plants are those, which fulfill the following conditions: compliance with the environment protection legislation, the radiation protection, fire safety, and physical protection requirements.
8.	**Regional Health Inspectorate-Vratsa, КД-04-3513/09.01.2013**	RHI gives specific guidelines for the scope of the assessment of risk to human health, comprising information about distances to settlements and sites subject to health protection, identification of potentially affected populace and areas; data about water sources	Accepted	The RHI requirements have been incorporated in the elaboration of ToR and play leading role in determining the scope and contents of the sections "Health-sanitation aspects of the environment and risk to human health" and

		and SSZ (sanitary-security zones); assessment of nuclear safety and radiation protection; risk factors for harm to human health at all stages of the IP; assessment of the health risk and the individual risk factors, judgment for the combined, comprehensive, or cumulative effect.		„Waters” Site selection is the subject matter of a related project implemented in parallel with this EIA of the NNF IP. Assessment in the EIAR will be made according to Art 25, Cl.1 of the Regulation on ensuring the safety of nuclear power plants (2004), which says that the sites favorable for placement of nuclear plants are those, which fulfill the following conditions: compliance with the environment protection legislation, the radiation protection, fire safety, and physical protection requirements.
9.	**Bulgarian Atomic Forum, 1/09.12.2012**	Satisfaction is stated with the fact that the Forum was involved in the EIA consultations. Due to insufficient time the Forum was unable to review in detail the IP's executive summary	Accepted	Bulatom will also be involved in the follow-up procedure stages
10.	**Regional Governor, Vratsa Region, 2600-15-(1)/07.01.2013**	The Regional Governor has no particular requirements differing from those stipulated in the EIA Regulation.	Accepted	
11.	**Regional Historical Museum, Vratsa, 135/27.12.2012**	RHM advises that archeological fixed cultural valuables (burial mounds) are registered in the zones of Sites 1 and 2, coordinates and square area unspecified. The zone of Site 3 is immediately next to another mound necropolis, its coordinates and square area also unspecified. There is no information about cultural valuables at Site 4. Field studies are recommended to clarify the exact coordinates of the mounds and clarification of the extent of danger to them.	Accepted	During EIAR elaboration field studies will be carried out to clarify the boundaries, square area, and level of danger to the referenced fixed cultural valuables.
12.	**DG FSPP, Regional Administration -Vratsa, 45/03.01.2013**	The documentation received at Regional Administration-Vratsa was forward to DG Fire Safety and Populace Protection at Ministry of Interior-Sofia.		
13.	**Executive Agency for Exploration and Maintenance of the Danube River, VIII-2-6/02.01.2013**	At this stage the Agency has no further guidelines and recommendations differing from those stipulated in the EIA Regulation.		

14.	**Mayoralty of Harlets village, 450/27.12.2012**	IP will result in positive developments for the municipality's economy. During site selection any potential impact on the water intake zone – PS Harlets 1, ShK 1 and ShK 2 is to be considered and assessed;	Accepted	The requirements are incorporated in elaborated of ToR and considered in the determination of the scope and content of section "Groundwater"
15.	**Mayor of Kozloduy Municipality, 43-00-63/1/02.08.2012**	Conditions have been created in the municipality to ensure equality in the public access to the IP publication; no opinions, objections and/or proposals concerning the IP have been received from the populace.	Accepted	If opinions are received in the future, these will be reflected in the EIAR.
16.	**Kozloduy Municipality, 73-00-128/1/03.01.2013**	1. The description and manner of treatment of the type and quantities of the expected flows of waste must strictly comply with the new Waste Management Act and the secondary legislation. 2. During the stage of facility construction a need could potentially arise to clear trees and shrubs from the site, in this context it is necessary to pay attention to the manner of treatment of biowaste and its composting. 3. Considering the fact that the investment proposal will be implemented in proximity to protected NATURA 2000 areas, it is recommendable to review separately the individual elements (plants and animals). 4. In the section concerning the description of the quality characteristics of groundwater and surface waters, it is necessary to pay attention to the impact on subsoil waters and the options for supply of potable water to the production buildings scheduled for construction within the investment proposal, 5. Review the effect and impact of the investment proposal on the current transport communications and infrastructure of the town of Kozloduy in view of the fact that the ring road, which could reduce traffic load in the town and directly and indirectly contribute to purity of air in the area, is yet to be completed.	Accepted	All recommendations and considerations raised by the municipal administration have been used in ToR elaboration and will be reviewed and assessed in EIA
17.	**GFU (Government Forestry Unit) - Oryahovo, 813/09.01.2013**	The proposed sites do not affect land properties in forest territories; EIAR must be aligned to the environment's characteristics and the extent of impact thereon	Accepted	The opinion has been taken into account in the ToR elaboration and will be reflected in the EIAR

18.	**SE RAW (State Enterprise Radioactive Waste), П-06-00-43/11.01.2013**	SE RAW approves of and supports IP's implementation and gives consent to the proposed draft contents of the ToR, which reflects the legislation requirements	Accepted	The opinion has been taken into account in the ToR elaboration and will be reflected in the EIAR
19.	**BSPB (Bulgarian Society for the Protection of Birds), 5/09.01.2013**	Detailed information has been provided on the presence and subject matter of protected areas within the IP zone and conservation targets therein. Specific requirements and recommendations have been stated to both EIAR and the Report on the assessment of impact on NATURA 2000 areas, such as Analysis of the mortality risk to large birds from the power line system; probability of deterioration of the food source quality, etc.	Accepted	The opinion will be taken into account in the EIA elaboration.
20.	**MH, 26-00-2370/11.01.2013**	MH recommends that in parallel with the requirements of Art 10, Para 3 of the EIA Regulation, the ToR must also consider the requirements of Appendix I from a Commission Recommendation dated October 11, 2010 on the application of Art 37 of the EURATOM Treaty, by clarifying the extent of impact and risk to human health. EIA must determine site selection criteria in compliance with the Regulation on ensuring the safety of nuclear power plants	Partially accepted	There is a dedicated site selection project under EU criteria. The requirements of Art 37 of the EURATOM Treaty regarding the requirements of Appendix I from a Commission Recommendation dated October 11, 2010 have been reflected in the ToR and will be taken into account in the elaboration of the EIAR for the extent of impact and risk to human health.
21.	**MoEW, RIEW – Vratsa, B2975/10.01.2013**	I. In principle, the ToR structure must follow the requirements Art 10, Para 3 of the Regulation on the conditions and procedure for conduct of environment impact assessment /the EIA Regulation/. II. Up-to-date date, state-of-the-art knowledge and assessment methods are to be used in the elaboration of the EIA Report in compliance with Art 11, Para 1 of the EIA Regulation. III. Comply with Art. 14, Para 1, Cl. 5 – Plan for implementation of the measures…. is to be elaborated in a spreadsheet format pursuant to Schedule 2a of the EIA Regulation. IV. Pay attention to the requirements of Art 95, Para 3 of the Environment Protection Act /EPA/ – consultations must be held with the affected community, with the outcomes reflected in the	Accepted	The recommendations (I-VII) have been reflected in the ToR and will be reflected in the elaboration of the EIAR Recommendation VIII-Cl. 5 was reflected in the ToR – Soils component, and will be reflected in the EIAR. Recommendation Cl.3-Waters was reflected in the ToR and will be reflected in the EIAR.

EIAR. Kozloduy Municipality is to be advised of your investment proposal and the stated opinion is to be taken into account.

V. The Report must assess the alternatives reviewed in pursuance of Art.96, Para 1, Cl.2 of EPA.

VI. Pursuant to Art.9, Para 5 of the EIA Regulation a report is to be drafted and attached about the conducted consultations and the reasons for accepting and rejecting the notes and recommendations, as well as evidence of actual conduct of consultations.

VII. In the EIA Report you need to consider the following recommendations:

1. Protected territories: IP does not affect protected territories within the meaning of the Protected Territories Act. The nearest protected territory is Protected Locality Kozloduy – some 10 km from the site. Provide information about the impact from the implementation and operation of your investment proposal, incl. cumulative effect on the protected locality.
2. NATURA 2000: As regards the Impact Extent Report /IER/, which is attached to the EIA Report:
   The protected areas nearest to the NPP site are: BG0002009 Zlatiata – located some 500 m from the site, BG0000614 Reka Ogosta - some 7,00 km, and BG0000533 Ostrovi Kozloduy - some 3,00 km from the location of the investment proposal's implementation. The Appropriate Assessment /AP/ must consider the proximity of these areas, particularly of the wild birds conservation zone BG0002009 Zlatiyata when assessing the investment proposal's impact on natural habitats and habitats of species, which are conservation targets therein. In the elaboration of AP the requirements of the Regulation on the Conditions and Procedures for Approriate Assessment of Plans, Programs,

		Projects and Investment Proposals with the Aim and Conservation Targets of the Protected Areas /the CA Regulation/ /prom. SG, issue 73/2007/ as regards its structure and contents. Pay special attention to the cumulative impact on the above protected areas, which impact will occur upon implementation of this investment proposal, in combination with the impact of other investment proposals at the existing site of Kozloduy NPP, as well as in proximity thereto. 3. Component – **Waters**: • Water intake for the technological processes – cooling, fire protection needs, spray ponds, etc., and residential water supply. • Expected quantities of wastewater – cooling, industrial, and residential. • Modes of treatment/cleaning of wastewater, depending on its nature. • Options for using the Main Drainage Channel for discharge of newly generated flows of wastewater. • Option to use the existing sewer system at the NPP site and options for constructing a new system either as part of the existing one or separately. • Option to use the existing wastewater treatment plant at EP-2 and an option for constructing a new wastewater treatment plant, shaping of the site to the new nuclear reactor. • Program for conduct of own radiation ad emission control of wastewater. • Systems for capturing leaked wastewater in potential emergencies, in the radioactive (first contour) and the non-radioactive zone (second contour). • We draw your attention to the fact that the permits /for water intake and		

		discharge/ issued up to now by BDDR Pleven are to the benefit of holder Kozloduy NPP AD, to which the new Client – Kozloduy NPP New Builds EAD is not entitled. 4. **Waste**: For each individual waste of the industrial, hazardous, residential, and construction waste generated during construction indicate the type, quantity, mode of storage and treatment in compliance with the legislative requirements. Stipulate measures and indicate the ways for reducing or preventing negative impacts of waste on the environment. 5. **Soils**: Provide information about soil monitoring, which will be carried out following commissioning of the new facility. 6. Incorporate into the EIA Report: • Description, analysis, and assessment of the assumed significant impacts on the populace and the environment resulting from implementation of the investment proposal • Measures for preventing, mitigated, and potentially fully compensating the adverse effects from the investment proposal's implementation on the environment • Carry out assessment of the application of best available techniques /BAT/	Not accepted	Nuclear power plants do not fall within the scope of the reference manuals for best available techniques /BAT/, as elaborated by the European Commission (Institute for Prospective Technological Studies – Seville, Spain) Integrate Pollution Prevention and Control (IPPC). The requirements for consistency with the so-called BAT may in this case be replaced with the recommendations of the *International Atomic Energy Agency (IAEA)* and EURATOM, as well as with the effective standards in the national legislation in this area.

22.	**MoEW, Executive Environment Agency (EED) 26-00-8 dated 14.01.2013**	Due to the investment proposal's specifics , during elaboration of EIAR focus must be placed on: • The radiation impacts of dominant role in the assessment of risk to the environment and the populace in the area of Kozloduy NPP; • assessment of the cumulative impacts from operation of the new nuclear facility, using up-to-date data; • change of the special status zone around the nuclear facility; • measures for prevention or mitigation of significant radiation impacts resulting from operation; • detailed and justified review of the expected operational conditions and design-basis accidents at the facility. The identified four sites, which are the subject matter of the investment proposal, do not fall within protected territories within the meaning of the Protected Territories Act (PTA), or within the boundaries of protected areas from the NATURA 2000 network within the meaning of the Biodiversity Act. The following *protected territories* are located within the 30-km zone around the investment proposal – Ibisha reserve, and protected localities Kozloduy, Daneva mogila, Ostrov Tsibar, Koritata, Kalugerski Grad Topolite, Kochumina, and Gola Bara, and the *protected areas* declared as per the Directive on the conservation of natural habitats and of wild fauna and flora – Zlatia BG0000336, Tsibar BG0000199, Skat River BG0000508, and Kozloduy BG0000527; and *protected areas* declared as per the Birds' Directive – Ostrov Ibisha BG0002007 and Ostrov to Gorni Tsibar BG0002008. The investment proposal is subject to a procedure for appropriate assessment of the subject matter and conservation targets of the above protected areas. Assessment must **also** be made in the EIA Report of the investment proposal's impact on the above protected areas.	Accepted	
23.	**National Electricity Company (NEC), 73-01-7 dated 16.01.2013**	I herewith advise you that following a review made on the documents attached by you to the above proposals, particularly, Annex 1: Investment Proposal for	Taken into account	

		Development of a New Nuclear Unit... and Annex 4: Tentative Content of Terms of Reference for the Scope of the EIA Report, the following general comments and notes arose: 1. The specific information required pursuant to Schedule 2 to Art. 6 of the Regulation on the Conditions and Procedure for Environment Impact Assessments (title amended SG, issue 3 of 2006), namely Information about the Judgment for the Need for EIA has not been submitted. Such information must be available prior to assigning the elaboration of Terms of Reference for the scope of the EIA Report, its absence does not allow for specific guidelines and recommendations to be given by NEC EAD, which are required in the incoming letter. The absent specific information should already have been submitted with a written request to MoEW by Kozloduy NPP New Facilities EAD, in compliance with Art. 6 of the Regulation on the Conditions and Procedure for Environment Impact Assessments, as related to Art. 93, Para 1 of EPA. 2. The draft ToR submitted by you do not request the following: • submission of specific information required within the meaning of the Convention on the EIA in a transboundary context; • satisfaction of the provisions of Chapter II, Art. 4, Para 3 of the Regulation on the Conditions and Procedure for Environment Impact Assessments; • satisfaction of the provisions of Chapter II Art. 9, Para 1 through 13 of Regulation No 4 of 21.05.2001 on the scope and content of investment projects; • description of NPP's electric part in connection to Regulation No 4 of 21.05.2001 on the scope and content of investment projects and Art. 2. Para 1, Cl. 1 of Regulation No of 9.06.2004 on Connecting Generators and Consumers of Electricity to the Transmission and Distribution		Selection of the procedure applicable as per EPA and the actions to be taken by the Client within the procedure are fully vested in the competent environment authority – the Ministry of the Environment and Waters. The investment proposal falls within the scope of Cl. 2.2 of Schedule No 1 to the Environment Protection Act /EPA/ and on the grounds of Art. 92, Cl. 1, as relating to Cl. 2 of the said Act, the IP **is subject to a mandatory** environment impact assessment (EIA). Correspondingly, the EIA stage of preparation of information to adjudge the need for an EIA is not applicable to this particular case Part of the NEC has to do with procedural steps, which are mandatory pursuant to the EIA legislation requirements, incl. in a transboundary context. As at the stage of the EIA procedure for this IP, all procedural requirements have been fulfilled.

		Grids; • description of the infrastructure of the identified sites pursuant to the Regulation on the Conditions and Procedure for Environment Impact Assessments (title amended SG, issue 3 of 2006) • satisfaction of the provisions of Rules for Management of the Electrical Energy System, as issued based on Art. 21, Para 1, Cl. 7 of the Energy Act by the Chair of the State Energy and Water Regulatory Commission, Appendix Cl. 1 of Decision No П-5 of 18.06.2007 , prom. SG, issue 68 of 21.08.2007 • satisfaction of the provisions of all statutory documents effective and applicable in Republic of Bulgaria, the EC Directives, the international conventions, to which Bulgaria is a signatory, and the IAEA requirements in the area of nuclear energy. These must be presented in the ToR as a list, with a requirement to elaborate an analysis of the investment proposal's compatibility therewith also due to be stipulated.		
24.	**Bulgarian Energy Holding (BEH), Ref. No 02-0064 dated 17.01.2013**	The letter states that in view of the MoEW requirements identified in a MoEW letter dated 05.07.2012, Kozloduy NPP New Facilities EAD has initiated a process of consultations with selected institutions, Bulgarian Energy Holding being among these. The indicated actions to be undertaken by Kozloduy NPP New Builds EAD for conducting the EIA procedure are detailed I Part I of the above MoEW letter. Cl. 1 states that elaboration of ToR on the scope and contents of EIA is to be assigned, and Cl. 2 indicates that conduct of consultation under the ToR must take place. The directions meet the requirements of Art. 10, Para 5 of the Regulation on the Conditions and Procedure for Environment Impact Assessments. The presented Annex No 4 Draft Content of the Terms of Reference for the EIA Report quotes the norm of Art. 10, Para 3 of the Regulation. Pursuant to Art. 10, Para 5 of	Accepted	The opinion has been taken into account and will be reflected in the EIAR.

		the Regulation on the Conditions and Procedure for EIA, the Client must conduct consultations on the elaborated ToR. The elaborated ToR have not been submitted. Cl.2 of the MoEW letter identifies the authorities recommended for consultation. We believe that "specialized institutions" are those institutions, which carry out functions associated with assessment of individual aspects of the investment proposal within the EIA procedure, which do not include Bulgarian Energy Holding EAD. In view of the above, we will be expecting from Kozloduy NPP New Facilities EAD, being a company from the group of Bulgarian Energy Holding EAD, to submit for review the revised ToR for the scope of the EIA Report.		
25.	**Ministry of the Interior, FSPP, ПО-398 of 17.01.2013**	We propose: to incorporate into Cl. 4 of Draft Content of the Terms of Reference for the EIA Report a section containing analyses and recommendations for emergency planning of the new nuclear facility, which would be prepared based on the potential pollutions, types of discharges, the perimeter of such discharges and pollutions in the anticipated Design Basis Accidents and Beyond Design Basis Accidents.	Partially accepted	The opinion has been taken into account and will be reflected in the EIAR. The entire information available at this early stage of Project elaboration (prefeasibility study stage) does not include the fill set of data required from the perspective of Beyond Design Basis Accidents. These will be available at a later stage, following selection of the particular reactor model and elaboration of the relevant documents associated with the Project's licensing according to the harmonized Bulgarian law in the area of safe use of nuclear energy for peaceful purposes
26.	**Ministry of the Economy, Energy, and Tourism, 26-A-10 of 22.01.2013**	The Security of Electricity Supply directorate does not propose any additions to the document's scope proposed by you and considers it fully compliant with the requirements of the EIA Regulation.	Accepted	The opinion has been taken into account and will be reflected in the EIAR.
27.	**WS&S-Vratsa, 53 of 22.01.2013**	During the field visit made on 21.01.2012 together with your representative Boris Zlatanov, we ascertained that the proposed four sites for development of new nuclear facilities do not affect any of our water supply networks and facilities. Therefore Water Supply & Sewage OOD- Vratsa approves of all four proposed sites.	Accepted	
28.	**Ministry of Culture,**	Pursuant to the information stored in the records of	Accepted	The opinion has been taken into account and will

	National Institute for Fixed Cultural Heritage, 4800-2 of 25.01.2013	NIFCH, the municipalities of Kozloduy, Valchedram, Heyredin, Mizia, Lom, Byala Slatina, and Oryahovo /within the indicated 30-km zone/ contain some 300 architectural-structural, historical, art, and archeological fixed cultural valuables. Located in the proximity of Kozloduy NPP are Roman Fortress Regiana – architectural-structural fixed cultural valuable, "national significance" category, as promulgated in the SG, issue 90/1965 and Archeological Reserve – Ancient Fortress Augusta, Harlets village, Kaleto locality, as declared with an Order of the Council of Ministers No 14/25.06.1984. The lands of the town of Kozloduy are characterized by high concentration of archeological fixed cultural valuables. As evident from the topographic maps, several mound necropolises are located in the immediate vicinity of Kozloduy NPP, these are likely to be affected by the investment proposal's implementation. By means of a CM Order No 1711 of 22.10.1962 all settlement and burial mounds and medieval defensive walls have been declared as culture monuments in the "national significance" category. Due to the specifics of fixed cultural valuables it is presumed possible that some yet unregistered sites of NCV status, pursuant to Art. 146, Para 3 of the Cultural Heritage Act, may fall within the areas of the proposed four alternative sites. NIFCH hereby requests: 1. That the EIA Report part concerning fixed cultural heritage be elaborated by a specialized archeologist and be based on a prior inspection of the plots, which would be affected by development of the new nuclear facility and its appertaining technical infrastructure. The purpose of such inspection is to ascertain the presence or absence of fixed cultural valuables. A written report containing the inspection outcomes must be sent to the Ministry of Culture. 2. Should impact on fixed cultural valuables from the investment proposal's implementation be found, the EIA Report must be submitted for review to the		be reflected in the EIAR.

		Ministry of Culture, and the follow-up activities must comply with the requirements of Art. 161 of the Cultural Heritage Act /CHA/ and must be agreed with the Minister of Culture pursuant to Art. 83 according to the procedure of Art. 84 of CHA.		
29.	**Institute for Nuclear Research and Nuclear Energy, ref. No1-1 of 25.01.2013**	The BAS Institute for Nuclear Research and Nuclear Energy provides its guidelines and recommendations as regards the ToR for the scope and content of the EIA for the investment proposal to develop a new nuclear facility at the Kozloduy NPP site. Attached please find the content of the EIA Report (*Note: EIAR of „**Reconstruction and transformation of research reactor IRT-2000 upon its transformation into a civil type reactor of low capacity (200 kW) and further application in medicine (neutron therapy of cancer diseases) –city of Sofia, Mladost area***)	Accepted	
30.	**MAF, Executive Forest Agency, EFA-4791 of 31.01.2013**	The submitted information does indicate whether the investment proposal affects land properties in forest areas. Should forest areas be affected, within the consultations conducted in pursuance of the provision of Art. 10, Para 7 of the EIA Regulation, the Executive Forest Agency has the following proposals, which supplement the contents of the submitted information: 1. **The scope of the EIA Report must take into account the particular land properties** in forest areas whereon the investment proposal will be implemented. Attach to the ToR for the elaboration of the EIA Report plats or draft plats of the properties from the cadaster map and an excerpt from the cadaster register with the property details or from the map of restituted property and the lot box for the plots, which comprise forest areas. The follow-up procedures as per the **Forests Act** (FA) inevitably have to do with ascertainment of how properties, whose purpose of use will be modified or where limited real rights (right to build and right-of-way) match the land properties falling within the scope of the EIA Decision. It is recommendable that the	Accepted	The opinion has been taken into account and will be reflected in the EIAR.

		properties be described according by procedures: ○ for those, whose purpose of use will be modified – as per the procedure of Art. 73 of FA; ○ for those, for which right-of-way will be created – as per the procedure of Art. 61 or Art. 64 of FA; ○ for those, for which right to build will be created without modifying the purpose of use – as per the procedure of Art. 54 of FA; ○ for those, which will be leased – as per the procedure of Art. 43 of FA. 2. The **administrative act** issued by the Ministry of the environment and Waters must **identify the land properties** in forest areas, whereon the various facilities will be constructed. Different processes relating to the issuance of administrative act and execution of contracts apply to the procedures for purpose of use modification (except for the cases of Art. 73, Para 1, Cl.5), for creation of right to build or right-of-way.		
31.	**MoD, 11-00-13 of 01.02.2013**	On the grounds of Art. 95, Para 3 of the Environment Protection Act and Art. 9, Para 1 of the Regulation on the Conditions and Procedure for Environment Impact Assessments, I hereby advise you that the Ministry of Defense has no notes, guidelines, and recommendations to the ToR for the scope and contents of the EIA for the investment proposal to develop a new, latest-generation nuclear facility at the Kozloduy NPP site	Accepted	
32.	**Kozloduy NPP EAD, Safety and Quality directorate, Д „Б и К“ 190/8.02.13**	1. Envisage assessment of cumulative impact of the new investment proposal on the current and future proposals located at the NPP site or in proximity thereto. 2. The activities of water use and discharge and the activities on non-radioactive waste must be aligned to the Environment Programs in Kozloduy NPP. 3. Comply with the conditions of the Permits issued to Kozloduy NPP EAD as regards the environment. I hereby ask that NPP New Facility EAD be requested to	Accepted	The opinion has been taken into account and will be reflected in the EIAR.

		forward, whenever there is a new revision of the ToR, the revised document to Kozloduy NPP EAD for review and opinion.		
33.	**MAF, ref. No 70-148 of 13.02.2013**	1. Out of the four alternative sites proposed, they believe that the most favorable one, within the meaning of the Protection of Farming Lands Act, provided that it is fit to host a new nuclear facility, is Site No 4 – within the alienated NPP plots. In case it is needed to select the other proposed alternatives, those affecting less productive lands are considered more appropriate.	Partially accepted	The opinion has been taken into account and will be reflected in the EIAR.
34.	**Nuclear Regulatory Agency, ref. No 47-00-171 of 12.02.2013**	Further to your letter No 252/05.12.2012, I hereby advise you that pursuant to the Transitional and Final Provisions of § 3, Para 2, Cl. 2 of the Regulation on ensuring the safety of nuclear power plants for the nuclear power plants existing prior to the Regulation's entry into force, the annual individual effective dose per capita, which is caused by the impact of liquid and gaseous discharges into the environment at all operational statuses must be lower than 0.25 mSv. Pursuant to Art. 37, Para 2 of the Regulation on the procedure for issuing licenses and permits for safe use of nuclear energy, when a nuclear facility is projected to be situated at the site of an already developed and operation other nuclear facility, the preliminary safety analysis report accounts for the potential impact of the new nuclear facility and the other facilities located at the same site. Therefore, the 0.25 mSv requirement refers to all units and facilities located or to be located at the Kozloduy NPP site . As at now, such nuclear facilities are Units 1-6, the SFSR, and the National Repository for Deposition of RAW. The limits of gaseous discharges from all ventilation pipes at the Kozloduy NPP site have been derived based on an individual effective dose per capita of 0.05 mSv per year. Based on the operational experience, the limits of discharges for the entire site are allocated to the individual ventilation pipes of Units 1÷6 and SFSR. For the liquid discharges the dose quota of 0.05 mSv per year was adopted. Following final termination of operation of Units	Accepted	The opinion has been taken into account in Clause 1.8.2.1.2 Emissions of Radioactive Products in the Atmospheric Air and will be reflected in EIAR, Chapter 4.11 – Radiation Risk to the Populace in Radioactive Discharges

		1+4 NRA has not received any requests to permit changes in the overall limits for liquid and gaseous discharges at the Kozloduy NPP site. By means of Permit No HX-3593 of 04.05.2012 by NRA for designing a nuclear facility for management of radioactive waste – National Repository for Deposition of RAW a condition was stipulated that the permit holder is to provide via its design suitable technical and organizational measures to limit the annual individual effective per capita dose for the relevant target group of the populace, which dose results from normal operation of the facility, as well as following its closure, to 0.1 mSv. Based on the above and in accordance with the legislation and the existing licensing practice it can be assumed that for a new nuclear facility located at the Kozloduy NPP site , the annual individual effective per capita dose, which is caused by the impact of liquid and gaseous discharges into the environment at all operational statuses, must be limited to up to 0.05 mSv. When calculating the doses for the populace it is necessary to take into account all radionuclides in the liquid and gaseous discharges, as identified in Recommendation 2004/2/Euratom. As regards the matter of the need to carry out assessment of the cumulative effect of all nuclear facilities in case of design basis accidents, pursuant to the effective legislation and the governing manuals, no assumption of simultaneous occurrence of design basis accident at all site facilities is required in the justification of that level of in-depth protection. At the same time attention should be paid to the fact that as a result of the stress tests conducted at European nuclear plants following the Fukushima-Daichi NPP accident, one of the resulting measures is to consider in the emergency action plans simultaneous occurrence of a severe accident at all site facilities.		
35.	**MC, ref. No 33-HH-81 of 19.02.2013**	Pursuant to the information stored in the records of NIFCH, the municipalities of Kozloduy, Valchedram, Heyredin, Mizia, Lom, Byala Slatina, and Oryahovo /within the indicated 30-km zone/ contain some 300	Accepted	The opinion has been taken into account in the elaboration of Clauses 3.12 and 4.12 and will be reflected in the EIAR

architectural-structural, historical, art, and archeological fixed cultural valuables.

Located in the proximity of Kozloduy NPP are Roman Fortress Regiana – architectural-structural fixed cultural valuable, "national significance" category, as promulgated in the SG, issue 90/1965 and Archeological Reserve – Ancient Fortress Augusta, Harlets village, Kaleto locality, as declared with an Order of the Council of Ministers No 14/25.06.1984. The lands of the town of Kozloduy are characterized by high concentration of archeological fixed cultural valuables. As evident from the topographic maps, several mound necropolises are located in the immediate vicinity of Kozloduy NPP, these are likely to be affected by the investment proposal's implementation. By means of an CM Order No 1711 of 22.10.1962 all settlement and burial mounds and medieval defensive walls have been declared as culture monuments in the "national significance" category. Due to the specifics of fixed cultural valuables it is presumed possible that some yet unregistered sites of NCV status, pursuant to Art. 146, Para 3 of the Cultural Heritage Act, may fall within the areas of the proposed four alternative sites

The Ministry of Culture hereby places the following requirements to „Terms of Reference for the scope and contents of EIA for the investment proposal to develop a new, latest-generation nuclear facility at the Kozloduy NPP site , town of Kozloduy:

1. The EIA Report part concerning fixed cultural heritage be elaborated by a specialized archeologist and be based on an prior inspection of the plots, which would be affected by development of the new nuclear facility and its appertaining technical infrastructure. The purpose of such inspection is to ascertain the presence or absence of fixed cultural valuables. A written report containing the inspection outcomes must be sent to the Ministry of Culture.
2. Should impact on fixed cultural valuables from the

		investment proposal's implementation be found, the EIA Report must be submitted for review to the Ministry of Culture, and the follow-up activities must comply with the requirements of Art. 161 of the Cultural Heritage Act /CHA/ and must be agreed with the Minister of Culture pursuant to Art. 83 according to the procedure of Art. 84 of CHA The opinion was drafted based on: 1. NIFCH's opinion, 2. Documentation.		
36.	**Kozloduy NPP EAD, ref. No 3145 of April 18, 2013**	1. The ToR submitted by you meets the basic requirements of Art.10 of the Regulation on the Conditions and Procedure for Environment Impact Assessments. The conditions and recommendations required by us in the letter for prior consultations for the drafting of the ToR have been fulfilled, you have been sent Letter No РиМ-98/14.01.2013. 2. For better accuracy of the information in the document it is expedient to remove the following inaccuracies: 2.1 Fig.1.2-1 is not a master plan of Kozloduy NPP, but a scheme for sampling points for the purposes of radio-environmental monitoring of the industrial site. A schematic presentation of the site facilities on the Master Plan and a Description were sent to you via letter No 992/05.02.2013, DVD 1, folder 11. 2.2. From the viewpoint of emergency preparedness the following are not listed in the settlements within the Zone for Urgent Protection Measures (ZUPM) – Zone No 3. Provisional radius 30 km around Kozloduy NPP EAD: – In Cl.1.3. Special Status Zones around Kozloduy NPP – the municipalities of Boychinovtsi, Krivodol and Borovan; – In Cl.3.5.1. current status Krivodol municipality, – on p. 231 Forest Landscape – Krivodol municipality; – In Cl. 3.10.2. Impact Forecast – the municipalities of Boychinovtsi, Krivodol and Borovan. 43 settlements with a total of 71321 residents fall within	Accepted	The opinions have been taken into account in the elaboration of the updated ToR and will be reflected in the EIAR.

		the ZUPM. 3. In addition, attached please find opinions of experts from Kozloduy NPP to be reflected in the next version of the ToR for the scope and contents of EIAR. Acknowledging the importance of the ToR for the scope and contents of EIAR of the site: for the investment proposal to develop a new, latest-generation nuclear facility at the Kozloduy NPP site, I believe that if our notes are reflected, this would improve the quality of the reviewed documents, hence, of the EIAR itself. Opinion reg. No НМ-34/10.04.2013 by NM Administration; Opinion reg. No УНМ-23/10.04.2013 by BK directorate; Opinion reg. No ХТС-СТ-44/15.03.2013 by P directorate; Opinion reg. No 13.УОС.СТ.212 by BK directorate; Opinion reg. No У(Б) 299/08.04.2013 by BK directorate	Not accepted	EIAR will work with the populace numbers within the 30 km zone as per the last census in 2011.
37.	**Ministry of Agriculture, Forests, and the Environment and Water Management of Austria, ref. No 541402 of 26.06.2013**	Austria advises Bulgaria that as per the procedure of Art. 3 Para 3 of the Espoo Convention and Art. 7 Para 2 of the EIA Directive, it will take part in the transboundary procedure pursuant to the Espoo Convention and the EIA Directive, since significant transboundary impacts on Austria's environment cannot be ruled out. Therefore, Austria requests that Bulgaria present the documentation associated with the environment impact assessment with information about the general public's involvement (e.g. the opportunities for the general public's involvement, timeframes) in order to grant the Austrian public equal opportunities according to Art. 2, Para 6 of the Espoo Convention. Therefore, Austria requests that the documentation is sent in German. As regards the EIA scope, Austria is expecting a comprehensive analysis and assessment of severe accidents with long impact range in the environmental assessment report.	Accepted	Reflected in the EIAR
38.	**Ministry of the Environment and Climate Change**	The Terms of Reference have been disseminated to the competent Romanian authorities, who requested that the document be completed with the following information, in	Accepted	Reflected in the EIAR

	(Romania), ref. No 3072/RP/06.08.2013	view of the fact that both banks of Danube river near Kozloduy include Natura 2000 sites and other protected areas: 1. Assessment of the impact of high-temperature water discharged in the Danube river by types of fish under legal protection, with special focus on *Alosa Sp*. Special technical measures must be implemented by the Bulgarian side, since these are fish types, which must not be endangered by the hot current of the discharged water. The same issue was raised in the case of Cherna Voda NPP and was resolved. 2. In addition, it is necessary to make assessment of the stage of development and expansion of alien invasive species (such as *Corbicula fulminea*) and their potential impact on the biodiversity. 3. Assessment of the impact on the flora and fauna within the Project area, on both sides of Danube river, which are within and outside the protected areas. 4. Assessment of the Project impact on biodiversity in each alternative, incl. the “zero alternative” – where the Project will not be implemented. 5. Assessment of the cumulative impact with other projects implemented at the proposed site and its vicinity, which may harm the nature capital of Romania and Bulgaria. 6. What are the measures to mitigate the impact on biodiversity and the data about the residual impact following their implementation. 7. The biodiversity monitoring program, including the invasive species. Considering the interests of the Romanian populace residing within the 30 km zone, we believe that discussion of the measures to overcome the Project effects in the EIA Report is of major significance.		

11 LIST OF THE REQUIRED ANNEXES, LISTS AND OTHER

11.1 ANNEX 1: LEGISLATIVE FRAMEWORK

11.2 ANNEX 2: METHODS USED

11.3 ANNEX 3: REFERENCES AND INPUT DATA

11.4 ANNEX 4: CONSULTATIONS

12 STAGES, PHASES AND DEADLINES FOR EIAR ELABORATION

The stages/phases and deadlines for EIAR elaboration are as follows:

Phase/Stage		Cut-off date
Phase 1 – Elaboration of Report on EIA, CA, and Transboundary Impact		
1	Elaboration of EIAR	**Q3 of 2013**
2	Elaboration of AA	
3	Elaboration of Transboundary Impact Report	
Phase 2 – First review by the competent authorities		
4	Receive comments from MoEW, reflect the MoEW comments, approval of the reports by MoEW	**Q3 of 2013**
Phase 3 – Public discussion and conclusions from the Public discussion		
5	Arrangement and conduct of the public discussion, organization of the public discussion, conduct of the public discussion, processing of minutes from the public discussion, opinion on the proposals, opinions, and recommendations and the outcomes of the public discussion.	**Q4 of 2013**
Phase 4 – Final approval by the competent authorities		
6	Filing of the EIA documentation for conduct of the SEEC meeting	**Q4 of 2013**
Expected decision on the EIA		

13 OTHER CONDITIONS OR REQUIREMENTS

In the context of determining the IP's transboundary impact data are required for the Romanian territory falling within the monitored zone of 30 km. The Client is making the necessary efforts to collect data as much as possible.

These ToR include analysis of the entire information available at the time of its elaboration, with efforts having been made to base the forecasts and additional analyses and assessments to be made during EIAR elaboration on real, reliable, and up-to-date information. For the purpose, information will be used in the EIAR from the following projects:

1. STUDY AND DETERMINATION OF THE LOCATION OF A NEW NUCLEAR UNIT AT THE KOZLODUY NPP SITE;
2. PERFOMANCE OF TECHNICAL-ECONOMICAL ANALYSIS TO JUSTIFY DEVELOPMENT OF A NEW NUCLEAR UNIT AT THE KOZLODUY NPP SITE.