CONSORTIUM

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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 7: INFORMATION ON THE USED ENVIRONMENTAL IMPACT FORECASTING AND ASSESSMENT METHODS

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7. INFORMATION ON THE USED ENVIRONMENTAL IMPACT FORECASTING AND ASSESSMENT METHODS

The preparation of the environmental impact assessment report for the proposed investment project involved several common methods typically used for such type of assessments, namely:

- ✓ Review of documents including texts, charts and numerical data;
- ✓ Integrated analyses of multiple factors including environmental and anthropogenic components of the environment and their interactions;
- ✓ Integrated assessment made by a group of experts;
- ✓ Geographic information system.

7.1 IMPACT FORECASTING AND ASSESSMENT METHODS

The specific methods used by experts to develop forecasts of any potential impact of the investment project on the environment are specified below:

No	Method name
1.	Methods provisioned by Regulation 6 on the indicators of noise emissions to the environment, which reflect the level of discomfort over different hours of the day, the threshold values of noise emissions to the environment, assessment methods of noise values and the harmful effects of noise on public health (Ministry of Healthcare, Ministry of Environment and Water, State Gazette 58/2006)
2.	Method of identifying total sound power emitted to the environment by industrial operations and identifying the noise level at the impact area, Ministry of Environment and Water, 2007.
3.	Monitoring method of greenhouse gas emissions generated by operators of installations involved in the scheme for greenhouse gas emission allowance trading, approved by Order RD-442/17.07.2008 of the Minister of Environment and Water.
4.	Methods of identifying alpha-, beta- and gamma-emitting radioactive isotopes to environmental components, 2001, National Centre of Agricultural Science, Sofia
5.	Comparison of obtained and existing data on soils from the project site against information from the available literature in terms of soil fertility and the agricultural land category.
6.	Guidebook on basic waste categorization and application of a set of criteria for waste disposal at various categories of waste disposal facilities, MoEW[1], Sofia, 2011.
7.	Guidebook on preliminary waste treatment before disposal, MoEW, Sofia, 2005
8.	Field research and reconnaissance surveys in the impact areas.
9.	Method of low-background identification of natural and technogenic gamma emitters to soils, water and other agricultural components

[1] Ministry of Environment and Water

10.	Method of radiochemical identification of strontium-90 in soils, water and agricultural sites
11.	ISO 18589-2,3:2007; Part 3: Measurement of gamma-emitting radionuclides
12.	ISO 18589-2,3:2007; Part 2: Guidance for selection of sampling strategy, sampling and pre-treatment of samples;
13.	Assessment and investigation method of electromagnetic emissions at high voltage substations (Outdoor and Indoor Power Distribution) and kiosk switchgears, Hygiene investigation methods, National Centre of Hygiene Medical Ecology and Nutrition, Volume IV, p. 31-34, 2002
14.	Galabov, M., Penchev, P. et all., Methodology Guidebook: Identifying groundwater resources, MoEW
15.	Method of quantitative risk assessment of groundwater pollution by dangerous and harmful substances (pursuant to art. 2, par. 1, Items 3, 4 and 5 and art. 93, par. 2, Item 4 of *Regulation 1/07.07.2000 on Groundwater Exploration, Use and Protection* - SG 57 of 14.07.2000), MoEW, 2001.
16.	Guidebook 26 A. Groundwater Conceptual Model. General strategy for application of the Waters Framework Directive
17.	CIS Guidance document 17, 2007: Direct and indirect inputs in the light of the 2006/118/EC Directive. Technical Report 2007 – 012
18.	CIS Guidance document 18, 2009: Groundwater Status and Trend Assessment. Technical Report 2007 – 026
19.	CIS Guidance document 16, 2007: Groundwater in Drinking Water Protected Areas. Technical Report 2007 – 010.
20.	CIS Guidance document 15, 2007: Groundwater Monitoring (WG C). Technical Report 2007 – 002.
21.	CIS Guidance document 20, 2009: Exemptions to the environmental objectives. Technical Report 2009 – 027.
22.	GUIDANCE FOR ASSESSMENT OF NUCLEAR POWER PLANT SITES
23.	Emission inventory method, EMEP/EEA, Technical Guidebook, 2009, Chapter: o road vehicles - NFR code 1.A.3.b.i, 1.A.3.b. ii, 1.A.3.b.iii and the chapter on off-road construction vehicles with internal combustion engines using diesel fuel - NFR code 1.A.2.f ii, asphalt laying -NFR code 1.A.6; o off-road vehicles - NFR code 1.A.2.f ii (SNAP 0808).
24.	Greenhouse inventory method by an international expert group on climate change (IPCC), Chapter 3 Combustion of internal combustion engines (NFR code 1.A.5.b.iii) combustion of carbon dioxide;
25.	US Environmental Protection Agency – emission factors (AP-42) of outdoor dust emission sources at mines and quarries, Section 11 an 13; Construction and Aggregate Processing and Fugitive Dust Open Sources http://www.epa.gov/ttn/chief/ap42/index.html
26.	Gromkova, N. - Pre-processed Hourly Data Set - The Meteorological Input of Applied Diffusion Models, 1998, Bulg. Geoph. J., v. XXIV, No 3-4
27.	Analytical and comparative assessment methods and models of the status of surface, ground, drinking and waste water; reference features and water quality criteria for the purpose of resources and reserve estimation
28.	Research, analysis, assessment, processing and suitable presentation of information obtained from various institutions for the purpose of the investment project
29.	ABC Tehnika, 1997, *Design standards for mat-slab foundations, Regulation 1,* Sofia, *p.72*
30.	Nuclear Regulatory Agency, 2008, *Regulation on ensuring the safety of nuclear power plants, NRA, Sofia, p.43.*

31.	International Atomic Energy Agency. 2012. *Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants Safety Guide Series No. NS-G-3.2, IAEA, Vienna, 32 p.*
32.	International Atomic Energy Agency. 2003. *Site Evaluation for Nuclear Installations. Safety Requirements. NS-R-3, IAEA, Vienna, 28 p.*
33.	International Atomic Energy Agency. 2004. Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants. Safety Guide Series No. NS-G-3.6, IAEA, Vienna, 53 p.
34.	International Atomic Energy Agency. 2010. *Seismic Hazards in Site Evaluation for Nuclear Installations. Specific Safety Guide Series No. SSG-9, IAEA, Vienna, 60 p.*
35.	International Atomic Energy Agency. 2011 *Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations. Specific Safety Guide Series No. SSG-18, IAEA, Vienna, 146 p.*
36.	Division methods of physicogeographical and landscape regions, Georgiev, M., Physical Geography of Bulgaria, University Press, Sofia University
37.	Basic principles of landscape differentiation, Petrov P., Geography of Bulgaria, Bulgarian Academy of Sciences, Sofia, pages 340-345
38.	Basic division methods and principles of determination of landscape regions, Petrov P., Geography of Bulgaria, BAS, Sofia, pages 345-356.
39.	Reconnaissance survey method of identifying the type and quantity of birds in a given area
40.	Transection method of identifying the quantity of nesting birds in a given area
41.	Fauna and Zoogeography of Marine, Freshwater, and Terrestrial Mollusks (Mollusca) in Bulgaria. In: V. Fet & A. Popov (Eds.). Biogeography and Ecology of Bulgaria. Springer, pp 141-198
42.	Analysis and assessment of the fauna diversity of the Orthoptera insects in Bulgaria. Doctoral thesis. Zoology Institute, Bulgarian Academy of Sciences, p.565.
43.	Biotic Index (modified Irish Biotic Index). Gerasimov & Peev,1999
44.	ISO 7828. Water quality – Methods of biological sampling – Guidance on hand net sampling of aquatic benthic macro-invertebrates, 6
45.	% EPT, % EPT taxsons by biotic index
46.	Structure of the bottom-dwelling coenosis: after Margalev, Shannon & Weaver, 1963; Pielou, 1966; Simpson, 1949
47.	Index KN (Yaneva, Rusev)
48.	Saprobity valence method, Pantle & Buck
49.	EN 14011 European Standard; Water Analysis – Sampling of fish with electricity
50.	Guidebook on basic waste categorization and application of the set of criteria for waste disposal at various categories of waste disposal facilities, MoEW, Sofia
51.	Guidebook on preliminary treatment of waste prior to disposal, MoEW, Sofia
52.	Guidebook on determination of number and type of required containers and equipment for waste collection and haulage, MoEW, Sofia
53.	Strategic national plan for management of construction and demolition waste on the territory of Bulgaria for 2011-2020, MoEW, Sofia
54.	Spent nuclear fuel and radioactive waste management strategy, approved by Council of Minister's Resolution No 49 /23 December, 2004
55.	Review of cultural heritage documents and the applicable legislation
56.	Proprietary scientific studies and publications of the authors and reviews of Environmental Impact Statements of similar sites

No	SOFTWARE APPLICATIONS
1.	**AERMOD –** Regulatory diffusion model of the US Environmental Protection Agency, which models the impact of surface and tall industrial sources on a flat or moderately complex terrain with Windows-based interface developed by the Canadian company Lakes Environmental
2.	**TRAFFIC ORACLE,** software application – Method for determination of the distribution of pollutants from the transport and their concentrations in the surface air layer (Order RD 994/04.08.2003 of the MoEW).
3.	**LEDA-CM**, Shield. Normal operation.
4.	**ESTE Kozloduy**

7.2 DESCRIPTION OF THE ESTE EU KOZLODUY SYSTEM

ESTE EU Kozloduy (software system and two work stations) is a system, whose purpose is to assess release sources and determine accident protection measures.

The work stations are situated in the Emergency Control Centre at Kozloduy NPP and the full-scale training simulator, PMS-1000.

The application is developed by ABmerit, Slovak nuclear science and software developer company.

ESTE EU Kozloduy is C# based software. The geographic information systems (GIS) are SharpMap-based; the graphical user interface (GUI) is based on Windows Presentation Foundation, and the system architecture is client/server.

7.2.1 ESTE REFERENCES

ESTE is the name of a group of software applications, which are used as a tool to assess radiological impact and identify its source in case of a nuclear accident or it can be used assessment the impact of a nuclear power plant as part of its normal operation.

ESTE, or its version for emergency response purposes has various modifications: ESTE EU, ESTE Dukovani, ESTE Temelin, ESTE Mohovtse, ESTE Bohunice.

ESTE used for normal operations is ESTE AI, and it is now adapted for use at the Bohunice NPP V-2, V-1, A-1).

ESTE AI (=Annual Impacts) is a software, which calculates radiation doses of releases to the atmosphere and hydrosphere as part of the normal NPP operation. Doses of critical community group members in the Kozloduy area are calculated and the critical group is identified on the basis of such calculation results. The software also supports collective dose calculations. The collective doses apply to local community members, i.e. the residents of the NPP area. The software also supports dose calculations of the entire population of the Slovak Republic and the neighbouring countries (Austria, Hungary and the Czech Republic) associated with the individual NPP operations. The calculations

include global nuclides as well. ESTE AI is approved by the Public Health Authority of the Slovak Republic and is used by Slovenske elektrarne a.s., NPP Bohunice and JAVYS a.s., Bohunice as a legally authorized tool.

ESTE EU is both an information system and software for calculation of radiological impact at the European countries in case of radiation accident within or outside a country. The system operates at the State Nuclear Safety Agency (Prague), the Nuclear Regulatory Agency (Sofia) and the Crisis Management Centre of the Austrian Federal Ministry of Environmental Protection (BMLFUW), Vienna. The training version, ESTE EU School, operates at the Nuclear Science and Engineering Physics Department (FJFI) of the Technical University in Prague (CVUT).

ESTE Kozloduy module is an ESTE EU application, which operates in the Nuclear Regulatory Agency, Sofia. The two systems, ESTE EDU (Dukovany NPP) and ESTE ETE (Temelin NPP) operate at the State Nuclear Safety Agency, Prague, and are used as a main tool for incident/accident response of emergency response teams. The systems are connected on-line to the operational data of the nuclear plants, the early warning system data (the EWS-calculated dose in the entire country), and the data of the METEO system.

Versions of ESTE DUKOVANY v.Austria and ESTE TEMELIN v.Austria operate at the Crisis Management Centre of the Austrian Federal Ministry of Environmental Protection (BMLFUW), Vienna. In case of emergency, both codes, of the Czech and the Austrian ESTE connect automatically with each other to exchange data.

A special version of the system, ESTE Mochovce-SIM, operates at Slovenske elektrarne a.s., the Mohovce NPP, and is connected on-line to the data generated by the Mohovce simulator. The system calculates and simulates the radiation situation within and outside the Mohovce NPP site for the purpose of personnel training and development of various scenarios.

The ESTE EBO system (Bohunice V-2 NPP) and ESTE EMO (Mochovce NPP) operate at Slovenske elektrarne a.s., Bohunice V-2 NPP and Mohovce NPP and are connected on-line to the relevant operational, radiological and metrological data.

7.2.2 DESCRIPTION OF ESTE EU KOZLODUY

ESTE EU Kozloduy system is adapted for the operation of reactor 5 and reactor 6 of Kozloduy NPP. Its purpose is to simultaneously assess an emergency situation at both reactors. The system is ready to manage emergency situation(s) of reactor 5 and/or reactor 6 of Kozloduy NPP.

ESTE EU Kozloduy has an integrated database of release sources. The data are calculated and specially prepared for emergency response at units 5 and 6 of Kozloduy NPP. The database is prepared specifically for the fuel inventory of reactors 5 and 6. The database contains release sources of potential emergency situations associated with the spent nuclear fuel storage facilities at various levels of damage classification of the pressurized structure (loss of pressure).

ESTE EU Kozloduy has an integrated core inventory database of Unit 5 and Unit 6, specifically calculated for emergency response purposes. Similarly, the system has an integrated and specifically calculated inventory of the spent fuel facilities of the Kozloduy reactors.

"Data adjustment" is a process, which is integrated in the ESTE EU Kozloduy system. It is a process of adjustment of the modelled and probable release parameters against the measured actual radiation parameters):

- "actual release" is calculated by conversion factors used for back calculation of detector readings from Gy/h to Bq/s or Bq/m^3 in the radioactive cloud;
- ESTE EU Kozloduy operates with a number of pre-set conversion factors calculated as part of the dose-rate monitoring. The factors are assessed by applying updated detector readings based on MCNP (software application). The conversion factors are individually calculated for each detector (from the 8 ones actually applied and used in the ESTE algorithms), and each one is individually calculated on the basis of the nuclide in the release (i.e. the energy of the photons of that nuclide), the release point – Stack_5, Stack_6, the roof of reactor 5 and reactor 6 building, 60m effective release height (equivalent to a release from the rooftop of reactor's building) and 150m (equivalent of a stack release), for three main types of meteorological conditions (Pasquill stability classes A, D, F) regardless of the wind speed (i.e. every one actually measured in the Kozloduy area);
- The activity rate of the radioactive cloud of actual releases (puffs) is adjusted according to the actual detector readings of the dose rate in the emergency planning zone. Therefore, the activity rate of a given cloud is adjusted in order to achieve maximum conformity between the impacts (i.e. the dose rate) – those calculated by the software and those actually measured.

The purpose of the system is:

- ✓ To assess a release source (included in the forecast) in case of Unit 5/6 emergency event with likely radioactive release to the environment. The system is adapted specifically to the requirements of reactors 5 and 6 of Kozloduy NPP to support simultaneous assessment of emergency situation at both reactors;
- ✓ To recommend immediate protection measures for the emergency planning zones of Kozloduy NPP; they are generated automatically or on the basis of manual data input by the user;
- ✓ To recommend protection measures for the Kozloduy NPP site (on the basis of a calculated forecast of the radiological situation at the Kozloduy NPP site);
- ✓ To assess the actual release (actual monitored release) of radioactive gas and aerosols to the environment and inform the user about such releases.
- ✓ To calculate the radiological situation (especially preventable doses) at the Kozloduy NPP and the vicinity as a result of actual release(s);

- ✓ To calculate doses during evacuation, doses of the field monitoring teams or rescue teams at Unit 5/6 in case of likely radioactive release to the environment.

7.2.3 MAIN FUNCTIONS OF ESTE EU KOZLODUY – DESCRIPTION

The main functions of ESTE EU Kozloduy software system include:

a. The system is connected to the existing operational and radiological and meteorological database of Reactors 5 and 6 of Kozloduy NPP– automated information systems: VRK ("ВРК"), RKPP ("РКПП"), SPDS;

b. The purpose of the system is to assess a release source included in the forecast in case of emergency situation at Unit 5/6, i.e. event of likely radioactive release to the environment;

c. The purpose of the system is to assess either automatically or based on commands by the user, the likelihood that emergency protection measures may be required;

d. The purpose of the system is to generate a forecast of the radiological situation at the Kozloduy NPP site and its emergency planning zones and show the results via the GIS, which is an integral part of the ESTE system;

e. The purpose of the system is to assess the actual release (actual monitored release) of radioactive gas and aerosols to the environment, alert the ESTE user about such release and calculate the radiological situation (especially preventable doses) at the NPP site and the adjacent area, as a result of the actual release;

f. The purpose of the system is to assess any coolant boiling symptoms, failure in the core boiling zone, symptoms of radioactive release from the reactor coolant pressure boundary (LOCA), symptoms of high-pressure bypass;

g. The purpose of the system is to assess any release in the reactor hall (to the pressurized area) and symptoms of release in the process of reactor shutdown or release from the spent fuel facility;

   The database of release sources in the event of severe accident with reactors 5 and 6 is an integral part of the ESTE EU Kozloduy (the database is developed specifically for reactors 5 and 6);

   Note: The release source database ESTE EU Kozloduy for emergency response purposes comprises calculations specifically made for the Kozloduy NPP project (particularly for reactors 5 and 6).

h. The database of the reactor 5 and 6 core inventory is an integral part of the ESTE EU Kozloduy (the database is developed specifically for reactor core No 5 and No 6.);

   Note: The inventory calculations of the core and the spent fuel facility are meant to be used for emergency response as part of the current project (calculated by ABmerit).

i. The graphical user interface of ESTE EU Kozloduy is accessible in Bulgarian and English.

The graphical user interface visualises the actual calculations of potential pathways. Even when no actual or potential release is in place, the system calculates and visualises

potential puffs from Kozloduy NPP where the pathways/trajectories are curves, which indicate the potential pathways of the centre of the puff (radioactive cloud), which at any time move at a given altitude above the surface.

"Wind rose" shows the actual meteorological readings measured in the Kozloduy NPP area (measured by Kozloduy NPP itself). "Wind rose" allows for visualisation of a "point" with its forecast meteorological parameters at the NPP site of the next 6 hours (where the ESTE EU user is notified by the system that the point with the forecast meteorological parameters should be entered manually by the user).

Indeed, the numeric weather forecast (wind field) could be entered as input data in ESTE EU Kozloduy for a broad Kozloduy area (entire Europe) and the data could be displayed by the "Trajectories" module.

Each calculated radiological parameter, which is a result of the calculated radioactive cloud dispersion, is reported to the GIS map user. Individual radiological values (near-surface air intensity rate, settling rate, doses and dose rate) are displayed on a grid, which covers the Kozloduy area up to 200km away from the plant (ESTE Kozloduy) and entire Europe (ESTE EU). ESTE EU Kozloduy calculates 48-hour trajectories of the puff's centre and visualises them by assuming the following hypothetical scenario:

The puff's centre rises from the release area (Kozloduy NPP area) to levels approximately equal to 50, 100, 200, 500, 1 500 and 3 000m above the earth's surface to the respective height observed at the release point. Then the puff moves from the given level within 48 hours.

Each calculated map is automatically archived. All maps are accessible any time and can be transferred to another computer (as a polygon layer in *.shp format).