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Environmental Impact Assessment Report

for Investment Proposal:

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

Chapter 1: ANNOTATION OF THE INVESTMENT PROPOSAL FOR THE CONSTRUCTION, OPERATION AND TECHNOLOGIES

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COMPANIES

“Kozloduy NPP – New Build” 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
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
BSR	Basic Safety Rules
CDTC	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 Earthquake
DeC	Decommissioning
DFC	Degree of Flammability Coefficient
DGS	Diesel Generator Station
DSFSF	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-fighting Pumping Station
FS	Fire Safety
FSFS	Facility for Spent Fuel Storage under water
GIS	Geographical Information System
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
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 domestic and industrial waste
LWR	Light Water Reactor

MAC	Maximum Admissible Concentrations
MARAW	Middle Active RAW
MC	Council of Ministers
MDA	Minimum Detectable Activity
MDBE	Maximum Design Basis Earthquake
MDC	Main Drainage Channel
MEW	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 Real Estate 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
OSG	Outdoor Switchgears
PA	Protected Areas
PAZ	Precautionary action zone
PB	Plant Building
PCB	Polychlorinated biphenyls
PFZ	Potential focal zones
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
RNG	Radioactive Noble Gases
RP	Radiation Protection
RPS	Radiation Protection Standards
S and SF	Supplies and Storage Facility
SASCEC	System of accelerographs for seismic control of the equipment and constructions
SB	Sanitary 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
SISP	System for industrial seismic protection
SMM	System for Meteorological Monitoring
SNF	Spent Nuclear Fuel
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 Supervisionn
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-cooled water-moderated power reactor
WWTP	Waste Water Treatment Plant
PWR	Pressurised Water Reactor

INTRODUCTION

The report on EIA for the investment proposal Building a new nuclear unit of the latest generation on the Kozloduy NPP site is developed in compliance with the Environmental Protection Act (EPA prom. in SG No 91/25.09.2002, amended and supplemented, SG No 27 of 15 March 2013 and the Regulation on the terms and procedure for environmental impact assessment, prom. SG No 25 of 18 March 2003, amended and supplemented SG No 94 of 30 November 2012.

The EIA report complies with the requirements of the Assignment for determination of the scope and content of EIA as updated after consultations with the competent authority on EPA for making a decision as well as with other administrations and institutions.

The investment proposal (IP) of Kozloduy NPP – New Build 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 Annex 1 of EPA, item 2.2. “Nuclear power plants and other nuclear reactors, including the dismantling or decommissioning of such power stations or reactors, except research installations for the production and conversion of fissionable or fertile 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 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 report is fully compatible with the requirements of art. 96, para. 1 of EPA and art. 12 of the Regulation on the terms and procedure for environmental impact assessment.

The main purpose of the EIA report is to identify the components and factors of the environment which may suffer potential impact in consequence of the realization of the IP, possible accumulation of the impacts, risk of accidents and potential transboundary impact. By considering three main technical and layout solutions for reactor installations of the latest generation (alternative A1 (hybrid) and alternative A2 – including 2 models of absolutely new project reactors) and 4 potential sites for location of the new nuclear unit, the assessment has to justify and motivate the most suitable alternative solution and offer mitigation measures to reduce, prevent or possibly fully eliminate the identified impacts on the environment and human health.

The report on EIA for the investment proposal Building a new nuclear unit of the latest generation on the Kozloduy NPP site is a single document as required in art. 12 of the *EIA Regulation* and outgoing letter No 26-00-1035 dated 09.04. 2013.

In response to the letter № EIA-53 30.09.2013, in this EIA report have been adjusted and corrected some incompleteness and inaccuracies, mentioned in the same letter in order to take full account of the recommendations of the competent authority Ministry.

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1 ANNOTATION OF THE INVESTMENT PROPOSAL FOR CONSTRUCTION, OPERATION AND TECHNOLOGIES

1.1 BASELINE CONDITIONS

1.1.1 HISTORY OF KOZLODUY NPP

The beginning of 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 technical and economic analysis, the construction site for the nuclear power plant was selected on the bank of the Danube River 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 unit 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 were implemented in three stages:

- → Stage I: 197 0 – 1 975 – Construction and commissioning of unit 1 and 2 with Water-cooled water-moderated power reactors WWER-440, model V-230, with two independent trains of the safety systems;
- → Stage II: 1973 – 1982 – Construction and commissioning of Units 5 and 6 with Pressurised Water Reactors WWER-440, upgraded model V-320 with three-fold redundancy of the safety systems.
- → Stage III: 1980 – 1991 – Construction and commissioning of Units 5 and 6 with WWER-1000, 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 shut down the first four units before the expiry of their design lifetime, which is 30 fuel campaigns **– Table 1.1-1.**

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	BBEP-440	1974	31.12.2002	23	66 675 397
Unit 2	BBEP-440	1975	31.12.2002	24	68 905 334
Unit 3	BBEP-440	1980	31.12.2006	22	68 703 260
Unit 4	WWER-440	1982	31.12.2006	21	66 11 966

1.1.1.1 ENERGY GENERATION

In 2002, the last year when the nuclear power plant operated all its six installed capacities, a record quantity of electricity was generated – 20 221 719 MWh, which was 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.**

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.

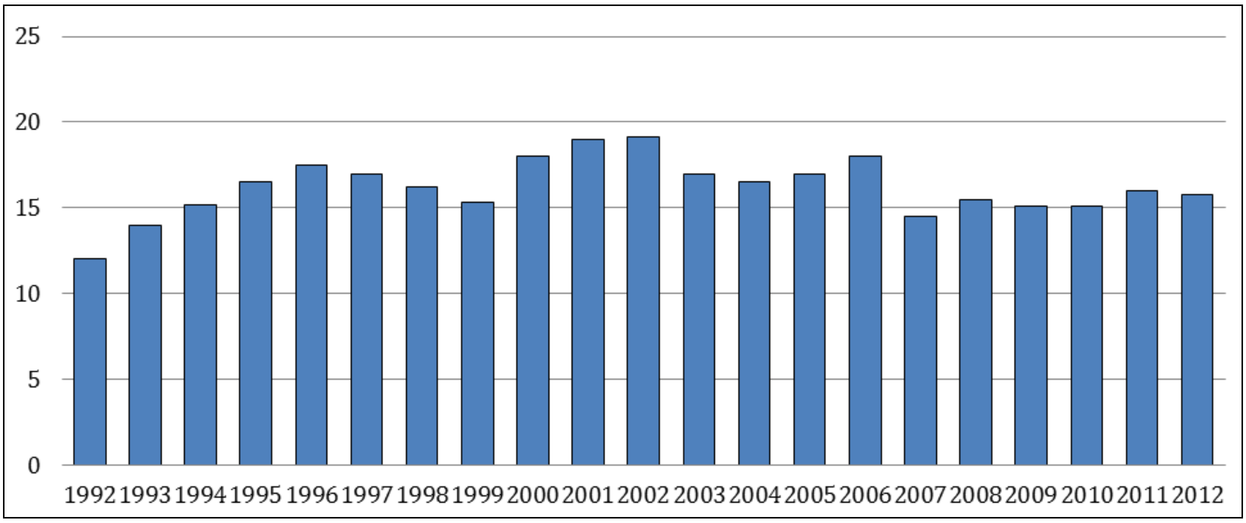

FIGURE 1.1-1: ANNUAL PRODUCTION OF KOZLODUY NPP

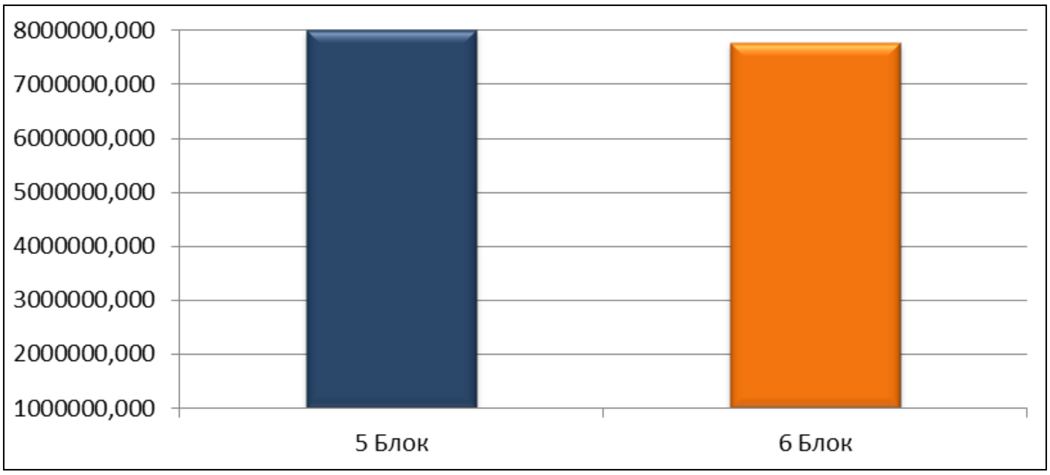

FIGURE 1.1-2: PRODUCTION FOR THE PERIOD JANUARY – DECEMBER 2012

Figure 1.1-2 shows the annual electricity generation of units 5 and 6 for 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.

1.1.1.2 NUCLEAR FACILITIES AND COMMON PURPOSE BUILDINGS ON 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 of + 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 a 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 %.

The Danube river is a surface water body, defined as category river with the name DanubeRWB01 and code BG1DU000R001 in RBMP in the Danube region, which is prepared in accordance with the requirements of Directive 2000/60 of the EU, and the Water Act, and approved with Order No. 293/22.03.2010 of The Minister of Environment and Water. The entire length of the Bulgarian section of the Danube River from the village of Novo Selo to the town of Silistra is receiving category III waters pursuant to Order № РД-272/03.5.2001[1] of the Minister of Environment and Water. It is defined as a heavily modified water body with moderate ecological potential and poor chemical condition according to RBMP of the Danube region in Bulgaria and letter No 3804/0801.2013 of BDWMDR.

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[1] While this EIA report was being drawn up, Regulation No 7/1986 on the indicators and norms for determining the quality of the running surface waters was repealed by the Regulation for the repeal of Regulation No. 7, published in State Gazette No. 22 of 05.03.2013

At present, the more important sites and facilities on the site of Kozloduy NPP (**Figure 1.1-3)** 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;
- → Special buildings 1 and 2 (SpB-1,-2)- serving respectively units 1,2 and 3,4 of EG-1; Special building 3 (SpB-3) – serving 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);
- → Storehouse;
- → Landfill for non-radioactive household 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 of 4 471.712 daa. It is divided in the following main zones:

I. Electricity generation -1 (EG-1) with 1÷4 power units, special buildings 1 and 2 and auxiliary facilities. On this territory is located a spent fuel pond (SFP) and dry spent nuclear fuel storage facility (DSNFSF) 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.

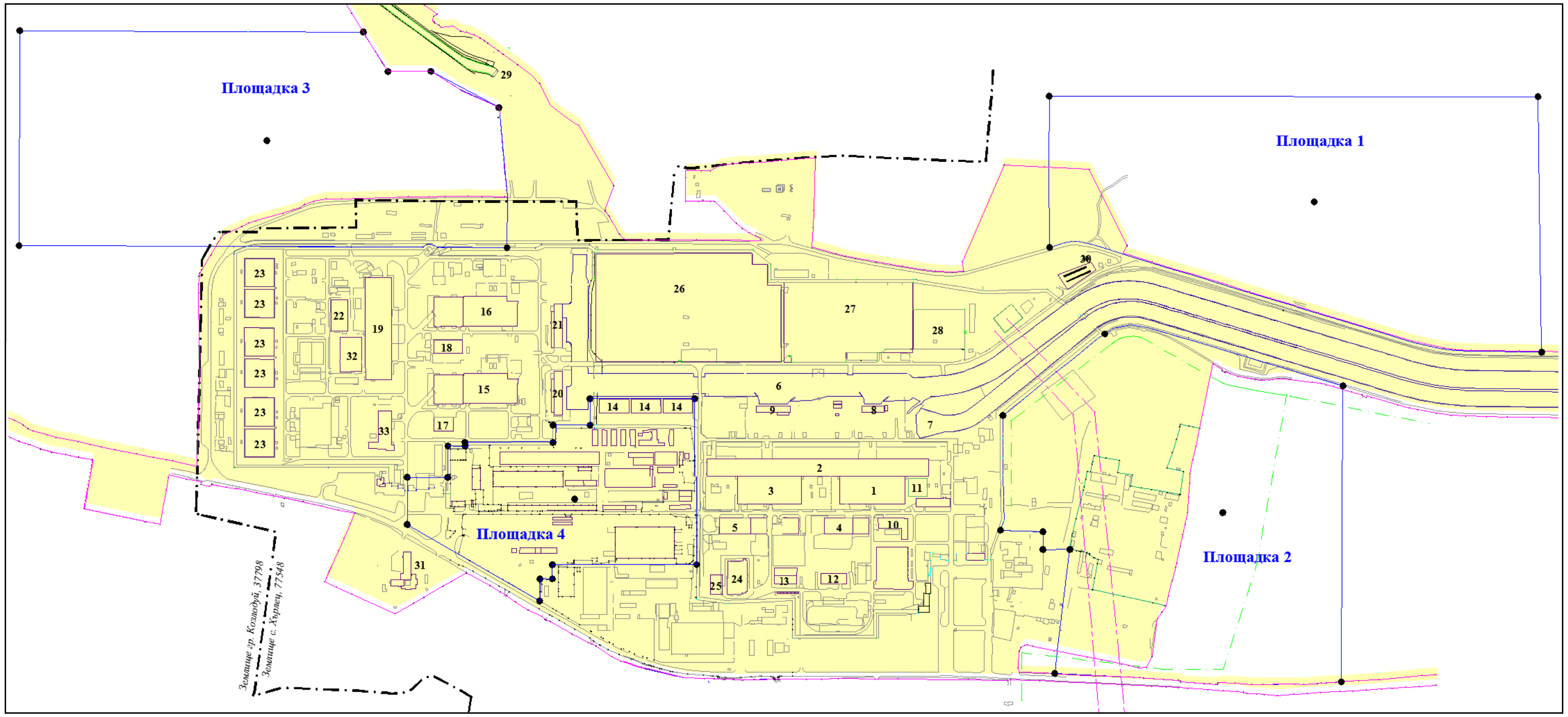

FIGURE 1.1-3 GENERAL PLAN OF KOZLODUY NPP AND LOCATION OF THE PROPOSED SITES OF NNU

Legend:

1. Reactor compartment units 1,2.
2. Machine hall units 1÷4 .
3 Reactor compartment 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. Shop for reducing the dimensions and inactivation – project.
12. Diesel Generator Station 1.
13. Diesel Generator Station 2.
14. Spray ponds units 3,4
15. Unit 5.
16. 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 municipal and industrial waste – LN-rMI.
31. Fire protection service.
32. SD RAW shop to SE RAW.
33. Occupational Medicine office

1.1.1.2.1 Nuclear facilities at Kozloduy NPP site

On the Kozloduy NPP site are built: 6 units with total power capacity of 3760 MW equipped with pressurized water reactors, spent nuclear fuel storage facility (SNFSF) and dry spent nuclear fuel storage facility (DSNFSF)

1.1.1.2.1.1 Units 1 and 2

Units 1 and 2 were decommissioned on 31.12.2002. 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 an operational regime – mode "E". No nuclear fuel is stored on the site of units 1 and 2.

1.1.1.2.1.2 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 cancelled the licences of Kozloduy NPP for the operation of the two units in an operational regime – mode "E". No nuclear fuel is stored on the site of units 3 and 4.

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

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

1.1.1.2.1.3 Units 5 and 6

Units five and six were commissioned respectively in 1987 and 1991 and now they are under procedure for operational lifetime extension and possibly capacity increase. Unit five is 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 B-320. The reactors are Russian – second generation with pressurized water and two circuits – primary (radioactive) and secondary (non-radioactive).

The cooling agent and neutron moderator used in the primary loop is a solution of chemically deionized water and boron acid (H_3BO_3), with boron acid concentration changing during the operation of the reactor.

→ *The primary circuit* has four loops, each having one main circulation pump and a horizontal steam generator (SG). There are auxiliary systems connected to the primary circuit.

→ *The steam turbine installation* is the main part of the equipment of the secondary circuit and includes turbine К-1000-60/1500-2, generator ТВВ-1000-4 and auxiliary systems.

The reactor, SG and the other equipment of the primary circuit, as well as the connected auxiliary systems operating at high pressure of the fluid (15.7 MPa) lie in a steel and concrete containment with an inner cladding. The unit is connected to the electrical grid (EG) of the Republic of Bulgaria by means of outdoor switchgear (OSG). The power consumers of the unit are supplied with electricity by a system for own purposes.

According to the concept for safety, design characteristics and construction, 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 Soviet Union and are analogous to the western reactors type PWR. The main safety concept of defence-in-depth is realized through design solutions characterized by redundancy, variety, independence, protection against failure and passive elements.

Each WWER-1000/V-320 reactor has containment with protection steel cladding resistant to mechanical stress similar to western reactors. Both units are in a procedure for extending their lifetime as well as increasing their capacity.

1.1.1.2.1.4 SNFSF

The spent nuclear fuel pond is located south-west of units 3 and 4 on the Kozloduy NPP site. SNFP 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 SNFP following the safety requirements.

1.1.1.2.1.5 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 of the activity being carried out so far on the NPP site – temporary spent nuclear fuel storage in SNFSF.

1.1.1.2.2 Other facilities and buildings owned by SE RAW

At present, pursuant to the licence for operation of nuclear facility 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 department (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 pre-treatment activities, treatment and conditioning of RAW from Kozloduy NPP.

   The main component unit for making the packages for the conditioned RAW is a reinforced concrete container (StCC) which is made and tested according to the permit 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 processing.

   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 the 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 above 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 on the Lime Plant 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 reinforced concrete containers (RCC) – (packages RCC-1 or RCC-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 reinforced concrete containers (RCC) – (packages RCC-2) ;

   → Site for solid RAW storage in large ton containers (LTC);

   → Storage for contaminated soil (SCS).

The facilities not included in the composition of the nuclear power units, planned to be built by SD RAW on the Kozloduy NPP site to 2015 are as follows:

1. Plasma melting facility – phase of work project and completed ISAR.
2. Size Reduction and Deactivation Shop – phase of technical design
3. National repository 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, fool-proof and packed in cubes of reinforced concrete. The repository will be of the trench type at the ground surface with capacity of 138 200 m^3 . It will consist of several sunken steel-concrete modules divided into chambers by inner partitions. After being filled up with packages, the chambers will be covered with a reinforced concrete plate and isolated 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 a National Repository for low and medium active waste (NRRAW) have been approved. Commissioning is expected to be done in 2015

1.1.1.2.3 Common Purpose Buildings and Facilities

1.1.1.2.3.1 Outdoor switchgear

Kozloduy NPP is connected to the electricity grid (EG) of Republic of Bulgaria by means of 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 bus system, Switchgear 110 kV – as a double busbar system with a bypass busbar.

1.1.1.2.3.2 Drinking Water Supply

There is a water network on 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 EOOD – Vratsa. They also provide water 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 where it reaches the individual consumers by gravity. The length of the thrust water pipeline from PS to the reservoir is 0.5 km[2]. The external water system – wells, pumping stations, water pipelines

[2] Letter by V&K OOD – Vratsa, No264/04.04.2013 г.

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 on 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 actual quantity of drinking water amounts to about 35÷40 l/s.
Balance of the drinking water supplied to the consumers on the site of Kozloduy NPP:

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

2. Consumers:

CONSUMERS:	DEVIATION – Ømm	OUTFLOW 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 tube well in the Valyata area is used. A Permit is issued for this facility under the WA by БДУВДР.

1.1.1.2.3.3 Water supply for technical purposes

The service water supply provides cooling water /circulation – for the condensers of the turbines and technical for other facilities/. Ii 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. Water for technology needs, and for the system of fire extinguishing, 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 from deep waters. 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 [3]. For the use of the water from the Danube as well as from the ground sources there are Permits for abstraction issued by BDWMDR.

[3]Energoproekt 1991 г .- Existing channels for service water supply of Kozloduy NPP.

Water from the Danube is supplied to the plant by the hydrotechnical facilities, which are crucial for the normal operation of the plant. The cold channel 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 to 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 intake cold outdoor channel for the Danube water is 19.50m wide at the bottom, batters 1:2 and depth of 5.6m.

The used water from the power units is discharged back to the Danube by a hot outlet channel HC-1. The hot channel HC-1 begins at the outlet shaft of the light 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 maximum capacity of 200 m^3/s and depends on the elevation of the spillway after the light pressure channels and the water level in the Danube. The outlet hot channel passes parallel to the cold CC-1 in the largest part of the route. The channels have a common dike and form a double channel. For the needs of power units 5 and 6, HC-2 was built, dimensioned for 110 m^3/s .

There is a bypass channel serving as a connection between HC-1 and the riverbed of the Danube and for damping the flow energy of the water. 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 fence 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 chutes 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 intake 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 for 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-flooded 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 – responsible and non-responsible depending on the responsibility for nuclear safety they bear. The responsible 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 responsible consumers, its cooling being provided by the spray ponds. In such cases reserve water is provided from the partition-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, the accepted necessary conservative value being 60 m^3/s, for the new unit. 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 1.1-2 ANNUAL QUANTITIES OF WATER MASSES USED FOR SERVICE AND DOMESTIC WATER SUPPLY

Abstraction locationl	Permitted quantity [thous. m3]	Used quantity [thous. m^3]						
		2006	2007	2008	2009	2010	2011	2012
Surface waters from the Danube River	5 000 000	3 331 722	2 323 800	2 629 876	2 593 459.5	2 564 530	2 660 788	2 415 903
Six tube wells (GWPS 1÷6)	7 884	-	-	0	0	0	24.779	55.556
Raney 5 well	1 600	190	314	75	15.929	24	2.729	1.578
Tube well Valyata	788.4	291	183	204	192.27	193	216.7	289.59
Urban water network	-	1 877.707	1 846	1 259	1 460	1 435	1 379	1 142.565

Source : Annual Report for ONM of environment in Kozloduy NPP for the period 2006-2012.

The information presented (**Table 1.1-2**) shows that the water quantities applied for considerably exceed the actual consumption, so the given water body is not overused and there will be enough water quantities available for drinking, domestic and industrial water supply upon the implementation of the Investment proposal.

The emergency service water supply is through pipelines from EPS of BPS to the fore chamber of CPS-11÷4. EPS is equipped with diesel generators providing supply for ESWP in case of failure of the regular connections of the external supply.

In the vicinity of Kozloduy NPP there is a HTF called Shishmanov Val, which is located in the valley of Berich river, southwest of the town of Kozloduy. It was possible to provide additional service water from the dam in emergency situations. The dam is property of Irrigation Systems EAD.

1.1.1.2.3.4 Sewerage system

Kozloduy NPP has a sewerage system for household and faecal, industrial and rain waters – combined for EP-1 and separate 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..

1.1.1.2.3.4.1 Non-radioactive wastewater

The non-radioactive waste waters on Kozloduy NPP site are household, faecal, industrial and rain. 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 fuel and crude oil facilities/fuel and lubrication facilities, the diesel-generator stations, vehicle fleet, etc.

The following main streams are formed at EP-2:

- → household-faecal wastewater – from the sanitary facilities and laundries in the controlled area and the clean area, which are conveyed along separate collectors to the EP-2 WWTP;
- → production waste waters – they comprise acid and alkaline waste waters from the CWTF, waters contaminated by crude petroleum products and oils, which are conveyed along 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 on 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 is conveyed into the rain water sewerage.

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

Stream 1: A mixture 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 for the household-faecal wastewaters from the energy buildings of units 1÷4, auxiliary buildings 1 and 2, DGS and other administration and staff buildings, part of which are the property of SD DC – a subsidiary 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 (not treated) 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 TH, DGS and the diesel and oil 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 a collector of Ø1000 mm.

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

There is a permit for discharge into the MSC issued for these waste water streams by the BDWMDR .

Besides the above four streams, waste waters are discharged 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 water discharged from the Special Water Treatment (SWT-3, SWT-5, SWT-7), including heating steam condensate ;
- waters from the demineralized water installations (after treatment in the neutralizing pits);
- waters from the expansion vessels of the overflows of the high-pressure deaerators (HPD) and from the expansion vessels of the steam generator (SG) blowdown ;
- water from the secondary circuit drainage tanks and from the flushing of the main condensate system ;
- flushing water from the circulating 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 EP-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 designed 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 diesel and oil facility. Its capacity is 50 l/s. The concentration of oil at its outlet is less than 0.5 mg/l. The treated waters from 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 (CWCF) of Electricity generation 1 (units 1÷4) and Electricity generation 2 (units 5 and 6) of Kozloduy NPP EAD water from the Danube River (raw water) is treated 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 EP-1 and EP-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 are 6.5 to 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 MEW/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 No 0562/14.03.2005;
- → Permit No 11530127/ 30.05.2008;
- → Permit No 11530127/30.05.2008;
- → Permit No 11530127/30.05.2008;
- → Permit No 13750001/20.04.2007 with its subsequent amendments;
- → Permit No 13120037/22.11.2010.

Permit for water abstraction No 11530127/30.05.2008 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 of Kozloduy NPP. During normal operation, the losses of water in the spray ponds of units 5-6 are compensated 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 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 – two pumps are installed, each with a discharge rate of up to 140 l/s.

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

The wastewater discharge and water abstraction permits issued according to the WA 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..

1.1.1.2.3.4.2 Radioactive contaminated waste waters

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

- → nuclear reactors primary loop leaks;
- → ponds and spent fuel storage facility;
- → deactivation of equipment;
- → regeneration and flushing of ion-exchange filters;
- → protective clothing laundry and sanitary access;
- → radiochemistry laboratories, etc.

These waters are treated (purified) in evaporation installations and ion-exchange filter complexes (Special Water Treatment SWT -3) in Specialized 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, deactivation 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 deaerators and from the steam generators blowdown are also debalanced. 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 special water treatment systems is collected and stored in special tanks for evaporation liquid concentrate. It is subjected to additional processing and disposal as RAW.

1.1.1.2.3.4.3 Interfaces between units 1÷4 to units 5 and 6 (steam, water, fire protection ring)

There are interfaces built 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 provide for 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 are combined in fire rings connected with each other and if required there is a possibility to transfer water for fire-extinguishing from one to another;
- → 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 demineralized water systems of units 5 and 6 are connected to those of units 1÷4, with a possibility to share demineralized water between themselves, whenever necessary.

1.1.1.3 FRESH NUCLEAR FUEL USED IN KOZLODUY NPP

The quality and operational characteristics of the fresh nuclear fuel are among the most important factors for the economic efficiency of the nuclear plant. Efforts are made to develop and apply new technologies for the production of FR and HRC to ensure safe and reliable operation of the core and high economic efficiency of the burning cycles. One of the main goals of the NF producers is to increase the depth of burning and so achieve higher economic efficiency including in the management of SNF it is generated in smaller quantities. In this connection the efforts are also focused on establishing the limits for ensuring the integrity of the second protection barrier – the liner of the fuel rods.

The transition of units 5 and 6 of Kozloduy NPP from operation with the core filled up with nuclear fuel TVS-M to filling up the core with NF of the type TVSA was completed in the period 2004-2008. Fuel TVSA has most of the neutron-physical and thermohydraulic characteristics of TVS-M, but is distinguished for considerably better mechanical qualities and lower frequency of deformation occurrence. Currently the so-called uranium – gadolinium fuel is widely used. The standard uranium oxide is mixed with up to 5 % weight parts of gadolinium oxide ($Gd_3 0_3$), which is a burnable absorber. FR with such a filling are called fuel rods with gadolinium (FRG). In the TVSA the construction of the fuel rods consists of tubes of zirconium alloy filled with tablets of sintered uranium dioxide (FR) or with tablets made from sintered uranium dioxide and gadolinium oxide (FRG) The introduction of a burnable absorber in HREG allows the energy distribution by the burning and burning cycles efficiency to be improved as well as safety. For example, the use of TVSA in units 5 and 6 achieved a stable decrease of the average activity of the iodine isotopes (^{131}I-^{135}I) in the moderator[4, 5].

The core of the reactor WWER-1000/V320 includes 163 FR. When TVSA is used each TOK contains 312 fuel elements. Of them 306 are HRE and 6 HREG. The total weight of uranium in the core is 71 tons. One TOK TVSA has a mass of 710 kg of which 494.5± 4.5 kg UO_2.

The natural radioactivity of fresh nuclear fuel is 0.5 Ci, gamma radiation on the surface being 20 mSv/h (for non-recycled fuel).

[4] Updated safety analysis report for facilities and operation of Kozloduy NPP **unit 5**, July, 2011.
[5] Updated safety analysis report for facilities and operation of Kozloduy NPP **unit 6**, July, 2011.

In the last years the strategy for the operation of units 5 and 6 is about 320 days at full capacity and about 45 days for the yearly refilling of the core[6].

1.1.1.4 SNF MANAGEMENT AT KOZLODUY NPP

The spent nuclear fuel is an inevitable technological product in the nuclear electricity generation. It is irradiated nuclear fuel with presence of fission radionuclides The practice of SNF management in R Bulgaria is done by storing the SNF on the Kozloduy NPP site in the spent fuel ponds at the reactors and in SNFSF under water followed by transferring SNF for technological storage and processing.

1.1.1.4.1 Spent fuel pond (SFP)

The spent fuel ponds at the reactors are used for short term storage of the fuel assemblies after being removed from the core for lowering their activity, respectively the residual energy release before being transported to SNFSF or to Russia. The regulation for storage in SFP is 3 years if the SH is to be transferred to SNFSF and 5 years if it is to be transferred to Russia.

The spent fuel storage system at the reactors in units 5 and 6 is an aggregate of systems, devices and facilities designed for spent nuclear fuel (SNF) storage and includes:

- storage pond with racks for compact storage of nuclear fuel, plates for covering SFP
- components for handling fuel rod assemblies (FRA)
- system for SFP cooling
- system for FRA control

Heat transfer from the NF in SFP is carried out by the joint operation of the cooling system for SFP and the system for service water supply to the consumers responsible for the safety.

The spent fuel pond and the whole system are filled with a boron acid solution with a concentration of 16 g/kg. The geometry of the racks and the steps of arrangement of the fuel casks ensure at least 5% state of below criticality including when the pond is filled with water solution without boron under all temperature conditions.

In the upper part of the pond there is a ventilation flow-sucking system which creates an air curtain and thus prevents the spread of gas aerosol products from the surface of SFP into the central hall. Thus the service personnel in the leak-tight zone/containment is protected under the regimes of the refuelling and repair of the unit.

The capacity of the SFP at unit 5 and unit 6 is 612 pcs. in each of FRA and provides storage for the spent FRA in the course of at least three years pursuant to the requirements of

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[6] K. Kamenov, Al. Kamenov, D. Hristov, Experience of TVSA Fuel Implementation at Kozloduy NPP, In: Proceedings of the 9-th International Conference on WWER Fuel Performance, Modeling and Experimental Support, 17-24 September 2011, Helena Resort, Bulgaria. pp 51-63, INRNE, 2011, ISSN 1313-4531.

GOST.95.7.5-87. Each cask has a different discharge burnup depending on the history of location in different places in the core of the reactor.

According to "List of structures, systems and components of units 5 and 6, classified by degree of safety, seismic and quality"[7]„ the building of the Reactor hall of power units 5 and 6 falls in the First seismic category and the safety class is 2-M.

1.1.1.4.2 Spent fuel storage facility (SFSF)

SNFSF is designed for long-term storage of spent nuclear fuel (SNF) under water. The design capacity of SNFSF is 5040 fuel casks of WWER-440. The first construction of the SNFSF has been modified and now there can be stored fuel casks of WWER-1000[8]. The concept underlying the 1968 design envisages a space filled with water where the containers (baskets) with the spent fuel casks will be placed. The water serves both as a biological shield and coolant of SNF. Around the pond for fuel storage there is a structure providing for the implementation of transport technological operations with SNF and protection of the environment and people against the inadmissible radiation impact. The pond itself is divided into sections with inner partitions, which increase the reliability of fuel storage.

The rooms of the building including the SNF pond are fitted with structures, equipment and systems providing safe implementation of the activities related to:

- **Reception of SNF from SFP of reactors WWER-440 and WW-1000**
  - reception of the container for SNF transportation and manipulation;
  - treatment and preparation of the container for its transfer to the SNFSF.
- **Internal transportation and handling**
  - taking the liner with SNF out of the container;
  - transportation of the basket to the place allotted for its storage
  - rearrangement of the liners and their shifting from one place to another;
  - operations with individual fuel assemblies
- **underwater storage in the sections of the ponds**
  - removal of the decay heat release from SNF;
  - ensuring that the water in the storage pond has the required physical and chemical properties;
  - collection and treatment of leaks from the pond or other radioactively-contaminated waters;

[7] 30.OU.00.SPN.02/1

[8] National report on the second extraordinary meeting on the nuclear safety convention

- collection of gaseous and aerosol products released from SNF and the water in the storage pond.

→ **Transportation of the fuel**

- reception and handling of empty transport containers
- filling "CONSTOR" casks with SNF from WWER-440 and subsequent transfer to DSNFSF;
- treatment and preparation of the transport containers for shipment of SNF from SNFSF.

The buildings of the SNFSF were designed in the period 1982-1984 with the following seismic characteristics: MDBE realizing VII degree by MSK-64 with PGA 0.1g for a period of repeatability of 10 000 years. After the building of the SNFSF, a number of strengthening operations were done accounting for the reassessed seismic characteristics of the site based on the currently actual seismic levels. MDBE with PGA 0.2g and DBE with PGA 0.1g:

- ✓ *Technical design "ANTISEISMIC STRENGTHENING OF THE BUILDING OF THE SPENT FUEL POND " dated 10.08.1994*
- ✓ *Technical design "SNFSF Improving the strength of the steel columns and roof frames under extreme wind and snow conditions of load" ENERGOPROEKT, January 1997.*

In order to guarantee normal functioning of the cooling system of the pond it is necessary to ensure a reliable operation of a number of systems

- responsible consumers group A – water supply;
- special water treatment
- sampling points
- facilities of the tank
- collection of boron containing water
- nitrogen gas and gas scavenging
- automated control of the technological process and control and measuring instrumentation and automation (CMI and A)

SNFSF is in the First seismic category and is safety class 2. The necessary passive and active measures have been taken to ensure maximum degree of fire safety in SNFSF. The passive measures include using reinforced concrete to build the main constructions and building the roof with fire protection belts of inflammable materials at every 6 m. The active measures include: external fire proof ring, internal fire extinguishing installation with fire protection taps in the rooms and dry tubes for extinguishing fire on the roof with water.

A standby electricity supply is provided by a diesel generator of SNFSF from UPS devices and, if necessary, from a mobile DG. The systems for radiation monitoring, the system for filling and supply of the pond and the system for returning the leak are supplied with electricity with priority. The reserves of fuel and oil for the emergency DG of SFP provide for continuous operation for 3 days (72 hours)

1.1.1.4.3 Dry spent nuclear fuel storage DSNFSF

The strategy for management of spent nuclear fuel and radioactive waste to 2030 recommends that SNF storage facilities be built on the sites of the NPP utilities. The advantage of this solution is the elimination of SNF transporting outside the NPP site and the use of the existing sites of the NPP, so intrusion on the landscape is also eliminated.

The building constructions of DSNFSF were designed before 2008. The design complies with the requirements of the Regulation for ensuring the safety of spent fuel management and the principle for in-depth defence is applied[9]. The project is based on the actual seismic characteristics of the site determined in 1992 design basis earthquake SL1 (OBE) with PGA 0.1g for a period of repeatability of 100 years and maximum design basis earthquake SL2 (DBE) PGA 0.2 g for a period of 10 000 years. The DSNFSF is classified as Design Basis class 3 (DC3) according to IAEA-TECDOC 1347 in relation to external events.

The purpose of DSNFSF is:

- To hold containers with spent nuclear fuel (SNF) generated as a result of decommissioning activities.
- To ensure sufficient storage capacity in case the fuel has to be removed from one of the functioning SNF ponds of the power units.

The goals in the design of the dry storage are:

- To ensure the necessary free capacity for transfer and storage of the spent fuel assemblies because of the decommissioning of units 1, 2, 3 and 4 of Kozloduy NPP.
- To prevent interruption of the operation of the power units by providing the necessary free capacity in the pond for storage of the fuel assemblies of spent nuclear fuel generated by the operating units.
- To guarantee long term storage of the assemblies of spent nuclear fuel for a period not shorter than 50 years.
- To ensure future safe removal of the spent nuclear fuel for shipment outside the storage.

The building is a monolithic steel and concrete construction on which is mounted a steel roof construction. Functionally DSNFSF is a one-storey hall divided into basic operational zones: reception zone and a hall for storage of casks. The two zones are separated by a shielding door. The reception zone and the hall for storage of the containers are serviced by a bridge crane with lifting capacity of 145 tons. The building, the crane 145 tons, the casks CONSTOR 440/84, the shielding door and the operational alarm for the door are of the seismic category DBC3

[9] National report for the second extraordinary meeting on the nuclear safety convention, Sofia, May 2012.

The storage technology is a container storage system using air cooled containers by natural convection. The casks used are type CONSTOR 440/84 with a capacity of 84 fuel assemblies designed for spent nuclear fuel storage from reactors WWER-440. DSNFSF has a capacity of 8 containers.

CONSTOR 440/84 has a system of leak-tight liners which provide a leak-tight containment for the spent fuel under conditions of operation and emergency. The inner side of the container where the spent fuel is placed is dried by a qualified process for vacuum drying of the container, which is then filled with helium. The inert atmosphere of the interior of the container makes corrosion of the fuel rods impossible for a long-term period of storage.

The building of DSNFSF ensures:

- Protection of the casks against the climatic conditions and the operations related to their servicing.
- Radiation shielding of the operators and the population.
- Control of the access to the zones for carrying out the operations.
- Internal separation of the storage zone, the reception zone and the administrative zone.
- Flat and stable basis for the storage of the casks.
- Access for the transport vehicles that transfer the casks within and outside the DSNFSF.
- Supports for the bridge crane 145/16 tons used for handling the containers and access for the maintenance of the crane.
- Administrative zone with environmental control, which provides sanitary and control rooms.
- Openings in the walls and the roof allowing for the casks to cool on the principle of the natural convection.

The decay heat from the storage of NF is released passively in the environment by heat conductivity, heat emission and natural convection. What is important for safety is the prevention of interruption in the natural convection around the fuel storage casks.

The DSNFSF is equipped with a modern fire alarming system, which provides local signalisation and alarming the firefighting service on the site. The road chosen for the fire fighting vehicles ensures fast and reliable access to DSNFSF.

The analyses in accordance with IAEA-TECDOC 1347 show that the building can endure loads under conditions of design base earthquake (DBE) and maximum design base earthquake (MDBE) without dramatic collapse. The nuclear safety of DSNFSF does not depend on the availability of electricity and water supply. The design of the casks and the building of DSNFSF is based on an examination of a scenario of explosion on the site or explosion of a vehicle in the vicinity of the DSNFSF. The building of the storage hall is designed to endure the pressure of the explosion wave of a gas cloud. Also, the consequences are analysed of an emergency where the release of the heat is lost under a hypothetic fall of pieces from the destroyed building over the containers combined with disturbance of the infrastructure and communications of the site in a way as the access to the building is seriously hindered. For a 100% covering up with pieces, the calculations, assuming the most conservative tolerance, show that the maximum permissible temperature of the shell of the NF can be reached and exceeded after more than 48 hours. A more realistic scenario where the roof construction causes less than 50% burying shows that the time for undertaking adequate actions, i.e. removal of the pieces and restoration of the natural ventilation is extended to over 7 days. The bridge crane can endure DBE and MDBE without causing destruction of the constructions or falling down of the load. The casks CONSTOR 440/84 are designed not to overturn under the impact of DBE as well as to endure the heavy emergency situation of a fire with 600°C for an hour in which case the temperature of the shells is maintained below 330°C. The walls of the containers are 480 mm thick and 500 mm and ensure lack of neutron interaction between the fuel in the cask and the fuel in the surrounding casks.

Flooding of DSNFSF cannot influence the state of below criticality of the fuel in the casks. The outer surfaces of the casks are not radioactively contaminated, thus flooding does not cause liquid leaks of radioactive material in the environment.

1.1.1.4.4 SNF stored on the site of Kozloduy NPP by 31.12.2011

SNF from the operation of Kozloduy NPP is stored in the storage ponds at the reactors (SFP) and in a storage for the fuel assemblies of the wet type subsequently transferred for technological storage and processing. The processing of SNF decreases the bulk of the stored waste, the title over the fission material being preserved so it is possible to use its energy resource in the future. The SNF HLW obtained after the processing are prepared for long-term storage and final disposal.

The management of SNF ensures that there is minimum free space for emergency removal of the core of the operational units of Kozloduy NPP for the purpose of complete freeing of SFP of the units which are being prepared for decommissioning.

For the period 1974- 2009 the total quantity of SNF generated during the operation of the units 1 to 6 was 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 were stored in the ponds at the reactors) was transferred in the pond for storage under water on 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 on the Kozloduy NPP site, stages 1 and 1a was designed to hold respectively 2800 and 2456 casks from reactors WWER-440. The design rate for filling the storage is 420 casks annually.

According to the contracts in force, HLW from the processing of SNF are subject to transferring back to R of Bulgaria after 10 years and 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 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 capsuled in 170-liters canisters in a matrix of 11-18% sodium-aluminum-phosphate glass weighing 450 kg. The HLW are transported in containers holding from 21 to 28 such canisters.

For the SNF shipped in the period from 1998 to 2009 the expected quantities of HLW 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.

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 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 heavy metal SNF in the period 2017/21 – 2032/36.

The processing of SNF is seen as a necessary process providing for separation of released 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 equal portions for a long period of time. Thus the principle of not encumbering the future generations is satisfied.

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 is stored on the Kozloduy NPP site. Notwithstanding all measures, the presence of such a large quantity of SNF on the site is a serious problem in the long term, which is a deferred decision that lays 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 long-term 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 Decommissioning of Nuclear Facilities Fund account (DNF). These means are normatively recognized expenses and are included in the production cost of energy.

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

1.1.1.4.5 Transportation of SNF from WWER-440 and WWER-1000 according to the contracts in force with the Russian company TVEL

→ **Shipment packaging**

For the transportation of SNF to Russia for processing, shipment packaging (TUK) are used as follows:

- TUK-6 – for transportation of SNF from WWER-440;
- TUK-13/1V – for transportation of SNF from WWER-440;

The packaging unit TUK-6 (RU/042/B(M)F-85T) consists of a shielded container, basket for placing the fuel assemblies, lid, draining and filling in device and gauges for technological parameters measurement (temperature and pressure). There are two trunnions welded on the body for lifting and handling and a system of ribs for enlarging the cooling surface. On the outer side, a support ring is welded for vertical positioning.

TUK-6 has the following technical characteristics and technological parameters:

- Capacity 30 FRA;
- Mass – maximum (empty), t 81;
- Mass – maximum of a filled unit, t 92;
- Heat carrier – water
- Maximum admissible pressure, MPa 0.40;
- Maximum temperature of the surface of a filled cask °C 85.

The packaging unit TUK-13/1B (RU/052/B(U)F-85T) consists of a shielding container with an additional cladding, basket for placing the fuel assemblies, lid and temperature gauge. The space between the body and the shielding is divided into two sections, one of them is filled with fluid (anti-freeze) to serve as a neutron shield protection. Two trunnions[10] are welded on the corpus to serve as handles, two trunnions for fixing and tilting and two additional support trunnions. The cask has two valves for drying, filling with gas heat carrier, testing for leak-tightness and cooling.

TUK-13 has the following technical characteristics and technological parameters:

- Capacity 12 FA/fuel assemblies/;
- Mass – maximum (empty), t 104;
- Mass – maximum of a filled unit, t 113;
- Heat carrier – gas (air)
- Maximum pressure:
    - inside the cask, MPa 0.07;

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[10] Positioning and centering elements

  - in the neutron shielding, MPa 0.6;
  - Maximum temperature of the surface of a filled cask , °C 102.

→ Transportation Facilities

- Road transport

For the road transport of TUK-13 with SNF from WWER-1000, the heavy duty Goldhofer trailer is used.

For the road transport of TUK-6 with SNF from WWER-440, the heavy duty Blumhardt trailer is used. TUK-6 is placed vertically for transportation

- Water transport

For water transportation of SNF a specialised vessel of the non-selfpropelled type (barge) is used. The barge is equipped with 8 cradles for vertically placed and supported TUK-6 and TUK-13, Ventilation system for cooling of TUK, System for control of the parameters, System for deactivation and a sanitary part. All TUK are transported positioned vertically.

→ **Transport roads**

Auto transport of SNF is to the port on the Danube river, which is within the boundaries of the Kozloduy NPP site.

Water transport is from the port of the Kozloduy NPP on the Danube river to the port of the town of Izmail, Ukraine.

In the port of Izmail the casks are transferred to a special railway composition by a floating crane. Then the transportation is on railways as far as the plant for reprocessing in Russia in compliance with the national regulations in the respective country.

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 a at ground long-term repository with a period of administrative control not shorter than 100 years for HLW and medium active RAW (MARAW) category 2b. 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 waste. Thus potential gross mistakes will be avoided concerning the final disposal in stable geological formations.

1.1.1.5 LONG-TERM RAW MANAGEMENT

NRRAW is designed for disposal of conditioned and packaged low and intermediate level short lived radioactive waste produced during the operation of NPP, decommissioning of nuclear reactors and by conventional sources – medicine, scientific research, technical applications, etc. The national repository is a facility with a multi-barrier protection for long-term storage of radioactive waste that is pre-treated, rendered safe and packed in cubes of reinforced concrete and their isolation from the environment and man[11].. The repository is of the trench type at the ground surface with a capacity of 138 200 m^3. It consists of several steel-concrete sunken structures (modules) divided into chambers by inner partitions. After being filled up with packages, the chambers are covered with a reinforced concrete plate and isolated from the atmospheric waters by piling up multiple layers of earth.

During the whole period of operation of the National repository a strict control of the incoming radioactive waste is enforced as well as radiation control and monitoring of the repository site and the environment.

According to the preliminary schedule, successfully followed by SE RAW, the first stage of NRRAW has to be completed at the end of 2015. It is expected the final approval of the technical design submitted in April 2013 to be issued, to obtain title on the terrain for the facility and an order by NRA for approval of the site, for which all the required documentation including preliminary assessment of safety has been filed in the Agency.

It is envisaged that the repository could operate, i.e. will be gradually filled up for a period of 60 years. It is planned to close it in 2075 and in the following 300 year it will be subject to constant control on the part of the authorised bodies.

1.1.2 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 readiness under nuclear and radiation emergency (prom, SG, No 94 of 29.11.2011) there are the following zones for emergency planning:

- → **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 tubes of units 5 and 6. The area of the zone is 12 566 daa of which 3 012 daa or 24% are 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)[12] zone No 3** , with a provisional radius of 30 km around Kozloduy NPP EAD and area of 284 874 daa.

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[11] Nontechnical summary of the report on the environmental impact assessment of the investment proposal of SE RAW for the building of a National Repository for the disposal of short-lived low and middle active radioactive waste – NRRAW ECO ENERGOPROEKT OOD, Sofia http://old.dprao.bg/?act=content&rec=9

[12] 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).

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 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.
- ✓ On the territory of R of Romania 19 settlements[13] in total fall within the zone from the districts Dolj and Olt: Ostroveni, Gighera, Valea Stanciului, Călăraşi, Oraşul, Bechet, Oraşul Dăbuleni, Piscu Vechi, Sadova, Gângiova, Măceşu de Jos, Măceşu de Su, Bistreţ, Goicea, Bârca, Vela, Nedeia, Sarata, Listeava, Horezu Poenari.

  (Kozloduy NPP EAD has the obligation to monitor the environment under emergency in a zone of 12 km)

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

[13] Updated data on the territory of Romania – letter by Kozloduy NPP – NB EAD EAD, 297/01.04.2013.

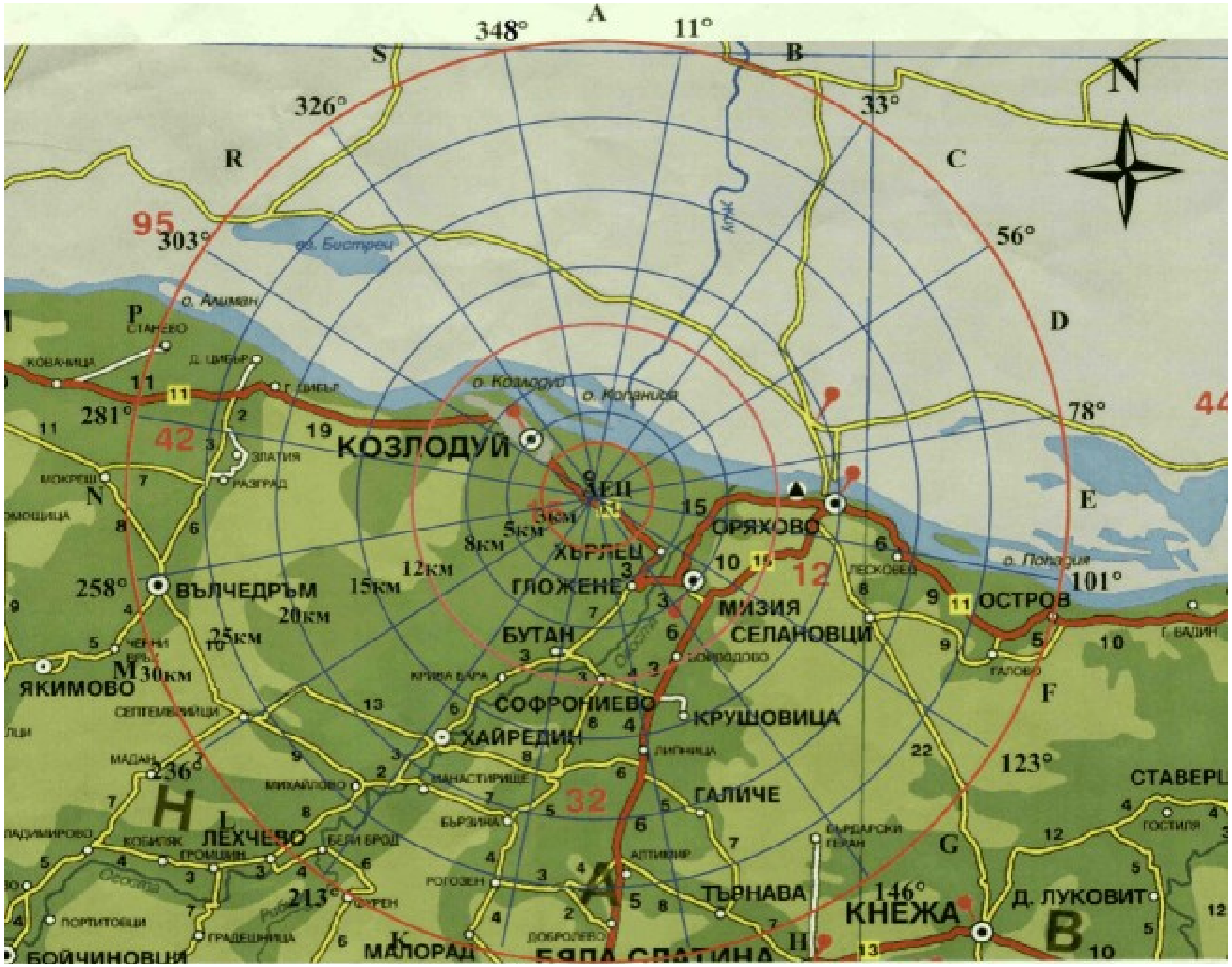

FIGURE 1.1-4: ZONES FOR EMERGENCY PLANNING

1.2 NECESSITY OF THE INVESTMENT PROPOSAL

The Republic of Bulgaria has operated nuclear power reactors of the pressurized 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 for the construction and commissioning of a new nuclear unit of the latest generation (Generation III or III+) with installed electric power capacity of approximately 1200 MW is to successfully utilize the whole capacity of Kozloduy NPP site, including the available infrastructure and the experienced and highly qualified personnel.

1.2.1 MAIN OBJECTIVES, PRINCIPLES AND SAFETY CRITERIA

The investment proposal envisages the construction of a new nuclear unit of the latest generation (Generation III or III+) with pressurized light-water reactor (of the type PWR – Pressurized Water Reactor) with an installed electric power capacity of approximately 1200 MW on one of the 4 potential sites and applying one of the two 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, 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 of 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 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.

1.2.2 SUBSTANTIATION OF THE NEED FOR THE INVESTMENT PROPOSAL

The need of building a new industrial nuclear reactor at 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.

As far as the new nuclear unit that is planned to be built is designed for the generation of electric and low-potential thermal power, the assessment of the need for the new nuclear unit has to prove that the IP will bring benefits to the society from the point of view of 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 failures/defects 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, elaborated and periodically updated for Bulgaria under an order of the DG Transport and Energy 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 forecast for the growth of energy consumption, the Bulgarian energy sector at present faces the necessity to cope with three basic challenges:

→ <u>High energy intensity of the 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 the import of energy resources:</u> Bulgaria provides for 70% of its gross consumption of energy resources by means of import. The dependence on imports of natural gas, raw 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 caused 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 projections on the energy balance of the Republic of Bulgaria, the growing consumption of energy during the 2020-2030 period can be fully guaranteed 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 IP and the importance of its implementation.

Considering the above, an analysis was made of the selection of the IP based on an assessment of the state and development of the electric power mix in Bulgaria as well as an assessment of the contribution the new nuclear unit to the achievement of the priorities related to the transition to low-carbon electricity generation, reduction of the dependence on imported energy resources and improvement of the national rating according to the GDP energy intensity index.

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

Bulgaria has a varied electricity generation 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 priorities 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 has planned 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.

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 1.2-1**). Import accounts for 70% of the gross consumption in Bulgaria:

TABLE 1.2-1: 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 Balance 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 1.2-1)**.

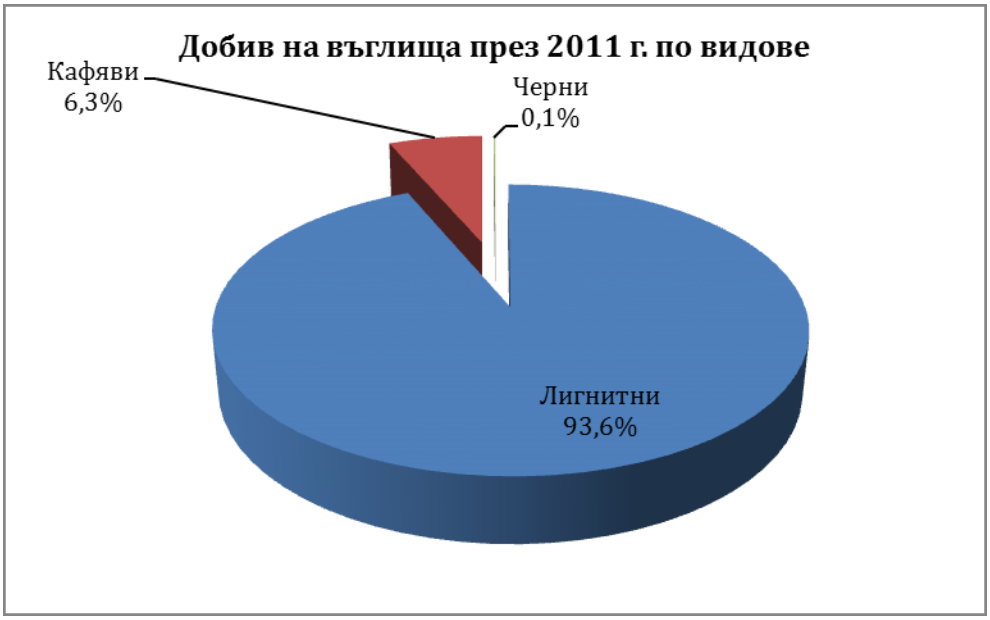

FIGURE 1.2-1: YIELD OF COAL IN 2011 ACCORDING TO TYPE

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. The total yield of black coal is insignificant (14.1 Ktons) and is realized mainly by the Balkan 2000 Mines EAD. .

Natural gas

The imports of natural gas to Bulgaria for 2011 amounted to 2 811 mln m^3 (including 248 mln m^3 of fuel gas for the functioning of the transit system), which is by 6% more than in the preceding year 2010, and is imported from Russia – the sole supplier of this resource for Bulgaria. The local yield of natural gas amounted to 443 mln m^3 in 2011, realized 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. Notwithstanding the fact that the resources of natural gas in the country are modest, they are of interest as a domestic source, which to a certain degree limits the growth of the prices of the imported natural gas.

Crude oil

The mining of crude oil in the Republic of Bulgaria amounts to insignificant quantities – 22 Ktons in 2011. It is implemented 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 petroleum are satisfied predominantly by imports. The main importer and petroleum processor is Lukoil Neftochim Bourgas EAD.

Uranium ores

The quantity and the potential of uranium ores are only estimates, while their mining was discontinued and the mines were closed down due to high costs, imperfect technologies and radioactive contamination.

In order to optimize the country's rating according to the energy dependence index, 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 as a local source and in this sense, the IP will have a positive effect on the energy dependence index in the long term. In support of this statement, the EAI will present forecasts and analysis of the changes in the dependence on energy resources imports as a result of the building and commissioning of the new nuclear unit on 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 as of date 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 produced energy is electric power, including 31% generated by nuclear power plants and 14,7% from renewable energy sources. Although contribution of RES has been significantly growing since 1990, the demands for electric power cannot be satisfied without the contribution of nuclear power generation worldwide. The new nuclear unit at Kozloduy NPP site will contribute to the validation of Bulgaria's position among the countries which develop reliable and secure diversified energy sources based on contemporary nuclear technologies for providing 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 the sustainable development of the IEA forecasts the progression, shown on **Figure 1.2-2** below in Gtpe (1 Gtpe = 1 Giga-ton petroleum equivalent = 11.63 MWh) for 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 available energy sources at present have increased their contribution. After the year 2030, when the contribution of solid fuels for primary energy is expected to drop, 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 the forecast of the IEA6[14] , the demands for energy worldwide until 2030 and the emissions of CO_2 it will produce will grow by 1.7% per annum.

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 within the foreseeable future. The same applies to the geo-thermal energy sources. Notwithstanding the fact that a large number of wind-powered generators have been built in Europe since 1990 so far, at present it is difficult to forecast how their production will be capable of replacing the electric power generated from gas, petroleum or coal or, respectively, the nuclear energy.

The latest ambitious aim of the EU to reduce the CO2 emissions by 20% by 2020 below the level of emissions for the year 1990 is based on a considerable reduction of the emissions in the transport sector, as well as by increasing the number and capacity of the photovoltaic and wind-powered power plants. For example, the electric power generation from wind-powered plants must grow approximately 17 fold in order to become equal to the electric power generation from the nuclear power plants. It is hard to forecast how such growth will be provided by 2020, moreover, these calculations do not include the expected growth in the energy demands by 1.7% per annum.

[14]International Energy Agency

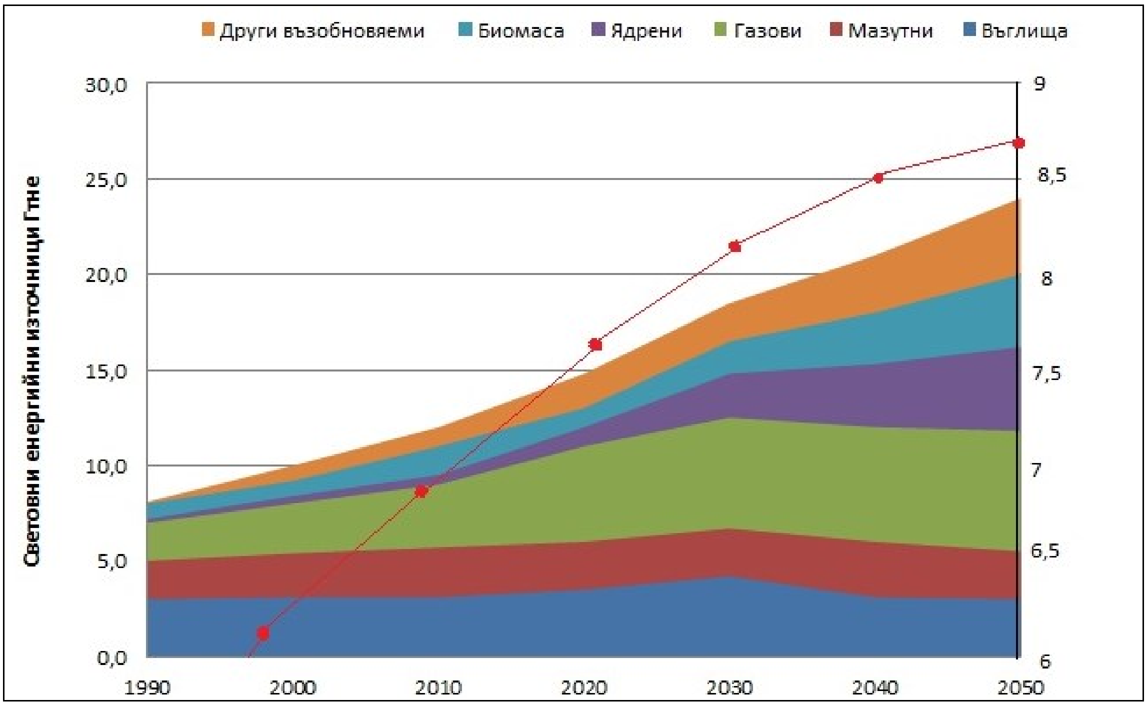

FIGURE 1.2-2: SCENARIO OF THE WORLD ENERGY SOURCES FOR A SUSTAINABLE FUTURE

For that reason, notwithstanding the encouragement of the development of RES, the achievement of the plan of the EU for reducing the CO_2 emissions practically depends to a high degree on the nuclear power generation.

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 1.2-3**. The emission values for the energy generation sector are 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 annualy, the quantity of emissions for the year 2009 only from the coal-powered plants is 19.8 mln tons of CO_2.

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 studied electric power plant and are shown on **Figure 1.2-4** as coupled columns for each type of fuel.

FIGURE 1.2-3: GREENHOUSE GAS EMISSIONS BY SECTORS OF THE BULGARIAN ECONOMIC, MLN TONS CO_2 EQUIVALENT, 1990 – 2008

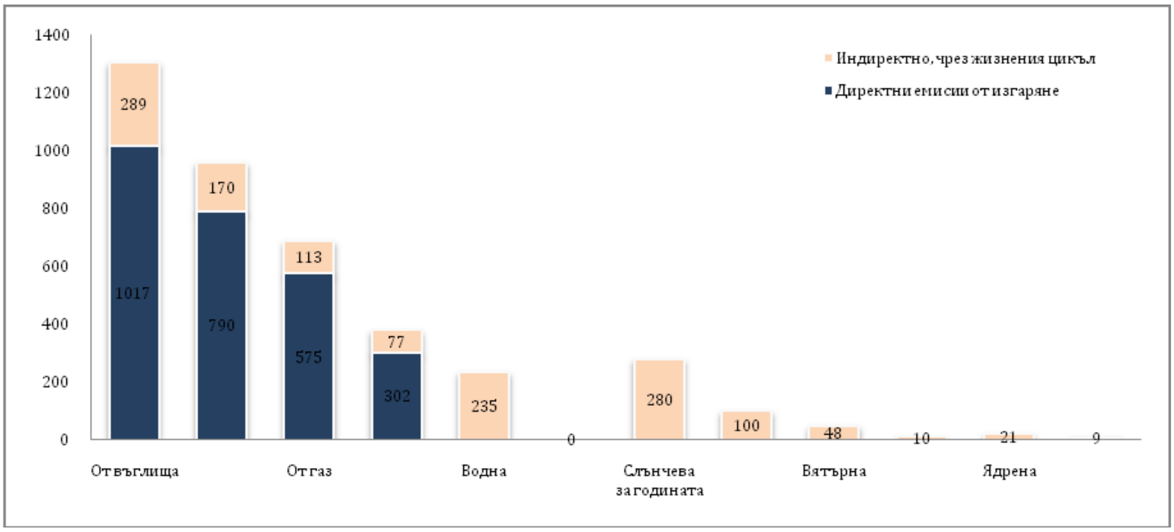

FIGURE 1.2-4: RESULTS FROM THE ANALYSIS OF THE LIFE CYCLE FOR EMISSION OF CO_2 FROM ELECTRICITY GENERATION BY DIFFERENT METHODS

As could be seen , the main contributor to the emissions is the burning of 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 Kozloduy NPP site is fully justified, since it will ensure the generation of an additional amount of energy without any CO_2 emissions.

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:

- → mastering the negative climate changes;
- → reduction of the energy consumption rates of the economy and improvement of the energy efficiency;
- → limiting the dependence of the European Union on imported energy resources; and
- → encouraging the economic growth and employment, thus providing a reliable and accessible source of power for the consumers.

The sustainable energy sector development has been defined as the center of the energy policy and 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 of the total energy mix and 10 percent share of energy from renewable sources in the field of transport;

Target 3: Improvement of the energy efficiency by 20%.

In compliance with the current European energy policy framework and the worldwide trends in the development of the energy technologies, the commitments of our country in this field are incorporated in the Energy Strategy of the Republic of Bulgaria by 2020. The main priorities in the Energy Strategy can be summarized to the following five targets: guaranteeing the security of the power supply; achieving the targets with reference to renewable energy sources; improving the energy efficiency; developing a competitive energy market and policy aimed at satisfying the energy needs, and protecting the interests of the consumers. These priorities also determine the view of the development of the energy sector during the next few years, namely:

- → Maintaining a reliable, stable and secure energy system;
- → The energy sector must remain a leader in the Bulgarian economy with a explicitly stated 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 energy, 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, competitive and reliable energy was published on March 8, 2008. Thereby, 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: increasing dependence on imports of energy and energy raw materials, rising prices of petroleum 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 changes by means of 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.

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

→ Combat against climate changes;

→ Reducing the dependence of the EU on imported energy supplies of petroleum and natural gas;

→ by 2020 the greenhouse gas emissions of the developed countries should be reduced by 30% as compared to 1990, with the EU undertaking unilaterally to achieve a reduction of the emissions by a minimum of 20% by 2020.The building of the new nuclear unit at Kozloduy NPP site fully complies with the national priorities in the field of the development of the energy system of Bulgaria as a part of the common European energy strategy. In practice, the NNU in conjunction with the power capacities for production of energy from RES will ensure approximation to the goals for achieving an energy cycle without emissions, as well as providing for an optimum mix of energy sources.

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

1.3.1 LOCATION OF THE NEW SITES AND EXISTING INFRASTRUCTURE

The site of the Kozloduy NPP is located on the right bank (at the 694th km) of the Danube river. It situated 3.7 km to the south of the river midstream and the state border with the Republic of Romania. In a straight line, it is situated at a distance of 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 +35.0 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 northwest of the village of Harlets – 3.5 km southeast of the village of Glozhene – 4.0km south east of the town of Mizia – 6.0km southeast of the village of Butan – 8.4 km south of the town of Oryahovo – 8.4 km east of the site.

The sites envisaged for the installation of the NNU in the area of Kozloduy NPP are shown on **Figure 1.3-1**.

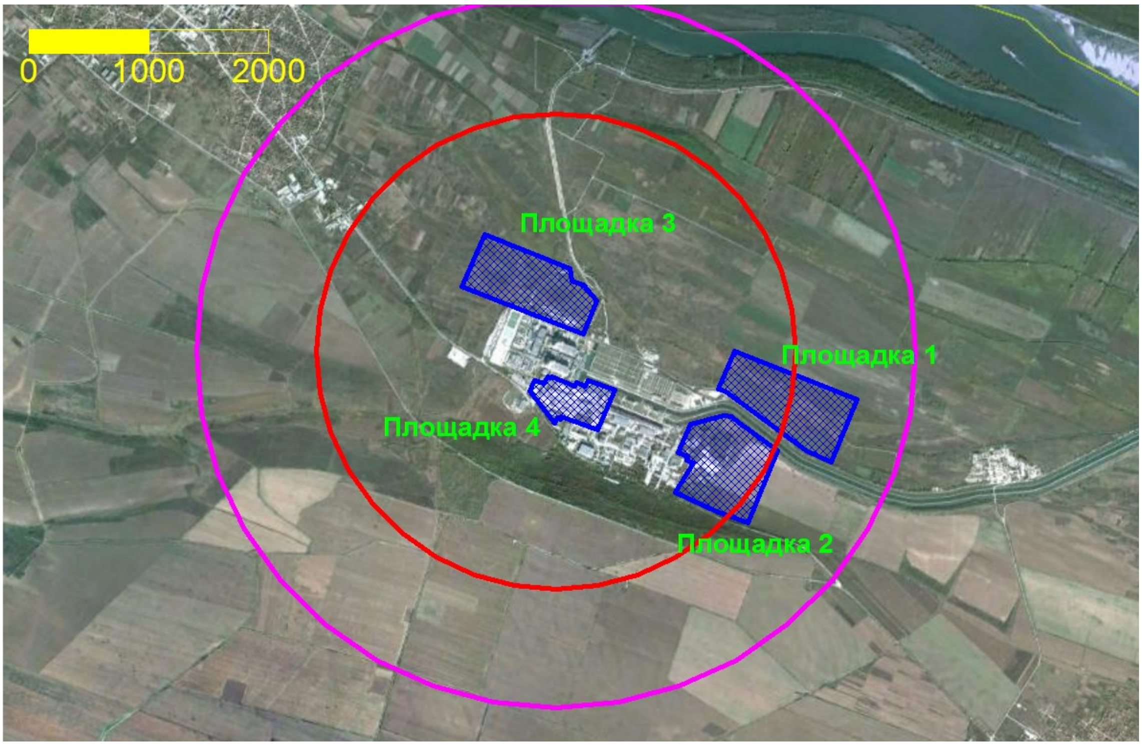

FIGURE 1.3-1: LAYOUT OF THE SITES FOR THE IP

(The red circle ( ) is the 2000 meters Precautionary action zone (PAZ), and the pink circle ( ) is the 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 comparatively 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. The open drainage channels located within the area of the site will have to be restructured. The humus loess layer will have to be removed in advance from the arable lands.

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 expropriated land 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 amounts to approximately 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 evacuating and dislocating of the above mentioned facilities.

None of the sites infringes upon any forest land.

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, chosen 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 Security of Nuclear Power Facilities, Nuclear Materials 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).

1.3.2 NECESSARY AREAS FOR THE IMPLEMENTATION OF THE IP (CONSTRUCTION AND OPERATION)

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 design of reactors – AES-2006 and AP-1000.

The necessary areas according to the layout solutions for the building of NNU on the potential sites are determined by the following criteria:

- ✓ Dangers such as internal and external flooding and fires.
- ✓ The independence between the components of the different categories concerning safety is maintained by means of a functional isolation and/or physical separation.
- ✓ The ALARA principle for achieving the target doses by placing the contaminated systems or components, including also some of the systems that are not contaminated, in different rooms and taking into account the facilitatation of inspection and maintenance in the space design.
- ✓ Orienting the turbine generators so that risks of objects flying towards the nuclear island caused by incidents or emergencies are avoided.
- ✓ The functional connection between the main building, the auxiliary buildings and scheme of the circulating water flows.
- ✓ Minimum length of the pipelines and cable routes.
- ✓ Electrical connections for connecting to external sources of power supply and delivering power to EES.
- ✓ Minimum building development.
- ✓ Spatial planning of the buildings from the viewpoint of construction and maintenance.
- ✓ Constructions which hold equipment and systems that are important for the safety:
    - Reactor hall and secondary construction of the containment (for some reactors)
    - Special building
    - Spent fuel storage facility (this facility can be located in the reactor hall for some reactors)
    - The connected machines and electrical auxiliary buildings
    - Facility for standby alternating current supply for safety

- Emergency Response Center
- Tanks or storage ponds related to safety

All the constructions and equipment having functions related to safety are seismic category 1.

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

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

Each of the alternative sites is large enough to accommodate 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 Contracting Authority for the temporary buildings and they will have to be located outside the site where the new unit will be built.

The layout possibilities of the alternative sites for location of the main buildings and facilities are described in the following 3 items.

1.3.2.1 LAYOUT PLAN OF THE LOCATION OF THE MAIN BUILDINGS AND FACILITIES OF REACTOR AES-92

The preliminary calculation of the area for the building of NNU with one unit AES-92 is about 35 hectares during the construction and between 15 and 25 hectares during operation – **Figure 1.3-2.**

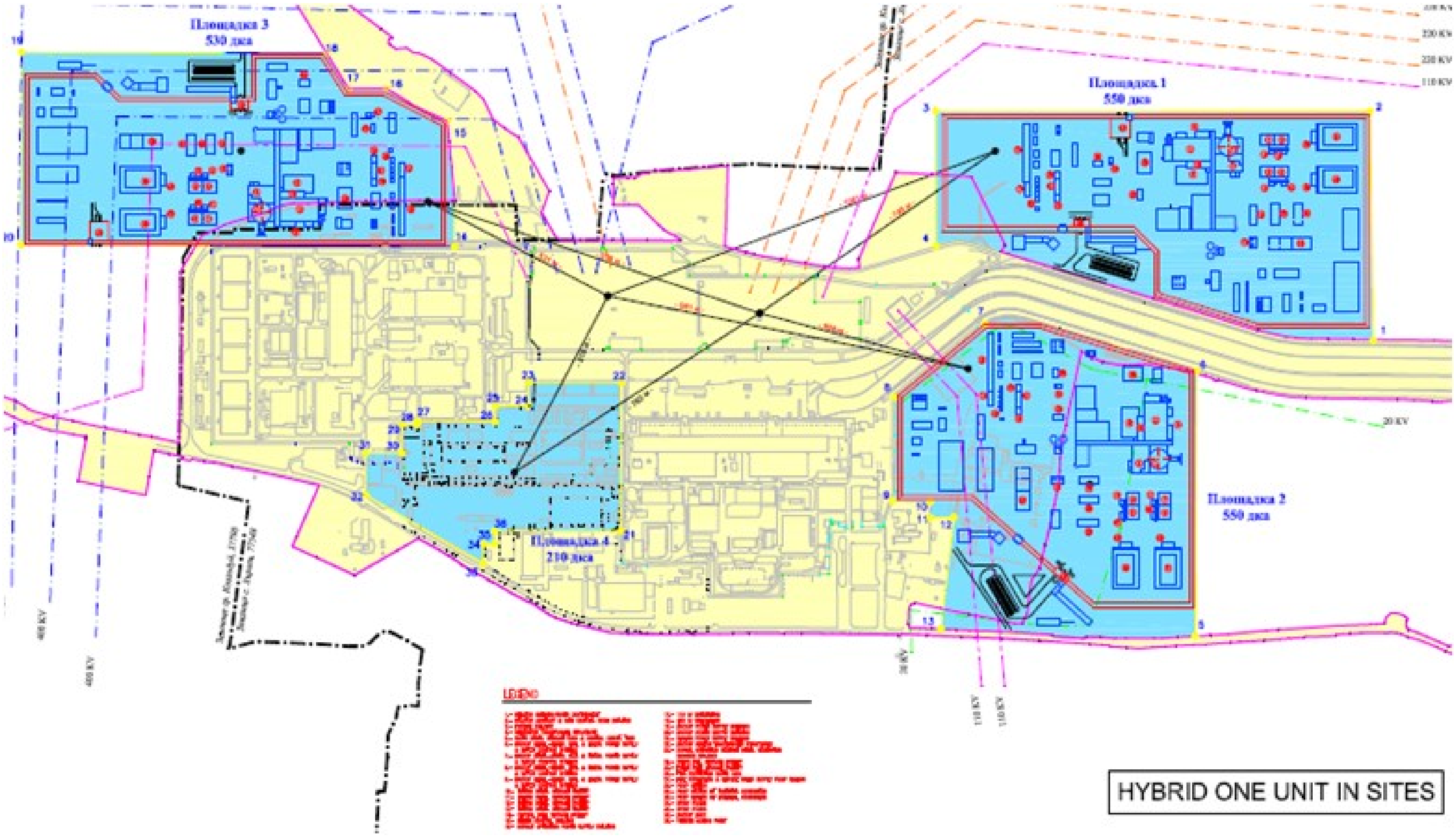

FIGURE 1.3-2: LAYOUT OF NNU WITH REACTOR AES-92 ON THE PROPOSED SITES

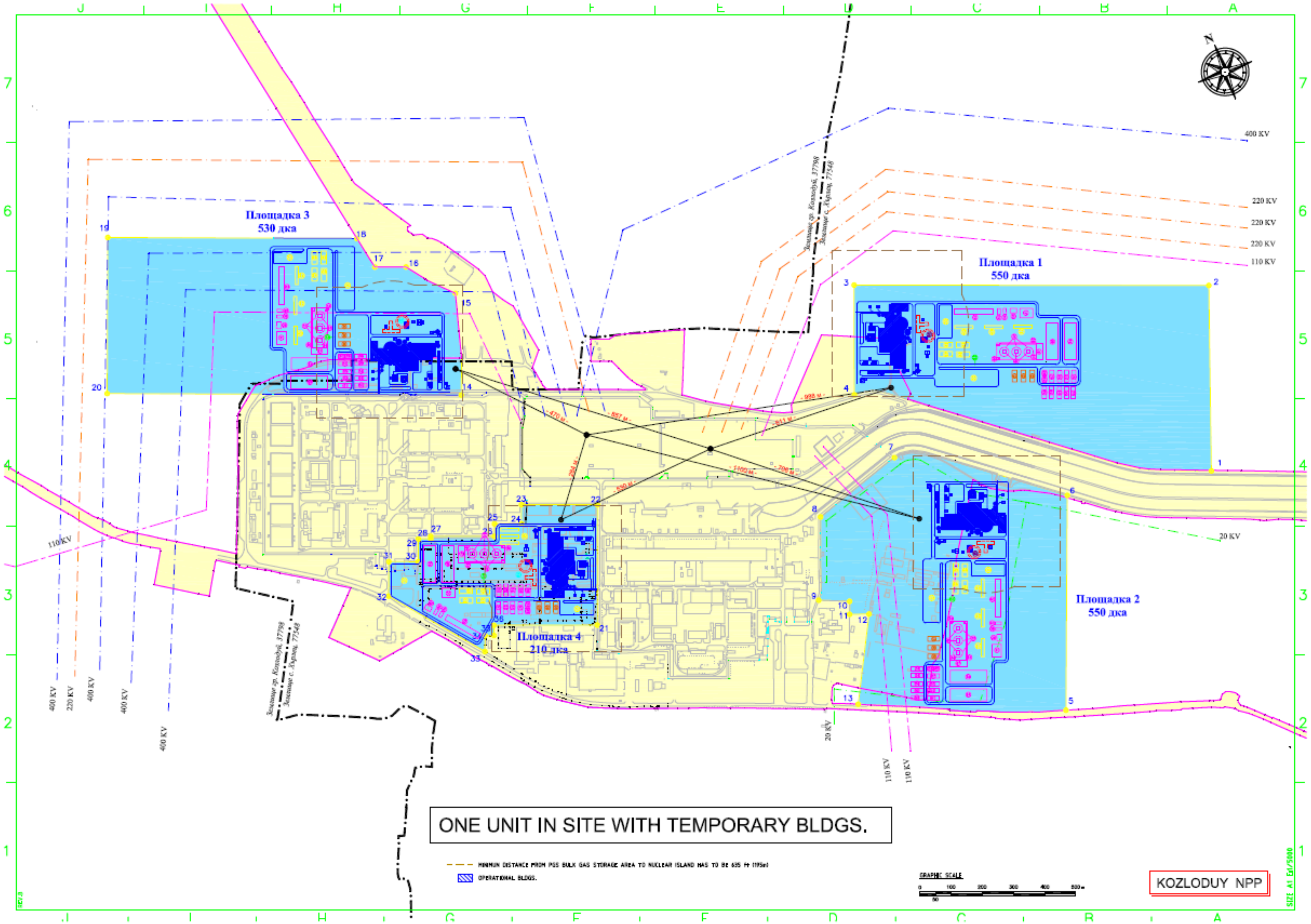

FIGURE 1.3-3: LAYOUT OF NNU WITH REACTOR AP-1000 ON THE PROPOSED SITES

FIGURE 1.3-4: LAYOUT OF NNU WITH REACTOR AES-2006 ON THE PROPOSED SITES

1.3.2.2 LAYOUT PLAN OF THE LOCATION OF THE MAIN BUILDINGS AND FACILITIES OF REACTOR AP-1000

The layout location of NNU with reactor AP-1000 for each of the proposed sites on the Kozloduy NPP site, including the temporary buildings is given in **Figure 1.3-3**. The calculated area for the building of one power unit of NPP AP-1000 including additional area necessary for the construction of temporary buildings during the stage of construction is about 21 hectares.

1.3.2.3 LAYOUT PLAN OF THE LOCATION OF THE MAIN BUILDINGS AND FACILITIES OF REACTOR AES-2006

The general layout is presented in **Figure 1.3-4.** According to the forecasts, the necessary area for the construction of a new nuclear unit with one reactor AES-2006 including the additional areas for the construction of temporary buildings during the construction stage will be similar to the size of NPP with reactor AES-92 – 35 hectares.

1.3.3 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 of a given reactor continuing with a licensing process and 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 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

1.4 DESCRIPTION OF THE BASIC CHARACTERISTICS OF THE PRODUCTION PROCESS

1.4.1 TECHNOLOGY

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

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

→ nuclear power sub-sites and facilities, implementing the main technological process – electricity generation, 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 effects on the environment.

The technology, which will be used for the generation of electric power from a nuclear source, will be a Pressurized (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 circuit includes a primary coolant pump, steam generator and circulation tubes.
- → 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 capacity, without worsening of the efficiency;
- → highly reliable systems, ensuring the defence in depth approach 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 envisages technical facilities to ensure avoidance of human errors or restriction 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 provisions and solutions for severe accidents management and minimizing their consequences, reduced probability for core meltdown;
- → burnable absorbers for extending the nuclear fuel resource.
- → burnable absorbers for extending the nuclear fuel resource.

The most significant advantage of the design for the new nuclear unit as compared to the designs of 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 technological diagram of the new nuclear unit is with two circuits (**Figure 1.4-1);**

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;
→ primary coolant loops;
→ steam generators, which produce saturated steam;
→ pressurizer;
→ primary 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.

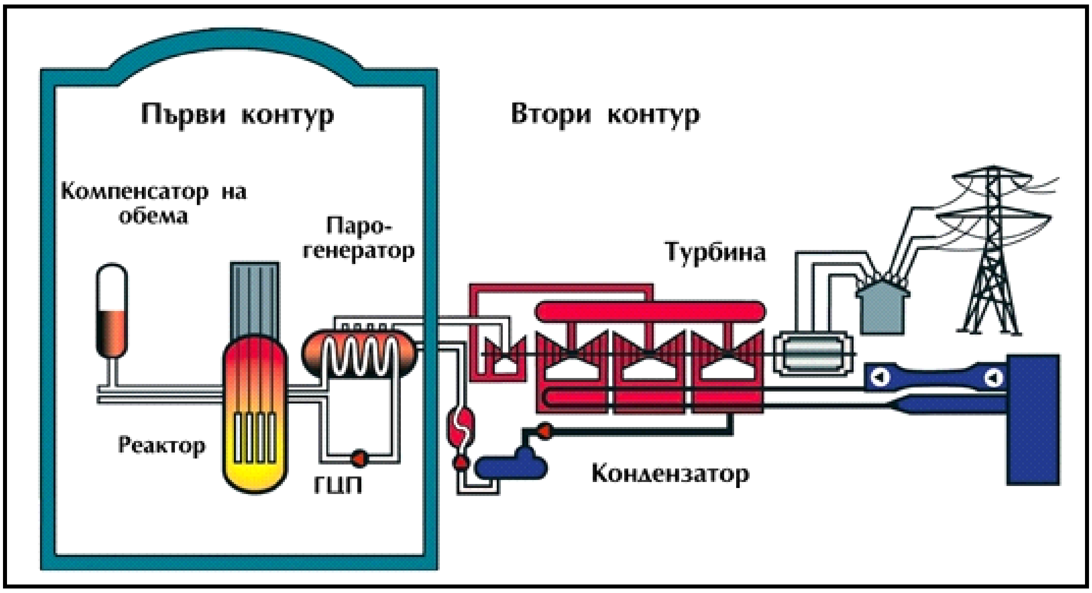

FIGURE 1.4-1: TECHNOLOGICAL DIAGRAM OF A PRESSURISED-WATER REACTOR

As a result of the forced circulation provided by the primary 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 primary coolant pumps are not operating.

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

✓ core cooling and heat removal 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 pressurized 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 1.4-2**. 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 reactor support barrel, the neutron reflector, etc.), and the control rod cluster drive mechanisms are located on the reactor head.

In the core, a chain reaction of fission takes place producing heat that is transferred to the coolant. The core consists of fuel assemblies, located in most cases in square or hexagonal meshes. The fuel bundle consists of fuel rods, guide thimble tubes, fuel alignment plates and rod holding plates.

The fuel rods consist of fuel pellets, which are encapsulated inside 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.

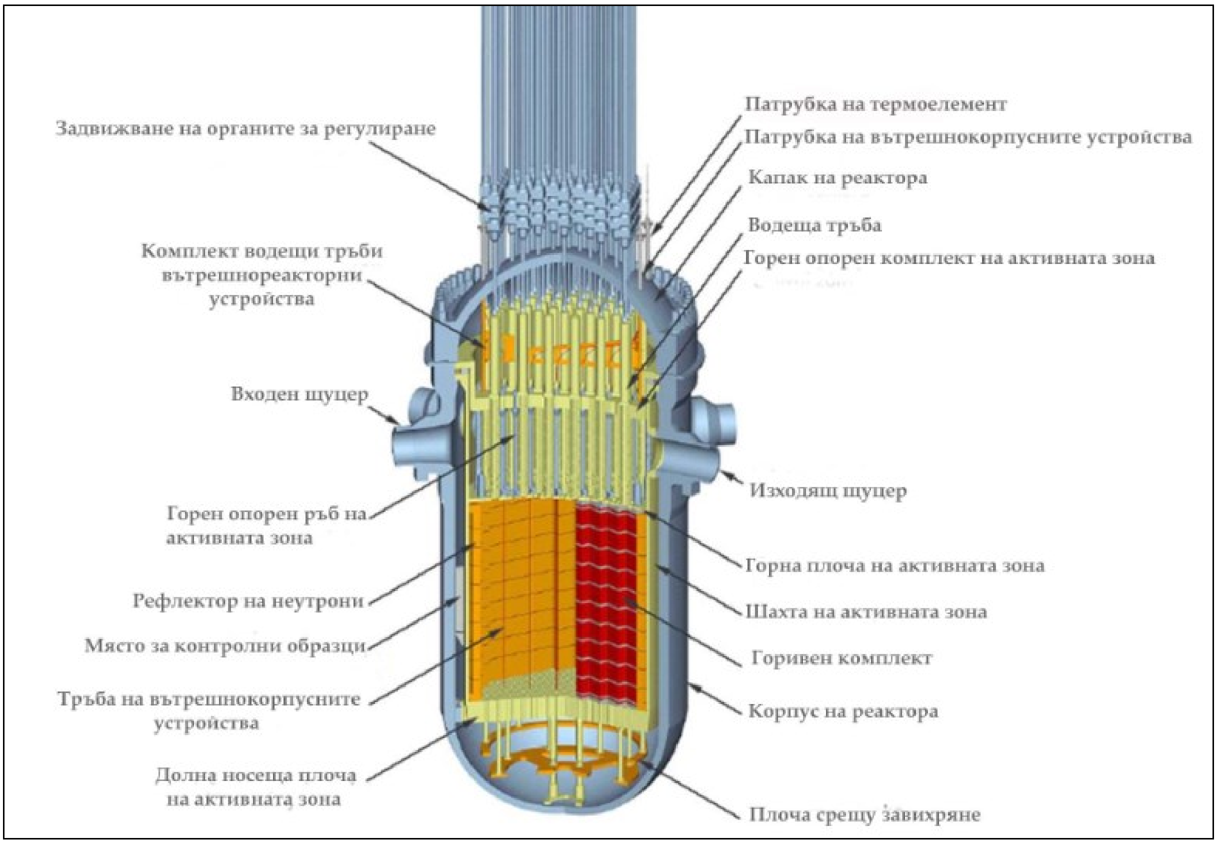

FIGURE 1.4-2: POSSIBLE STRUCTURAL SOLUTION FOR A REACTOR OF THE TYPE PWR

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

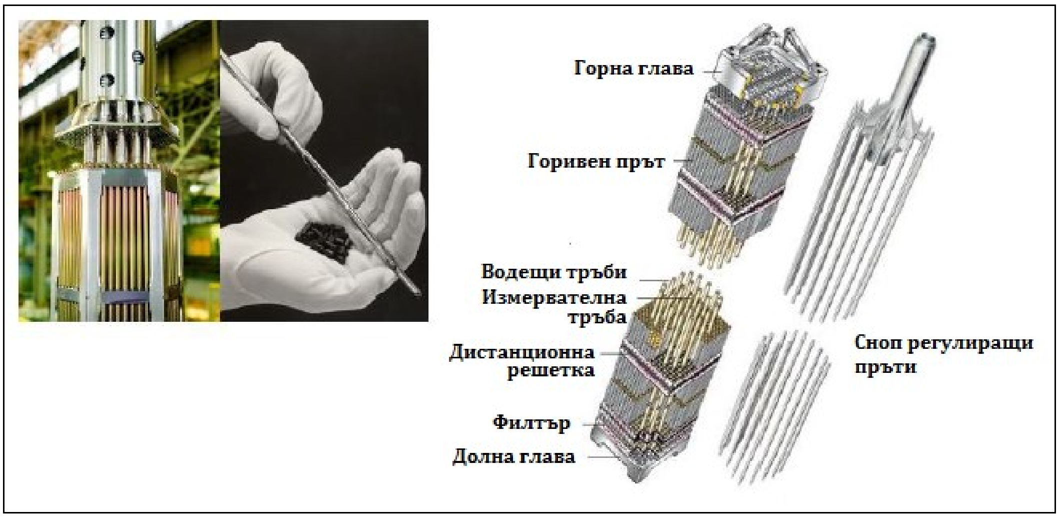

FIGURE 1.4-3: FUEL PELLET, FUEL ROD AND FUEL ASSEMBLY

The power capacity of the reactor is controlled by means of control rods (**Figure 1.4-3**) 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 sufficient margin.

Steam generator – The steam generator is a pressure vessel with a horizontal or vertical design with a feed water and emergency feed water distribution system, a heat- exchange surface system consisting of tubes and with a steam header. In the nuclear power plant with a pressurized 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 to saturated steam, which is transferred to the turbine.

Main coolant pump – The primary 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 primary 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 pressurizer, pressurizer relief tank, relief valves unit and pipelines, connecting the individual components to the connected systems. The pressurizer is a vertical welded vessel with an elliptic bottom. The pressurizer 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 rise in emergency modes, as well as to provide for the smooth rising and dropping of the pressure during heating and cooling of the primary circuit. The pressure in the primary circuit is created and maintained by the heating of the water volume in the pressurizer by means of electric heaters. In case of high pressure, it is reduced by injecting coolant from the primary circuit to the steam part of the pressurizer. The relief valves unit is designed to reduce the undesired rise of the pressure in the primary circuit under abnormal modes.

Primary circuit support systems

- *Primary circuit make-up and maintaining chemical modes* - 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 coolant chemistry treatment system will be installed.

  The systems perform the following functions:

  – maintaining the required balance of the coolant in all operating modes of the unit by draining and makeup;
  – 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 increasing 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 exhausted via the vent pipe.

The liquid RAW are generated during the purification of the primary circuit coolant, deactivation 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 exhausted 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 cleaning 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[15], which are accidents involving loss of coolant in the primary circuit. In the case of such incidents 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.
- *Decay Heat Removal System* – The decay heat removal system removes the decay heat, occurring in the stopped reactor 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.

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

- *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. It provides a protection barrier against radioactivity penetration into the service water system in abnormal modes.
- *Service Water Supply System for consumers responsible for the safety* – This system provides for the decay heat removal from all the important systems of the unit which cannot operate under long-term absence 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 decay 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 Generator 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 removal 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 inner steel liner plate and a concrete shell. The containment consists of the structure itself and leak-tight units (penetrations, airtight locks) and inside –the temperature and pressure control systems (e.g. passive heat removal, spray system, hydrogen ignition system, etc.) are located.

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 acceptable radiation effects. The structure and the system of the containment are designed with a view to protect the reactor, the primary circuit and all related facilities that are important from the point of view of nuclear and radiation safety, 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 exhausted 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 within 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, main steam isolation valves, safety devices and steam pipe connections.

- *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.
- *Lubrication system for the turbine and the generator* – it is located in the turbine hall. There is installed a tank, coolers, pumps, pipelines, valves and other equipment. 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. In the feed tank (deaerator), thermal degassing also takes place. The control valves, together with the feedwater pump, ensure the maintaining of the required level of feed water into 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. *S*ome of the support systems provide services to the whole unit, e.g. the chemical preparation of the water and the demineralized water reserve.
- *Circulation system* – the system includes a cooling water 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 will be used water from the Danube River, which flows along a third circulation loop and has 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 will 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 may be used facilities, using combined digital and analogue technology. With a view to minimize the human factor effects and to restrict the consequences of a human induced errors, a high degree of automation will be used and. Only proven equipment will be used, taking into consideration the accumulated experience.

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, which are important for the nuclear safety during normal operation and in emergencies conditions.

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

The instrumentation and control systems will produce visual and sound alarms, warning of the occurrence of operational states and processes deviating from the normal operation limits thus threatening 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 and will record it;
- information that allows to forecast and characterize the emissions of radio- nuclides and radiation in the vicinity of the nuclear facility, in order to allow for the timely undertaking of measures for the protection of the population.

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.

Protection systems

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

- capable of recognizing emergency states and automatically activate the respective systems, in order to guarantee that the design limits will not be exceeded;
- with possibility of providing for „manual” activation of the protection, if needed.

The protection 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 protection system to perform its required safety function.

The protection system solution will have a high functional reliability ensured by redundancy and independence of the channels, 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 of the power plant systems.

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

The information on the operation and the alarms signalling occurring operational situations 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 regulations thereby related.

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

1.4.2 TYPE AND QUANTITY OF USED RAW MATERIALS AND MATERIALS DURING THE OPERATION

1.4.2.1 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 gasoline, etc., the EIA report specifies provisional quantitative and qualitative characteristics of the fuels and analyses the possibilities for their safe storage.

→ ***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, sulfuric acid, hydrochloric acid, nitric acid, sodium hydroxide, etc. The chemical substances and mixtures will be delivered accompanied by their respective Safety Data Sheets, which specify 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 will be delivered and used, some of which are: boric acid, nitric acid, sulfuric 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 1.4-1.**

TABLE 1.4-1: DESCRIPTION OF THE USED CHEMICAL SUBSTANCES

No	Name	CAS No	EU No
Chemical reagents for production of denineralised water, deactivation, 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 water	1336-21-6	215-647-6
8.	Sulfuric 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 gasoline unleaded	68334-30-5	269-822-7
20.	Antifreeze[16]	107-21-1	203-473-3
21.	Gas for lighting (kerosene)	106-97-8	203-448-7

[16]Hazard category, R and S – phrases are for the subtsance ethyleneglycol, the contents of which in antifreeze is > 90%.

No	Name	CAS No	EU No
22.	Extraction benzene	-	-
Oils			
23.	Turbine oils	-	-
24.	Engine oils	-	-
25.	Transformer oils	-	-
26.	Hydraulic oils	-	-
27.	General purpose mechanical oils	-	-
28.	Compressor oils	-	-
29.	Transmission oils	-	-
Greases and lubricants			
30.	Lubricants (K2, 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 dealants			
32.	Sealants, pastes, adhesives (loctite, Univer, Proma), silicon, liquid metal, etc.[17]	-	-
Paints, primers, varnishes, thinners и diluters			
33.	Paints non-water based (alkyd, oil, etc.)[18]	-	-
34.	Paints water based (facade paint, emulsion paint)[19]	-	-
35.	Thinners, diluters, rust converters, etc..	-	-
36.	Koresilin	-	-
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.	Cargon 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% CO_2)	7440-37-1 124-38-9	2311470 2046969
48.	Freon 22 (chlordifluormethane)	ЛД	ЛД
49.	Refenrece gaseous mixture Ar –CH_4 (90% - 10%)	7440-37-1 74-82-8	2311470 200-812-7
50.	Carbon dioxide	124-38-9	2046969

[17] 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)..

[18] The hazard category, R and S – phrases are for the substance terpentine, the contents of which in the non-water based paints, varnishes and thinners varies within the range of 15 and 40%

[19] The hazard category, R and S – phrases are for 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.

1.4.2.2 NUCLEAR FUEL (NF)

1.4.2.2.1 General Schematic

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, all the stages of the process will be examined 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 .

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

Any NF to 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, in the EIA report is considered at least:

→ 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;
- HRE fragmentation and melt-down of the fuel rods.

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:

- ensuring possibility for incoming fuel inspections, 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 dropping and/or falling of the fuel assemblies when transported;
- prevention of dropping and/or falling of heavy objects onto the fuel assemblies.

1.4.2.2.2 Fresh nuclear fuel envisaged to be used by NNU

The types of NF developed by the Russian producers for the WWER technology and particularly the fuels TVSA and the new modification TVS-2M[20], can be used for the new nuclear unit AES-92 hybrid and/or AES-2006. The tendency is that the increase of the efficient use of the nuclear fuel in the burning cycles can be achieved by increasing the level of the average enrichment with ^{235}U. .

The core of the reactor in the project AEC-2006 is composed of 163 FA, 121 of which contain valves of the control and protection system (CPS). For refilling 42 FA are used. The mass of $^{235}UO_2$ in FA increases from 494 kg to 533 kg, the average enrichment by $^{235}UO_2$ is increased from 4.26 t. % to 4.79%. The average discharge burnup of all FA reaches 55.5 MWD/kgU, and the maximum –59.1 MWD/kgU.

The reactor testing of FR with discharge burnup 50 – 55 MWD/kgU show that the oxide layer of the containment does not exceed the safe limits, and the release of gaseous products in FR is of the order of 3%. These results show that, FR have a margin to reach the planned discharge burnup of 60-65%. There is data showing that 63 MWD/kgU per fuel assembly can be reached and 72 MWD/kgU per HRE[21].

[20] V. Molchanov, Nuclear Fuel for WWER Reacrors: Actual State and Trends. In: Proceedings of the 9-th International Conference on WWER Fuel Performance, Modeling and Experimental Support, 17-24 September 2011, Helena Resort, Bulgaria, pp 27-39, INRNE, 2011, ISSN 1313-4531

[21] V. Molchanov, Nuclear Fuel for WWER Reacrors: Actual State and Trends. In: Proceedings of the 9-th International Conference on WWER Fuel Performance, Modeling and Experimental Support, 17-24 September 2011, Helena Resort, Bulgaria, pp 27-39, INRNE, 2011, ISSN 1313-4531

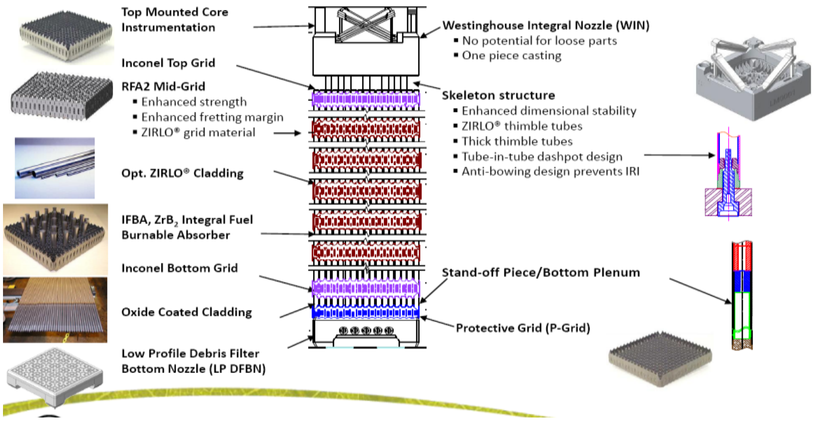

FIGURE 1.4-4: COMPOSITION OF NF TYPE WESTINGHOUSE RFA

The diversification of the supplies of nuclear fuel is achieved with the nuclear fuel WFA (Westinghouse Fuel Assemblies) for WWER-1000, which is undergoing a successful testing within the frame of the Ukraine Programme for Qualification of Nuclear Fuel. The fuel is produced in the Westighouse plant – Sweden and a discharge burnup over 52 MWd/kgU[22] is achieved. WFA is designed not only for 100% compatibility with WWER reactors. It allows safe and reliable operation in mixed cores in combination with the Russian FA.

AP-1000 uses fuel type RFA (robust fuel assembly), produced by the Westighouse plant in the state of Columbia and Sweden – **Figure 1.4-4.**

The core of the reactor AP-1000 consists of 157 fuel assemblies with length of 426.7 cm. The fuel assembly has 264 TOE, which are tube elements ZIRLO. The fuel of enriched uranium in the form of cylindrical granules of uranium dioxide is placed in them. The core is arranged in three radial zones with different enrichment of the fuel, varying from 2.35% to 4.45%.

1.5 LISENCES ISSUED TO EXISTING NUCLEAR FACILITIES ON THE TERRITORY OF KOZLODUY NPP

The Council of Ministers has issued Decision No 839 of 20.12.2008 regarding units 1 and 2 and Decision No 1038 of 19.12.2012 regarding units 3 and 4, all with reactor type WWER – 440/V230 on the basis of which NRA has issued licenses to SE RAW for operation of nuclear facilities within the scope of radioactive waste management facilities:

- Unit 1 – Series E, No 03492/18.10.2010 through specialized division Decommissioning – Kozloduy, term of validity to 17.10.2015.
- Unit 2 – Series E, No 03493/18.10.2010 through specialized division Decommissioning – Kozloduy, term of validity to 17.10.2015.

[22] J. Hoglund, O. Riznychenko, R. Lattorre, P. Lashevich. Performance of the Westinghouse WWER-1000 Fuel Design In: Proceedings of the 9-th International Conference on WWER Fuel Performance, Modeling and Experimental Support, 17-24 September 2011, Helena Resort, Bulgaria, pp 196-202, INRNE, 2011, ISSN 1313-4531

- Unit 3 – Series E, No 04152/25.02.2013 through SE RAWM – units 3 and 4, term of validity 5 years
- Unit 4 – Series E, No 04153/25.02.2013 through SE RAWM – units 3 and 4, term of validity 5 years

Kozloduy NPP is a licensee of the following nuclear facilities[23, 24]:

- Unit 5 – Series E No 03000/02.10.2009, term of validity to 05.11.2017, Scope – operation of the unit in compliance with the terms of the issued license.
- Unit 6 – Series E No 03001/02.10.2009, term of validity to 02.10.2019, Scope – operation of the unit in compliance with the terms of the issued license.
- Spent nuclear fuel storage facility (SNFSF) – Series E, № 01032/24.06.2004, amended 30.09.2010г, term of validity to 24.06.2004, Scope – manipulation and storage of spent nuclear fuel from the units of Kozloduy NPP, in compliance with the requirements of the issued license. SNFSF has been in operation since 2002.
- Dry spent nuclear fuel storage facility – permit for commissioning from 25.11.2011. Current state: commissioning the buildings, facilities and installations with main, auxiliary and service functions directly needed for the operation of the storage, in accordance with the terms of the issued license.

1.6 LICENSING A NEW NUCLEAR UNIT IN BULGARIA

The description of the licensing process including the responsibilities of the different institutions for ensuring safety and physical protection is referred to in reply to the letter from Romania – MEF, letter with outgoing No. 3672 RP 18.10.2012

The activities relating to the building of NNU – selection of a site, design, construction, commissioning and operation are subject to a licensing regime in accordance with the requirements of the Safe Use of Nuclear Energy Act (ASUNE) and the Regulation on the procedure for issuing licences and permits for safe use of nuclear energy (ROILPSUNE)

1.6.1 PART I LICENSING A NUCLEAR SITE

1.6.1.1 APPLICATION UNDER ART.33, PARA. 4 OF ASUNE FOR ISSUING A PERMIT FOR DETERMINATION OF THE LOCATION OF THE NUCLEAR FACILITY (SELECTION OF A SITE)

Under Art. 4 of **ROILPSUNE** the Applicant shall submit to the Chairman of NRA written application, which shall contain:

1. applicant's identification data;
2. the type of the required licence or permit and general description of the activity to be performed;
3. the term of validity for which the licence or permit is required;

[23] Updated safety analysis report for facilities and operation of Kozloduy NPP unit 5, July, 2011.
[24] Updated safety analysis report for facilities and operation of Kozloduy NPP unit 6, July, 2011.

4. general description of the basic characteristics and location of the nuclear facility or a source of ionising radiation to be utilised if operation of such an entity is foreseen;
5. information on the administrative acts issued by other state authorities, related to the stated activity;
6. list of the documents attached to the application.

Under Art. 35 of **ROILPSUNE,** the following documents are attached to the application:

1. a copy of the document certifying the business registration of the applicant;
2. document certifying that the applicant is not subject to bankruptcy proceedings
3. document declaring lack of previous convictions for crimes of general nature – for the members of the management and supervisory bodies of the applicant – legal person or sole trader;
4. documents confirming that the applicant possesses sufficient financial resources for performing the activity in conformity with the nuclear safety and radiation protection requirements, standards and rules;
5. documents confirming that the applicant possesses sufficient technical resources for performing the activity in conformity with the nuclear safety and radiation protection requirements, standards and rules;
6. documents confirming that the applicant possesses sufficient material resources for performing the activity in conformity with the nuclear safety and radiation protection requirements, standards and rules;
7. documents related to the management and organisational structure of the applicant;
8. documents related to the actual number of personnel, specifying the level of education, qualification, and allocation of duties;
9. justification for the proposed the term of validity;
10. list of the standards applied to this activity as well as other documents confirming the compliance with the requirements for performing the activity envisaged in this chapter.

Under Art. 36 of ROILPSUNE, the following documents are attached to the application:

1. conceptual description of the nuclear facility, general characteristics and criteria for acceptability of the sites;
2. plan requirements for preliminary investigations containing information about the scope of the envisaged pre-investment investigations according to the Regulation No. 4 for the Scope and Contents of the Investment Projects (promulgated in the SG No. 51/2001);;
3. description of the management system for the activity.

1.6.1.2 *Application for an order for approval of the selected site*

Under art.37 of ROILPSUNE the following documents shall be attached to the application for an order for approval of the selected site:

1. preliminary safety analysis report for the nuclear facility, which shall contain at least the following:
   1) general description and characteristics of the nuclear facility;
   2) basic goals, principals and criteria for safety applied to justification of safety;
   3) the types and quantities of RAW expected to be generated as a result of the facility operation, the mode of management until their final disposal or exemption;
   4) comparison of the proposed sites from nuclear safety and radiation protection point of view and selection of an option, taking into account: the impact of natural and human origin factors on the facility safety; the radiological impact of the nuclear facility over the population and environment; the specific characteristics of the site having an impact on the migration and accumulation of radioactive substances; potential for undertaking population protection measures in case of accident; the size of the special-statute areas and emergency planning area;
   5) the results of the investigation of the characteristics of the selected site, including: geographic, topographic and demographic conditions; factors of human origin; hydrometeorological conditions; geological, hydrological, seismological and engineer-geological conditions; the specific characteristics of the region and site for the purposes of emergency planning, accident management and physical protection;
   6) list of literature references, containing data and information used for justification of the selected site;
   7) list of the specialists contributed to the preparation of the documentation and to site investigation, as well as data for their qualification;
2. on-site monitoring programmes, including: seismic monitoring, groundwater and surface waters monitoring and monitoring of other natural phenomena;
3. decision on the environmental impact assessment (EIA), or a decision of a competent authority under the Environment Protection Act confirming that EIA is not necessary;
4. programme for implementing additional investigations connected with the selected site if the prepared safety analysis report substantiates such necessity;
5. other documents confirming the compliance with the requirements of the regulations under Article 26, Paragraph 2 of the ASUNE and with the conditions of the site selection permit.

1.6.1.3 APPLICATION FOR A PERMIT FOR DESIGN OF A NUCLEAR FACILITY

Under **art.49** of **ROILPSUNE,** the application for a permit for design of a nuclear facility shall comply with the requirements under Article 35, Paragraph 1. The following documents shall also be attached to the application:

1. technical specification or a contract for designing;
2. description of the management system for the activity;
3. list of the standards applied to the designing stage.

1.6.1.4 APPLICATION FOR AN ORDER FOR THE NUCLEAR FACILITY TECHNICAL DESIGN APPROVAL

Under art. 40 of **ROILPSUNE,** the following documents shall be attached to the application for an order for the nuclear facility technical design approval

1. intermediate safety assessment report for the nuclear facility, which shall include:
   1) intermediate safety analysis report prepared on the basis of the preliminary safety analysis report and the technical design; the minimum content of the Safety Analysis Report shall comprise the topics stipulated in Enclosure No 1;
   2) the results of the verification of the design compatibility with the nuclear safety and radiation protection requirements, standards and rules, including those connected with effectiveness of safety as well as with the results of an independent verification of the safety assessment;
2. technical design for the nuclear facility;
3. other documents confirming the fulfillment of the design permit conditions.

1.6.1.5 APPLICATION FOR A PERMIT FOR CONSTRUCTION OF A NUCLEAR FACILITY

Under **art.41 of ROILPSUNE**, the application for a permit for construction of a nuclear facility shall comply with the requirements under Article 35, Paragraph 1 and shall contain the registration numbers of the orders under Article 33, Paragraph 4 of the ASUNE.. The following documents shall also be attached to the application:

1. preliminary general schedule for implementation the construction and assembling works;
2. technical design and/or work design for nuclear facility construction;
3. description of the management system for the activity;
4. to the application for a construction permit of a nuclear power plant, a decision of the Council of Ministers for construction of a nuclear power plant under Article 45, Paragraph 1 of the ASUNE shall also be attached.
5. The decision on the above item 4 shall be taken on the basis of a proposal submitted by the Minister of Economy, Energy and Tourism containing an assessment of:
   a) the nuclear safety, radiation protection and physical protection;

b) the environmental impact assessment;

c) the social and economic significance of the construction of the nuclear power plant for the country or separate regions;

d) radioactive waste and spent nuclear fuel to be generated as a result of the operation of the nuclear plant as well as the mode of their management.

6. Environmental Impact Assessment under Paragraph 3, Subparagraph 2 shall be performed according to the provisions of the Environment Protection Act.

Under **art. 41 of ROILPSUNE,** the application for a permit for construction of a nuclear facility shall contain the registration numbers of the order for approval of the selected site and the order for approval of the technical design of the nuclear facility. The following documents shall be attached to the application:

1. preliminary general schedule for implementation of the construction and assembling works;
2. technical design and/or work design for a nuclear facility construction;
3. description of the management system for the activity.

to the application for a construction permit of a nuclear power plant, a ***decision of the Council of Ministers for construction of a nuclear power plant under shall also be attached***. This decision shall be taken on the basis of a proposal submitted by the Minister of Economy, Energy and Tourism containing an assessment of:

1. the nuclear safety, radiation protection and physical protection;
2. environmental impact assessment according to the provisions of the Environment Protection Act.
3. the social and economic significance of the construction of the nuclear power plant for the country or separate regions;
4. radioactive waste and spent nuclear fuel to be generated as a result of the operation of the nuclear plant as well as the mode of their management.

The steps and terms of the legislative procedures before the approval of construction of NNU are shown in **Figure 1.6-1.**

1. Application for issuing a permit for selection of a site	
Permit for selection of a site	Within 9 months (Art. 18, para. 2, p. 1 of ASUNE)

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2. Application for issuing an order for approval of the site selected	
Order of NRA Director for approval of a selected site	Within 9 months (Art. 34, para. 4 of RILPSUNE)

↓

3. Application for issuing a permit for design of nuclear facility	
Design permit for a nuclear facility	Within 9 months (Art. 18, para. 2, p. 1 of ASUNE)

↓

4. Application for issuing an approval order of a technical project of a nuclear facility	
Order of NRA Director for approval of a technical design of a nuclear facility	Within 9 months (Art. 34, para. 4 of RILPSUNE)

↓

5. Application for issuing a construction permit for a nuclear facility	
Construction permit for a nuclear facility	Within 9 months (Art. 18, para. 2, p. 1 of ASUNE)

↓

6. Application for issuing a commissioning permit for a nuclear facility	
Commissioning permit of a nuclear facility	Within 9 months (Art. 18, para. 2, p. 1 of ASUNE)

↓

7.Application for issuing a license for operation of a nuclear facility	
License for operation of a nuclear facility	Within 9 months (Art. 18, para. 2, p. 1 of ASUNE)

FIGURE 1.6-1 STEPS AND TERMS OF THE LEGISLATIVE PROCEDURES BEFORE THE APPROVAL OF CONSTRUCTION OF NNU

1.6.2 PART II: LICENCING A NUCLEAR FACILITY

The licencing of the nuclear facility according to the normative rules shall be done in two stages:

Stage I – commissioning

Stage II – obtaining a licence for operation.

At every stage the appropriate fees shall be paid and the required documents shall be submitted as follows:

1.6.2.1 STAGE I:

Permit for commissioning of a nuclear facility

1.1 Fees

1.1.2	Application review fee for a permit
1.1.3	Application review fee for issuing a permit for commissioning of the nuclear facility
	1.2 Documents:
1.2.1	This shall be submitted in the Nuclear Regulation Agency according to the Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy. The application, according to **Article 4** shall contain: 1. applicant's identification data; 2. the type of the required permit and general description of the activity to be performed; 3. the term of validity for which the licence or permit is required; 4. general description of the basic characteristics and location of the nuclear facility where the activity will be performed; 5. information on the administrative acts issued by other state authorities, related to the stated activity; 6. list of the documents attached to the application
1.2.2	according to **Article 35** 1. court ruling for registration of the applicant and current legal status certificate issued by the court of registration of the applicant; 2. document by the respective court certifying that the applicant is not subject to bankruptcy proceedings; 3. document declaring lack of previous convictions for crimes of general nature for the members of the management and supervisory bodies of the applicant – legal person; 4. documents confirming that the applicant possesses sufficient financial resources for performing the activity in conformity with the nuclear safety and radiation protection requirements, standards and rules; 5. documents confirming that the applicant possesses sufficient financial resources for performing the activity in conformity with the nuclear safety and radiation protection requirements, standards and rules; 6. documents confirming that the applicant possesses sufficient financial resources for performing the activity in conformity with the nuclear safety and radiation protection requirements, standards and rules; 7. documents related to the management and organisational structure of the applicant; 8. documents related to the actual number of personnel, specifying the level of education, qualification, and allocation of duties; 9. justification for the proposed term of validity; 10. list of the standards applied to this activity as well as other documents confirming the compliance with the requirements for performing the respective activity.
1.2.3	Under **Article 43** for issuing a permit for commissioning of the nuclear facility the following documents shall be attached: 1. decision of the Council of Ministers under Article 129, Paragraph 1 of the ASUNE if the nuclear facility is a nuclear installation within the meaning of the Vienna Convention on Civil Liability

for Nuclear Damage;

2. document confirming the existence of financial security covering civil liability for nuclear damage according to Article 132 of the ASUNE;
3. utilisation facility permit issued under the procedure of the Act on the Territorial Structure;
4. commissioning programme for the nuclear facility determining the commissioning stages, activities to be performed during each stage and planned duration of each stage; the commissioning programme contents shall confirm:
    a) that all tests determined by the intermediate safety assessment report as necessary for approval of the nuclear facility design characteristics are included;
    b) that the tests are planned by stages in order the load to be increased gradually before the transition to heavier load;
    c) determination of time periods of deferred commissioning in which the facility will be operated according to previously set conditions and period;
    d) the availability of a list of the systems and equipment intended to be used during each commissioning stage;
5. document confirming that the instructions for operation have been approved by the management body of the applicant;
6. programme for ensuring the quality of the commissioning of the nuclear facility;
7. description of the approved modifications in the nuclear facility technical design;
8. description of the results of the pre-operation acceptance testing of the structures, systems and components;
9. the technical specification for nuclear facility operation, which shall contain at least:
    a) rules and basic methods for safe operation;
    b) the general order of carrying out the technological operations related to the safety of the facility;
    c) limits and conditions for operation, including: safety limits; values of the parameters for actuation of the safety systems; operational limits and conditions; tests, inspections, surveillance and in-service inspections over the systems important to safety; minimum number of operating personnel to carry out activities connected to the respective operational states, including qualified and authorised main control room staff; actions to be taken in case of deviations from the operational limits and conditions;
10. list of the internal rules, instructions and procedures applied to nuclear facility operation;
11. list of the positions in the organisational structure of the applicant exercising functions related to ensuring nuclear safety and radiation protection for which competence for employment at nuclear facilities is required under Article 64, Paragraph 2, Subparagraph 1 "a" and "b" of the ASUNE;

	12. programme for on-site radiation monitoring and for monitoring of the special statute areas during the operation of the nuclear faculty; 13. list of the structures, systems and components important to safety; 14. the availability of a list of the systems and equipment intended to be used during each commissioning stage; 15. methods and programmes for performing tests and experiments during each commissioning stage; 16. instructions for ensuring nuclear safety during commissioning and operation; 17. instructions for ensuring radiation protection during commissioning and operation; 18. instruction for ensuring nuclear safety during on-site transport and storage of nuclear material; 19. instruction for physical protection of the nuclear facility and nuclear material; 20. instruction for admission regime; 21. instruction for prevention the progression of accidents during the operation of the nuclear facility; 22. instruction for accounting and control of nuclear material; 23. document confirming the presence of sufficient personnel possessing required level of qualification and competence for employment at nuclear facilities for performing commissioning and operating activities 24. description of the applicant's system for providing personnel training and retraining as well as for continuous improvement and control of the qualification; 25. on-site emergency plan for the nuclear facility; 26. instruction for the personnel actions in case of radiological accident at the nuclear facility; 27. manual for assuring the quality of the activity of the applicant; 28. documents arranging the special-statute areas and controlled access areas; 29. programme for radiation monitoring of the environment; 30. programme for monitoring the radiation parameters of the nuclear facility site.

1.6.2.2 STAGE II:

Issuing a licence for operation

	2.1 Fees
2.1.2	Application review fee for the application for issuing a licence for operation
2.1.2	Initial fee for issuing a licence for operation of a nuclear facility
2.1.3	Annual licence fee
	2.2 Documents:
2.2.1	To be submitted to the Nuclear Regulation Agency pursuant to the Regulation on the procedure for issuing licences and permits for safe use of nuclear energy. The application, according to **Article 4** shall contain: 1. applicant's identification data; 2. the type of the required permit and general description of the activity

	to be performed; 3. the term of validity for which the licence or permit is required; 4. general description of the basic characteristics and location of the nuclear facility where the activity will be performed; 5. information on the administrative acts issued by other state authorities, related to the stated activity; 6. list of the documents attached to the application;
2.2.2	Under **Article 35** the following documents shall be attached to the application 1. court ruling for registration of the applicant and current legal status certificate issued by the court of registration of the applicant; 2. document by the respective court certifying that the applicant is not subject to bankruptcy proceedings; 3. document declaring lack of previous convictions for crimes of general nature for the members of the management and supervisory bodies of the applicant – legal person; 4. documents confirming that the applicant possesses sufficient financial resources for performing the activity in conformity with the nuclear safety and radiation protection requirements, standards and rules; 5. documents confirming that the applicant possesses sufficient financial resources for performing the activity in conformity with the nuclear safety and radiation protection requirements, standards and rules; 6. documents confirming that the applicant possesses sufficient financial resources for performing the activity in conformity with the nuclear safety and radiation protection requirements, standards and rules; 7. documents related to the management and organisational structure of the applicant; 8. documents related to the actual number of personnel, specifying the level of education, qualification, and allocation of duties; 9. justification for the proposed the term of validity; 10. list of the standards applied to this activity as well as other documents confirming the compliance with the requirements for performing the activity envisaged in this chapter.
2.2.3	Under **Article 48** for issuing a permit for operation of the nuclear facility the following documents shall be attached: 1. final safety analysis report, prepared on the basis of the report under **Article 40**, Paragraph 1, Subparagraph 1, taking into account the commissioning stage results; 2. the documents under **Article 43**, Paragraph 1, Subparagraphs 7, 14, 16, 17, 22, 24, and 28 updated on the basis of the results of the commissioning stage; 3. instructions for the operation of the facilities, systems and equipment important for the safety; 4. schedule and instructions for testing and control of the systems important for the safety; 5. time-schedule plan for maintenance and repair of the main equipment; 6. programmes and plans for spent nuclear fuel management for the

	nuclear facility lifetime and following final shut down of the facility; 7. programme for RAW management for the term of validity of the licence and for the whole lifetime of the nuclear facility; 8. rules, procedures and programmes for personnel training and for continuous improvement and control of the qualification; 9. analysis of the activities executed by contractors, as well as the positions in the organisational structure of the applicant to manage and control these activities and the minimum number and qualification of the staff to occupy them; 10. programme for ensuring the quality of the operation of the nuclear facility; 11. list of the documents on the assurance and sustaining the quality of the activities related to the operation of the nuclear facility; 12. documents, approved by the management body of the applicant, defining the safety policy, including for establishing and maintaining a high level of safety culture; 13. instruction for the procedure for reporting and methods for analysis of the operational occurrences; 14. programme and a time-schedule for personnel training and exercise related to the activation of the on-site emergency plan of the nuclear facility; 15. programme for equipment lifetime management for the requested term of validity of the licence and for the nuclear facility lifetime, including for monitoring the status of important to safety components; 16. updated plan for decommissioning of the facility.
2.2.4	for issuing an operating licence for a nuclear facility, the following is required under Art. 51: 1. physicochemical and radiochemical properties of the nuclear material, which is extracted, produced, processed, stored or handled at the facility; 2. (Amended, SG No 76/2012) neutron-physical characteristics, isotope composition and enrichment with fissile isotope of the nuclear material at the facility if it is a special nuclear material within the meaning of § 1, Subparagraph 36 of the Final provisions of the ASUNE; 3. characteristics of the final product if nuclear material is produced or processed at the nuclear facility; 4. description of the operating activities in their technological sequence; 5. list of the instructions and procedures for performing main technological activities related to nuclear safety and radiation protection during operation; 6. operating instructions for technological systems connected with performing the facility intended purpose; 7. technical specification for nuclear material packages corresponding to the acceptance criteria for on-site storage or disposal of nuclear material

1.6.3 OPERATION PERMITS OF NNU

In compliance with the national legislative documents concerning problems of the environment the operator of NNU shall have all the administrative acts with the force of permits required pursuant to the respective laws and regulations in accordance with the provisions of the EA and SDA.