ENVIRONMENT IMPACT ASSESSMENT REPORT ON

INVESTMENT PROPOSAL

CONSTRUCTION OF NATIONAL DISPOSAL FACILITY FOR LOW AND INTERMEDIATE LEVEL RADIOACTIVE WASTE – NDF

PART VII

TRANSBOUNDARY IMPACT

Sofia, January 2015

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7 TRANSBOUNDARY IMPACT

The approach for environmental impact assessment of the Investment proposal in a transboundary context includes:

→ The defining of a possible transboundary impact on the territory of another country or countries resulting from the implementation of an investment proposal for “Construction of national disposal facility for low and intermediate level radioactive waste – NDF at site “Radiana”

→ Special attention should be paid on the aspects with transboundary impact (if there is even hypothetical such) specific measures should be proposed for their prevention and limitation.

The present section aims to present the environmental impact assessment in a transboundary context in accordance with the procedure provided in the applicable Bulgarian legislative system and more specific in accordance with article 98, paragraph 1 of the Environmental protection act and article 25 of the Regulation on the Terms and Procedure for Elaborating an Environmental Impact Assessment, as well as in accordance with The Convention on Environmental Impact Assessment (EIA) in a transboundary context (Espoo Convention). The Convention is adopted in 1991 when the European Communities have several-year experience in the enforcing Directive 85/337/EEC for the environmental impact assessment. The provisions of the Convention envisage an expansion of the national procedure for the Environmental Impact Assessment regarding the assessment subject, the participants and the duties of the competent authorities.

The local Bulgarian mechanisms for the enforcement of the Espoo Convention are regulated in article 98 of the Environmental protection act (EPA) and chapter eight (article 23-26) of the Regulation on the Terms and Procedure for Elaborating an Environmental Impact Assessment. (RTPEEIA).

Article 24 of the RTPEEIA determines the Minister of Environment and Water as a competent body for the procedures of EIA in a transboundary context.

Article 25 of the RTPEEIA describes the steps of EIA in a transboundary context in the cases when Bulgaria is the country of origin such as the present case.

In addition, the competent body – the Minister of Environment and Water has to assess whether the investment proposal may have possible major impact on the territory of another country/countries. In this case the IP falls in Appendix 1, item 2 of the Espoo Convention and belongs to the category of the investment proposals which according to the national legislation have to have mandatory EIA – item 2.2 of Appendix 1 to article 92, item 1 of EPA. At the time of the drafting of EIAR the competent authority defines the Republic of Romania as an affected country furthermore the location of the IP is comparatively close to the river Danube which is the border between the Republic of Bulgaria and the Republic of Romania. It is the Minister of Environment and Water, who has to decide whether to notify other countries – article 3 of the Espoo Convention.

7.1 JUSTIFICATION OF INVESTMENT PROPOSAL IMPLEMENTATION OF NDF

7.1.1 CLASSIFICATION OF RADIOACTIVE WASTE IN THE REPUBLIC OF BULGARIA

In accordance with article 6 (item 1) of the Regulation on Safe Management of Radioactive Waste, 2013 a classification of RAW has been introduced. It is based on the division of the solid RAW in categories and subcategories and its aim is their safe and long-term management and disposal and in item (2) in accordance with the activity and their specific characteristics the solid RAW are classified the following way:

1. **Category 1** - waste, containing radionuclides with low activity which do not require measures for radiation protection and it is not necessary a high level of isolation and retaining;
2. **Category 2 –** low and intermediate level radioactive waste: RAW, containing radionuclides in concentrations requiring measures for safe isolation and retention but do not require special measures for the heat removal during its storage and disposal; RAW form this category are subdivided additionally into:
   a) category **2a** – low and intermediate level radioactive waste, containing mainly short-lived radionuclides (with a half-life shorter or equal to that of the cesium-137) as well as long-lived radionuclides at considerably lower activity levels limited for the long-lived alpha emitters under 4.10^6 Bq/kg for every single package and the maximum average value of all the packages in the respective facility 4.10^5 Bq/kg; for such RAW is required reliable isolation and retention for a period of several hundred years.

   б) category **2b** – low and intermediate level radioactive waste, containing long-lived radionuclides with activity levels of the long-lived alpha emitters exceeding the limits of category 2a;
3. **Category 3 –** high level radioactive waste: RAW with such a concentration of the radionuclides that heat generation shall be considered during storage and disposal; for this category is required a higher level of isolation and retention compared with the low and intermediate level radioactive waste. This waste should be disposed in deep, stable geological formations.

This classification is applicable for the liquid and gaseous RAW depending on the characteristics and form of the solid RAW suitable for disposal which are expected to be obtained after the conditioning of the liquid and gaseous RAW.

7.1.2 THE NEED OF NDF IN THE REPUBLIC OF BULGARIA

Republic of Bulgaria commissioned the first power unit of NPP Kozloduy in October 1974 and until August 1991 commissioned gradually 5 more power units. Following the memorandum between the Bulgarian government and the European Commission from November 1999 units 1 and 2 were decommissioned on 31.12.2002 and units 3 and 4 on 31.12.2006. Units 1-4 are to be decommissioned in accordance with the requirements of the nuclear legislation[1,2], the international commitments of the Republic of Bulgaria and the Strategy for management of spent nuclear fuel and radioactive waste up to 2030[3]. Units 5 and 6 of NPP Kozloduy are also to be decommissioned after the end of their service life and the service life of units 5-6 will be prolonged with 20 years[4].

The activities in medicine, industry and scientific researches which use radioactive sources of ionizing radiations have developed in the country since the beginning of the 60s of the last century. They include the usage of radioactive sources in various technological control devices in the industrial processes, the meteorological control and calibration of dosimeter and radiometer devices, devices for radioactive measuring, fire alarm sensors and their gradually decreasing usage

[1] Act on the Safe Use of Nuclear Energy, Promulgated SG 63/28.06.2002, last amended SG 68/02.08.2013.

[2] Regulation on safety during decommissioning of nuclear facilities, promulgated SG 73/20.08.2004

[3] Strategy on Spent Fuel and Radioactive Waste Management to the year 2030. Approved by the Council of Ministers by a Protocol Decision of 05.01.2011, amended by the Council of Ministers Protocol Decision of 25.06.2014

[4] Decision 6-ПР/2014 for defining the need of environmental impact assessment for the investment proposal for „Prolonging the term of operation of units 5 and 6 of the Kozloduy NPP“ - http://www.moew.government.bg/files/file/Industry/EIA/2014/Pretsenka6-PR-2014.pdf

in scientific researches. The usage of radioactive sources in medical diagnostics and therapy is extremely important.

Radioactive waste is obtained from all these activities. This waste should be managed safely in compliance with the requirements of the Bulgarian legislation and the EC directives and the International Atomic Energy Agency safety standards.

The safe disposal of low and intermediate level radioactive waste **category 2a** and its long-term and complete isolation from the environment and humans determines the construction of a suitable facility which **does not exist in the Republic of Bulgaria** for the time being. NDF has to secure the necessary capacity for safe disposal of conditioned and packed low and intermediate level radioactive waste **category 2a** obtained during the operation of NPP Kozloduy (units 5 and 6), decommissioning of units 1÷4 of NPP Kozloduy as well as of new potential nuclear powers at the KNPP site. In the NDF shall be disposed RAW **category 2a** which is generated during the usage of radioactive sources of ionizing radiations in industry, medicine, agriculture and scientific researches. The construction of a repository for the disposal of low and intermediate level RAW has the highest priority under the Strategy on spent nuclear fuel and radioactive waste management[5].

On the other hand, the construction of NDF reflects the international commitments taken by the Republic of Bulgaria:

- ⇒ Effective management of low and intermediate level RAW by closing the managing cycle of RAW in accordance with the requirements of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management[6], (ratified by the Republic Of Bulgaria with an act passed by the 38th National Assembly on 10.05.2000,Official Gazette, No 42/23.05.2000),
- ⇒ The implementation of the first stage at which should be provided safe disposal of the RAW of the decommissioned units 1÷4 of NPP Kozloduy, funded by the Kozloduy International Decommissioning Support Fund assisting the decommission of units 1÷4 of NPP Kozloduy.
- ⇒ The obligations of the Republic of Bulgaria under Directive 2011/70/Euratom of 19th July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste[7];
- ⇒ RAW management in the EU according to the safety standards of the International Atomic Energy Agency (IAEA) and best practices in the Union.

7.1.3 RADIANA SITE SELECTION

The NDF establishment activities – the site selection, design, construction, commissioning and operation are a subject of a licensing regime in compliance with the requirements of the Act on the Safe Use of Nuclear Energy[8] and the Regulation on the Procedure for Issuing Licenses and Permits for Safe Use of Nuclear Energy[9]. State Enterprise RAW carries out all the activities in accordance with the conditions of the permits issued by the Nuclear Regulatory Agency chairman (NRA).

[5] Strategy on Spent Fuel and Radioactive Waste Management to the year 2030. Approved by the Council of Ministers by a Protocol Decision of 05.01.2011, amended by the Council of Ministers Protocol Decision of 25.06.2014

[6] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Ratified by Law, adopted by the 38th National Assembly on 10.05.2000, SG 42/23.05.2000.

[7] Council Directive 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste

[8] Act on the Safe Use of Nuclear Energy, Promulgated SG 63/28.06.2002, last amended SG 68/02.08.2013

[9] Regulation for the procedure for issuing licences and permits for safe use of nuclear energy, promulgated SG 41/18.05.2004, last amended SG 76/05.10.2012

In accordance with the International Atomic Energy Agency (IAEA) [10], standards, the international experience and the best practices at the managing of the RAW in the developed European countries, as well as the requirements of art. 25, item1 of the Regulation on Safe Management [11] of Radioactive Waste, the process of a site selection goes through four phases:

⇒ **Phase 1: Development of a concept** for disposal and planning of the activities for site selection;

➢ **Phase 2: Data collection and analysis of areas**, including:

  a. analysis of the regions – doing analysis and evaluation on the territory of the entire country, exempt large areas with adverse conditions for locating facility for radioactive waste disposal and determine the areas for analysis, which are large areas with favourable geological and tectonic, geomorphological (topographic), hydro geological, geotechnical, hydrological, climatic and other characteristics

  b. **selection of prospective sites** - in the areas for analysis are localized potential sites that meet the criteria for site selection for facility for radioactive waste disposal, and identify promising sites for a thorough examination

⇒ **Phase 3: Site characterization –** the prospective sites are examined thoroughly and one of them is selected as preferred site;

⇒ **Phase 4: Site confirmation** – studies are carried out regarding the confirmation of the preferred site.

In accordance with the Regulation for Safe Management of Radioactive Waste, the NDF site should meet the following requirements:

(1) the geological structure of the site should be suitable for the retention of the RAW and the limitation of the radionuclides migration into the biosphere and also to secure stability of the disposal system and to have the necessary geotechnical characteristics for construction of the facility;

(2) the site hydrogeological characteristics should possess low speed and long routes of movement of the underground waters in order to limit the radionuclides migration;

(3) the geochemical characteristics of the underground waters and the geological environment should further limit radionuclides emission from the facility and should not reduce considerably the resources of the protective barriers;

(4) the site should be located in an area of low tectonics and seismic activity which do not threaten the system retention capacity;

(5) processes at the facility surface such as erosion, landslides and floods as well as extreme meteorological conditions should not influence the disposal system capacity to carry out its major safety functions;

(6) the site should be located so that the possibility of violating the retention function of the site resulting from the present or future generations activity on or close to it should be low;

(7) When selecting a site for the disposal of RAW, the sites requiring minimum geological and hydrogeological studies and falling to simple and reliable mathematical modeling are given priority;

(8) When selecting a site, should be taken into consideration the existing road infrastructure which provides the transport of the RAW to the facility at minimum risk.

[10] IAEA, Siting of near surface disposal Facilities, IAEA Safety Series No.111-G-3.1, 1994

[11] Regulation for safe management of radioactive waste, SG 76/30.08.2013

At the development of the criteria assessing the sites has been implied multiple analysis and have been taken into consideration the requirements for the environmental protection as well as the basic principles for safe management of the radioactive waste.

SE RAW has prepared a preliminary safety assessment[12], which is part of the application to the Nuclear Regulatory Agency for the issuing of an order approving the selected site. The chosen methodology for a preliminary safety assessment is based on the requirements of the nuclear legislation[13],[14], the safety standards of the International Atomic Energy Agency (IAEA) [15,16] and the generally accepted ISAM methodology of IAEA. The preliminary safety assessment aims to prove the ability of the selected site to ensure the safety in accordance with the safety criteria.

Basic criterion is the individual effective dose for the critical group of the population which should not exceed 0.1 mSv per year resulting from activities related to the disposal facility for RAW after a considerable period of time which should be enough for reaching the maximum estimated dose.

The safety analyses results, carried out within the framework of the preliminary safety assessment undoubtedly indicate that the selected site “Radiana” has the capacity to ensure the safe RAW disposal and its isolation form the environment.

7.2 DESCRIPTION OF THE PHYSICAL CHARACTERISTICS OF THE INVESTMENT PROPOSAL AND THE REQUIRED LAND AREAS

7.2.1 LOCATION OF THE NDF SITE

The Radiana site where the NDF will be located is situated in the vicinity of Kozloduy NPP between two roads, one on the north – a road, controlled by Kozloduy NPP and regarded as factory road, and on the south – a section of second-class road (national road II-11) Kozloduy-Harlets-Mizia.

The site is positioned 3.3 km south-east from the regulatory line of town of Kozloduy, 4.3 km north-west from the construction boundaries of the village of Harlets and about 4.2 km south-west from the right bank of the Danube River. It covers an area of approximately 46 hectares, roughly rectangular in shape as shown in **Figure 7.2-1** with maximum dimensions 470 x 1250 m and is located within the boundaries of the two-kilometer Precautionary action zone (PAZ) of „Kozloduy” NPP.

[12] SE RAW, 20014, Preliminary safety assessment of NDF

[13] Regulation for the procedure for issuing licences and permits for safe use of nuclear energy, promulgated SG 41/18.05.2004, last amended SG 76/05.10.2012

[14] Regulation for safe management of radioactive waste, SG 76/30.08.2013

[15] IAEA, Safety Assessment for Near Surface Disposal of Radioactive Waste, Safety Guide, Safety Standards Series No. WS-G-1.1, 1999

[16] IAEA, The Safety Case and Safety Assessment for the Disposal of Radioactive Waste, IAEA Safety Standards, Specific safety Guide No.SSG-23, 2012

FIGURE 7.2-1 THE RADIANA SITE LOCATION

The part in orange (▬) shows the area of Radiana site

The site is situated at the slope between the second and sixth loess terraces with displacement between them of about 55 m (from elevation +35 m to elevation +94 m) of the right bank of the Danube River. The lower terrace, (T2), is relatively flat with elevations between 39 and 45 m and occupies the northern and northeastern part of the site. Upper terrace (T6), with elevations between 65 and 94 m occupies the southern part. The average gradient of the site is 8º30’. The slope outlines on the south the Danubian plain of Kozloduy.

7.2.2 DESCRIPTION OF THE BASIC CHARACTERISTICS OF THE PRODUCTION PROCESS

7.2.2.1 IONIZING RADIATION SOURCE

The main source of ionizing radiation (IR) are mainly the RAW containers which might be a radioactive risk during their transportation to the NDF, their arrangement in disposal cells until the moment when every cell is filled and sealed with a reinforced concrete cover slab and until the cells are covered with protective multilayer cover.

The containers are made of reinforced concrete and have cubic shape with length 195x195x195 cm and wall thickness no less than 10 cm. The bottom of the container is no less than 14 cm and the cover – no less than 8 cm – **Figure 7.2-2**. The maximum mass of every container filled with conditioned RAW does not exceed 20 t. Every container is marked and the dose rate is written on its surface. All the containers characteristics are stored in an electronic database and a hard copy. All the containers sent to the repository are checked and certified meeting the following approved radioactive criteria:

⇒ The equivalent dose gamma rate from one package with treated RAW is limited to:
  → 2 mSv/h on the container surface;

→ 0.1 mSv/h at a1-meter distance from the container surface.

⇒ The non-fixed surface contamination averaged for 300 cm² of the package should not be less than:
→ 4 Bq/cm^2 for β and γ emitters
→ 0.4 Bq/cm^2 for all kinds α emitters.

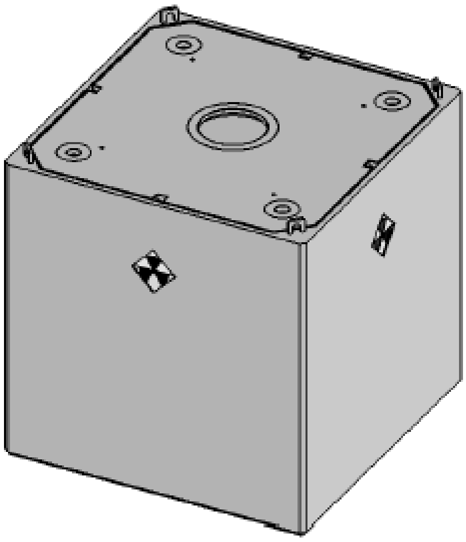


FIGURE 7.2-2 TYPE OF THE PACKAGE/CONTAINER WITH CONDITIONED RAW

The nuclide vector of all the radionuclides in a container filled with RAW is a covered source. This is precondition for detectable alpha and beta radiation outside the container. The exposure rate of the ionizing radiation is proportional with the concentration of radioactive isotopes. The following limits of the activity have been specified[17]:

⇒ **From a package** – the maximum specific activity of the long-lived radionuclides is ≤ 4.0E+06 Bq/kg according to the definition for category 2a,
⇒ **From the disposal cells** – the maximum average value of the long-lived radionuclides should not be higher than 4.0E+05 Bq/kg.

Because of the composition of the radionuclide vector there is no measured neutron emission from the package, the cement matrix itself and the container shielding eliminate the alpha and beta radiations. In the Interim Report on Safety Analysis of the NDF is reported and calculated the dose rate resulting from the penetrating gamma radiation from the container. The main sources in the cement matrix composition are ^{60}Co, ^{134}Cs и ^{137}Cs.

The doses of this ionizing radiation resulting from the activity at normal operation with the containers are given in details in item 4.10 of the present report.

On **Figure 7.2-3** is shown the annual dose rate as a result of the ionizing radiation from a cell with disposed RAW containers with wall thickness 50 cm as function of the distance. The blue line is the doses for the operational personnel (1700 hours per year) and the pink one shows the doses (8800 hours per year) for the population.

[17] Interim Report on Safety Analysis (IRSA), R5-NDF-ISA_Rev1, Consortium Westinghouse – DBE Technology – ENRESA. March 11, 2013

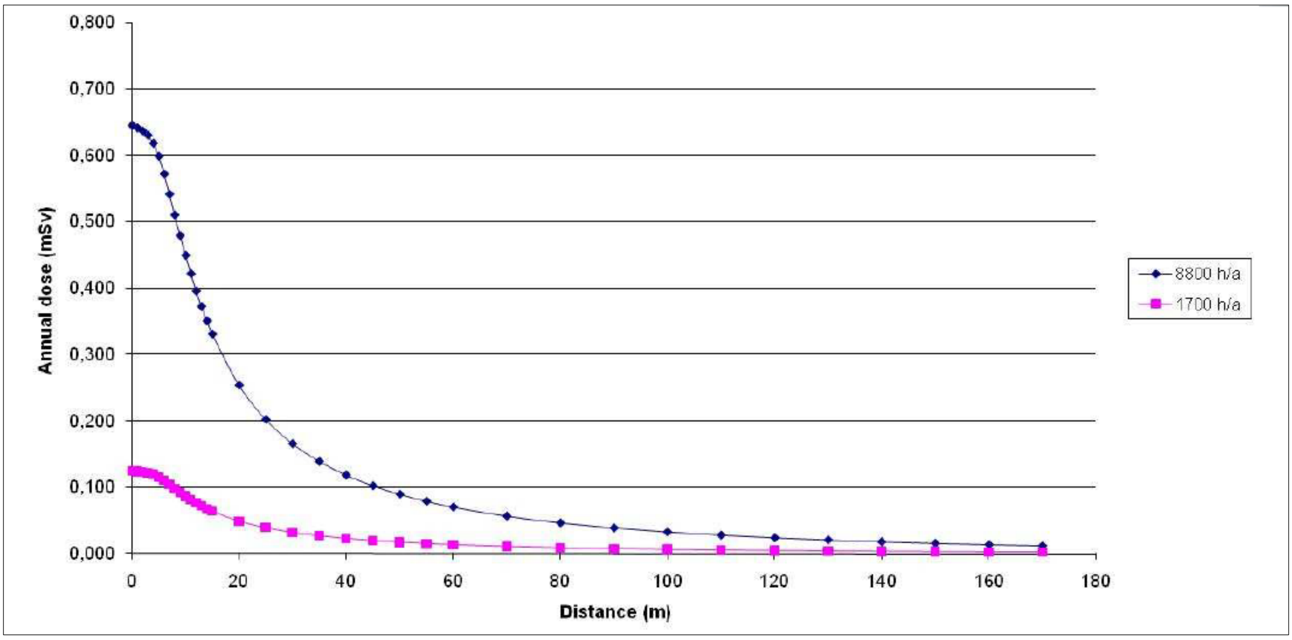


FIGURE 7.2-3 THE DECREASE OF THE ANNUAL INDIVIDUAL DOSE AT DIFFERENT DISTANCES FROM A CELL FILLED WITH CONTAINERS.

The location of the NDF outer fence is at about 140 m to the closest point of the disposal area – the disposal cells with reinforced concrete containers. Depending on the levels of the dose rate shown on **Figure 7.2-3** at a distance of 140 m the annual dose for the population is 0.017 mSv, which is more than 5 times lower than the maximum effective dose for a critical group of the population which is 0.1 mSv per year, in accordance with the Regulation on basic norms of radiation protection – 2012. Therefore for the population of the nearest town or village on the territory of the Republic of Bulgaria (distance of 2500 m) the radiological impact is assessed as practical non-existing and in conclusion **no transboundary impact is expected.**

7.2.2.2 TYPE OF INSTALLATION

The investment proposal of SERAW for establishment of NDF includes construction of module repository for disposal of low and intermediate level radioactive waste category 2a, under Regulation for safe management of radioactive waste [18], and is a multi-barrier engineered near surface repository. The selected type of repository is strictly defined by the legislator in the Regulation for safe management of radioactive waste, according which (Article 18, item 4) RAW from category 2a must be disposed in **near <u>surface engineering facilities</u>** for disposal of RAW.

The type of the facility meets the safety standards set by the International Atomic Energy Agency and the best practices in the developed European countries.

NDF is constituted of facilities for disposal and ancillary buildings and facilities. There will be provided physical security on the site as the NDF will be surrounded by a fence, secured and guarded in accordance with the Ordinance to ensure the physical protection of nuclear facilities, nuclear material and radioactive substances[19].

[18] Regulation for safe management of radioactive waste, SG 76/30.08.2013

[19] Regulation for the provision of physical protection of nuclear facilities, nuclear material and radioactive substances, SG 77/03.09.2014, last amended SG 44/9.05.2008

The site is divided in “controlled area” and “supervised area”. The facilities for disposal and the Waste reception and buffer storage building are situated in the controlled area. In the supervised area are situated the administrative buildings and the auxiliary facilities – building for access control (checkpoint), administrative building providing appropriate working conditions for the staff with offices, conference room, space for archives and auxiliary equipment, laboratories for performing laboratory analyses of different potential and radioactive samples, technical service building with workshops for various applications, industrial section which contains the energy supply systems and other service systems, industrial security building and control room, designed for 24-hour object control and monitoring of the facility, general service building, located on the border between the controlled and supervised areas designed for radiation protection, access control to the controlled zone, radiological control of the people and materials.

The access of staff and vehicles to/and out of the NDF area will be controlled and carried out through the checkpoint.

Except the waste reception and buffer storage building all other buildings have similar construction consisting of reinforced concrete columns (40 x 40 cm), beams and slabs. The outer walls are built from 25 cm ceramic hollow bricks with thermal insulation of 100 mm mineral wadding and completed with a plaster. The roofs are flat with a second concrete layer providing a tilt and they are also thermal insulated with a minimum of 100 mm mineral wadding. The main inner separating walls are designed from plasterboard.

The waste reception and buffer storage building for temporary operational storage of the packages of radioactive waste is located in the controlled area which also includes the disposal area. It is intended for acceptance, incoming control and buffer storage of the packages with radioactive waste before their disposal into the cells of the repository. The dimensions of the building are: 18.20 x 49.40 x 15.80 m, and the capacity for temporary (buffer storage) is 120 reinforced concrete containers. The building is built from reinforced concrete columns with 100 mm mineral wadding. The roof is a concrete construction above which is built a reinforced concrete covering slab, which is thermo and water insulated. The building is equipped with a 40-ton overhead crane for carrying out manipulations with the RAW packages.

Based on the current international practice, domestic and foreign regulations and recommendation documents, is selected disposal of low and intermediate RAW category 2a in an engineering near surface disposal facility[20],[21],[22], which by definition is placed in depth up to several tens of meters from the ground surface[23], according to the Bulgarian Regulation for Safe Management of Radioactive Waste. For the specific conditions on site “Radiana” the disposal facility will be situated up to 35m below the ground surface.

7.2.2.3 PROTECTION SYSTEMS

The disposal facility is a multi-barrier engineering facility of modular type; its safety is ensured by passive means. The safety is based on the implementation of defense in depth, which is accomplished by simultaneous appliance of system for physical barriers and technical and organizational measures ensuring the following levels of protection:

- → System for consecutive physical barriers along the propagation path of radioactive substances in the environment;

[20] Strategy on Spent Fuel and Radioactive Waste Management to the year 2030. Approved by the Council of Ministers by a Protocol Decision No 1.5/05.01.2011, amended by the Council of Ministers by a Protocol Decision of 25.06.2014

[21] IAEA, Near Surface Disposal of Radioactive Waste, Safety Requirement, Safety Standards Series No. WS-R-1, 1999

[22] IAEA, Near Surface Disposal Facilities for Radioactive Waste, IAEA Safety Standards, Specific Safety Guide N.SSG-29, 2014

[23] IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection, 2007 Edition. Vienna, 2007

- → System of technical and organizational measures for protection of the barriers and their efficiency;
- → System of technical and organizational measures for protection of the operational personal;
- → System of technical and organizational measures for protection of the population and environment.

The system of physical barriers (multi barrier protection) has to ensure the safety during the process of operation of the facility and after the closure of the disposal facility. In the post closure period the safety of the NDF is ensured completely by the engineering and natural barriers.

The multi barrier system for isolation of NDF comprises the following parts:

- **The first engineering barrier** is the form of the waste. It actually is cemented RAW some of which have been first put into steel drums with or without super compaction. The safety function of the waste form (cement matrix including the waste) is connected with the radionuclides immobilisation into the matrix hard phase as well as their retention through adsorption and their precipitation in the highly alkaline cement environment. The cement matrix is considered a chemical barrier which does not lose its safety functions for thousands of years.

- **The second engineering barrier** is a reinforced concrete container with thick walls, bottom slab and a cover slab. It contains the cemented radioactive waste. The free space between the cemented matrix and the container cover is filled with grout forming a monolithic block. The reinforced concrete container must ensure a possibility for the waste retrieval until the final closure of NDF. The safety function is to ensure a complete retention by maintaining its mechanical integrity including integrity of the holds for handling during the operation of the repository which will last about 60 years. The reinforced concrete container keeps its safety functions as a chemical barrier for thousands of years.

- **The third engineering barrier** includes the reinforced concrete disposal cells, the foundations, the closing slabs and the filling material. The safety function is the retention of potentially released radionuclides form the packages of RAW by maintain the cells integrity to a reasonable degree for 300 years. The concrete keeps its safety functions of a chemical barrier for thousands of years.

- **The fourth engineering barrier** includes the loess-cement cushion foundation and protective multilayer . The loess-cement cushion is not only a barrier against the migration of radionuclides but it also improves the geotechnical characteristics of the earth foundation with increased the thickness of the unsaturated area. The multilayer cover must be constructed from natural materials (clay, sand, gravel etc.) and its construction ensures numerous important and safety functions the most important of which are:

  - To reduce the risk of rain water infiltration into the repository system and to guarantee the water infiltration below 1,5 L/m^2 per year through the repository modules.
  - To serve as barrier against human intrusion, intrusion of animals or plants;
  - To protect against erosion caused by exogenetic processes and phenomena;

- **The fifth (natural) barrier** is the favorable natural characteristics of the site.

7.2.2.4 RADIATION PROTECTION AREAS AT THE SITE OF NDF

During the operation of the NDF is expected ionizing radiation with different intensity at the site classified areas. The impact of this ionizing radiation can be regulated by taking measures to limit its radiation impact on the operational personnel.

The harmful effect of the ionizing radiation on humans results in two types effects – determined and stochastic (probable). The first group is directly connected to the radiation dose. These are threshold effects, i.e. they appear if one is exposed to a certain dose. The dose threshold is different for the different effects. It slightly varies depending on the individual radiation sensitivity. They are a result of the death of a certain number of cells from a certain organ or tissue which cause their dysfunction. The degree of the dysfunction is getting higher with the dose increasing. These effects are somatic, they affect only the body cells and appear only in the person exposed to radiation. Depending on the radiation sensitivity of the organs, the received dose and mainly its rate, they can be early (starting minutes, days and weeks after the radiation) or late (years after the radiation).

The stochastic effects appear later. Depending on the type of the affected cells they are somatic – the people exposed to radiation suffer from malignant diseases or genetic - mutations in the posterity. They do not depend directly on the dose. Their frequency is growing with the increasing of the received dose but it is considered that they do not have a threshold appearance. Their effect depends on the affected part of the genome of the respective cell.

The ionizing radiations as a factor harmful to the working environment have some characteristics typical only for them. The ionizing radiation biological impact is connected to the possibility of appearing of effects harmful to the health directly on the individual exposed to the radiation and on his/her posterity too. An important characteristic of the ionizing radiation impact is that it’s difficult to be distinguished in a working environment directly by the individual because people don’t have organs of senses for it. The impact of the ionizing radiation is cumulative and the damages on human organism are irreversible. These characteristics of the ionizing radiation upon the organism define the concepts “radiological risk” and “damage”. They underline the principles of the radiation protection which main purpose is to minimize the radiological risk at reasonable level which is lower than 10^{-4} per year. The World Health Organization (WHO) considers professions with such a risk level safe. In order to reduce the radiological risk to reasonable level, it’s necessary to standardize strictly the radiation factor of the working environment by defining the dose limits and taking mandatory measures for protection of the individual. This is done through legislative regulating documents and the creation of a proper work organization.

For normal operation with sources of ionizing radiation, the above mentioned limit of the annual effective dose is fixed by the International Commission on Radiological Protection at life risk 10^{-3}. The averaging quantity of the coefficient for the fixed dose limits for the staff and population is 0.05 Sv^{-1} (as an example where the individual dose limits equals to $1.10^{-3}/5.10^{-2}= 2.10^{-2}$ Sv/a , which is 20 mSv/a). For example, if the worker is exposed to 6 mSv/a, then the biological risk for him/her is $6.10^{-3} \times 5.10^{-2} = 3.10^{-4}$.

The regulatory documents ensuring radiological protection of the staff are the following:

- → Regulation on basic norms of radiation protection, 5th October 2010
- → Regulation on Radiation Protection during Activities with Sources of Ionizing Radiation, 08.10.2012
- → Regulation for safe management of radioactive waste, 30.08.2013 г.
- → Design permit for a nuclear facility with registration No: НХ-3593, 4th May, 2012

For the purpose of the radiological protection the NDF staff working with sources of ionizing radiation is divided into two groups: category A and category B. These categories are regulated in Regulation on basic norms of radiation protection, 2012 are:

- → Category A – staff that might receive an annual effective dose over 6 mSv or annual equivalent doses higher than 15 mSv for the eye lens or higher than 150 mSv for the skin and limbs;
- → Category B – staff that does not fall into category A.

The defined annual limits for the staff from category A are the following:

The limit of the effective dose for professional radiation is 20 mSv for every single year.

→ By using the limits from paragraph 1, the limits of the annual equivalent doses for the staff are:

- 20 mSv for the eye lens;
- 500 mSv for the skin (this limit is for the average dose received from every surface of 1 cm^2 regardless of the area of the radiated surface);
- 500 mSv for the palms, armrests, feet and ankles.

The NDF investment proposal includes radiation control and radiation protection program and guarantees that the radiation of the workers is in accordance with the ALARA principles and is limited in accordance with the Regulation on basic norms of radiation protection, 2012.

In the Interim Report on Safety Analysis[24] of the Investment proposal has been done a conservative analysis of the individual dose rate of the staff when accepting, arranging and placing the containers – packages in the repository. The purpose of the estimation of a worker’s dose is to analyze at which operations is formed the bigger part of the annual dose exposure. The repetition and duration of every activity (inspection, transport manipulation, disposal in the repository) is an important factor for the accumulation of an individual dose.

The operation doses are estimated by considering the outer radiation from all the radiation sources and the duration of each activity. For each activity the operation dose is estimated by the formula:

$$D_i\ (\mu\text{Sv}) = \sum DR_i \times T_i \text{ where}$$

DR_i is the dose rate of the worker’s activity [μSv/h] and T_i – the time needed for the activity completion, [h].

The professional doses are set by using the calculations of the software Grovesoftware MicroShield, Version 9.04, 1995-2012. These calculations are based on the assumption that every single package has a nuclide composition which provides the maximum permitted dose rate at a distance of 1 meter.

There is an assumption for a homogeneous distribution of the nuclides in the cement matrix. As a result of it this conservative assumption the calculated nuclide composition is about three times higher than the total package activity provided for disposal in the NDF. In addition to this conservatism the corrections for the nuclide half-life haven’t been taken into consideration. This is important to note because the short-lived ^{60}Co contributes for the dose rate outside the concrete protection.

Generally, the duration of the different activities is roughly estimated based on the operational experience in a similar facility and the reasonable assumption for the type of activity and the ALARA measures. The dose exposure of the staff for the different activities has been estimated. Here are the activities:

→ Acceptance and confirmation (inspection, monitoring) of a RAW container;
→ Transportation of the container from the acceptance room to the disposal area;
→ Maintenance activities :

- The crane located in the Waste reception and buffer storage building
- The crane located in the disposal cells area
- The disposal area

[24] Interim Report on Safety Analysis (IRSA), R5-NDF-ISA_Rev1, Consortium Westinghouse – DBE Technology – ENRESA. March 11, 2013

- Closure and sealing of the cells.

Below are shown the tables with the dose rate for the different distances and the dose for the different activities, duration and the exposure for this activity.

TABLE 7.2-1 DOSE RATE AT DIFFERENT DISTANCES FROM A PACKAGE/CONTAINER AND THE WHOLE AREA (INTERIM REPORT ON SAFETY ANALYSIS, ROW 2)

Distance (m)	Dose rate [μSv/h]		Effective dose at a single package	Effective dose at a single package	Effective dose at 8800 h/a form the whole disposal area at a cell wall thickness 50 cm [mSv/a]
	From one package	From the whole area with cells	8800 hours [mSv/a]	1700 h [mSv/a]	
0	192.700	0.073	1695.760	327.590	0.644
1	100.000	0.073	880.000	170.000	0.641
2	41.490	0.072	365.112	70.533	0.636
3	21.410	0.072	188.408	36.397	0.630
4	12.830	0.070	112.904	21.811	0.618
5	8.484	0.068	74.659	14.423	0.598
6	6.000	0.065	52.800	10.120	0.571
7	4.454	0.061	39.195	7.572	0.541
8	3.430	0.058	30.184	5.831	0.510
9	2.719	0.054	23.927	4.622	0.479
10	2.205	0.051	19.404	3.749	0.449
15	0.971	0.038	8.548	1.651	0.330
20	0.533	0.029	4.687	0.905	0.253
25	0.336	0.023	2.952	0.570	0.202
30	0.227	0.019	2.000	0.386	0.165
35	0.163	0.016	1.433	0.277	0.138
40	0.121	0.013	1.068	0.206	0.118
50	0.074	0.010	0.648	0.125	0.089
60	0.048	0.008	0.426	0.082	0.070
70	0.034	0.006	0.296	0.057	0.056
80	0.024	0.005	0.214	0.041	0.046
90	0.018	0.004	0.160	0.031	0.038
100	0.014	0.004	0.122	0.024	0.032
110	0.011	0.003	0.095	0.018	0.027
120	0.009	0.003	0.076	0.015	0.023
130	0.007	0.002	0.061	0.012	0.020
140	0.006	0.002	0.049	0.010	0.017
150	0.005	0.002	0.041	0.008	0.015
160	0.004	0.001	0.034	0.006	0.013
170	0.003	0.001	0.028	0.005	0.011

On the basis of these values can be done easy but conservative calculations for the maximum individual dose for a worker category A and B (fifth column) if they are permanently around the container at a certain distance which would be unusual and against the working procedures and rules.

In the tables below are given the estimated individual effective doses and the collective doses for typical activities done by the NDF staff.

TABLE 7.2-2 RADIATION EXPOSURE OF A WORKER ACCEPTING A CONTAINER AT A REGULAR BASE – 800 TIMES YEARLY (INTERIM REPORT ON SAFETY ANALYSIS, ROW 2)

Type of activity	Duration [min]	Number of workers	Location	Source	Dose rate [μSv/h}	Individual dose [mSv/a]	Collective dose [man.mSv/a]
Check of the access permit to the controlled zone	15	2	Control zone of P3	Container buffer zone	0.024	0.005	0.010
Preparation for the trail discharge	3	1	Acceptance buffer zone	Container trail	100	4.000	4
Transport of the container to the base	15	1	Control panel	0	0	0	0
Measuring of the container: smear and P-gamma	3	1	Inspection room	Base container	182.5	7.300	7.300
Visual inspection	10	1	In the acceptance room	Base container	0.027	0.004	0.004
Going out of the trailer	2	1	In the cabin	Base container	0.07	0.002	0.002
Transport of the container from the base to the buffer zone	20	0	Control panel in building H	0	0	0	0
TOTAL	90						11. 315

TABLE 7.2-3 RADIATION EXPOSURE OF A WORKER WHILE THE CONTAINER IS TRANSPORTED TO THE DISPOSAL ZONE (INTERIM REPORT ON SAFETY ANALYSIS, ROW 2)

Type of activity	Duration [min]	Number of workers	Location	Source	Dose rate [μSv/h}	Individual dose [mSv/a]	Collective dose [man.mSv/a]
Trailer parking at a definite location	5	1	Buffer zone route	Container buffer zone	0.068	0.005	0.005
Container loading onto the trailer	15	0	Control panel	Container trailer	0	0	0
Transport preparation of the container to the base	2	1	Buffer zone route	Container trailer and buffer zone packages	100	2.667	2.667
Container transportation to the disposal zone	15	1	Near the cells	Container trailer Cells	20	4	1

Type of activity	Duration [min]	Number of workers	Location	Source	Dose rate [µSv/h}	Individual dose [mSv/a]	Collective dose [man.mSv/a]
Preparation for the trail discharge	3	1	Near the cells	Base container, cells	100	4	1
Placing the container in a cell	5	1	Near the cells	Air container, cells	50	3.333	3.333
Return of the trail to the buffer zone	5	1	Near the cells	Disposal cells	0.068	0.005	0.001
TOTAL	50						14.009

For the maintenance and repair of the mobile roof, crane and disposal zone which are done once a month and take about an hour is estimated conservatively a collective annual dose of 0.240 man.mSv, which is considerably lower than that shown for the routine activities in the above mentioned table.

TABLE 7.2-4 DOSE EXPOSURE WHILE SEALING A CELL WITH REGULARITY ONE PER YEAR (INTERIM REPORT ON SAFETY ANALYSIS, ROW 2)

Type of activity	Duration [days]	Number of workers	Location	Source	Dose rate [µSv/h}	Individual dose [mSv/a]	Collective dose [man.mSv/a]
Preparation and scaffolding	7	4	Near the cells	Cells	0.068	0.003	0.013
Filling the empty spaces with gravel	2	4	Above the concrete slab	Cell	2.333	0.033	0.131
Polyethylene placing	8	4	Above the concrete	Cell	2.333	0.131	0.523
Topographic levelling	4	2	Above the concrete slab	Cell	2.333	0.065	0.131
Horizontally levelling /concrete levelling/	1	9	Above the concrete slab	Cell	2.333	0.016	0,147
Abrasive processing of studs	11	4	Above the concrete slab	Cell	2.333	0.180	0.719
Abrasive processing	3	2	Above the concrete slab	Cell	2.333	0.049	0.098
Steel construction activities	42	4	Above the concrete slab	Cell	2.333	0.698	2.744
Placing casing and its removing	22	6	Above the concrete slab	Cell	0.068	0.010	0.063
Concrete structural pointing	1	21	Above the concrete slab	Cell	0.068	0	0.010
Placing a temporary fence	14	2	Near the cells	Cells	0.07	0.007	0.010
Mobile roof displacement	1	4	Near the cells	Cells	0.068	0	0.002
TOTAL	116						4.592

The duration of the activity is based on the operational experience from referential facilities and reasonable assumptions connected to the type of activity and also if any measures have been taken in order to reduce to collective dose in accordance with the ALARA principle.

The maximum collective dose is estimated to about 30.7 man.mSv. Because of the conservative approach of the above mentioned calculations the dose rate is expected to be considerably lower. The individual effective dose of a worker is expected to be less than 6 mSv/a.

7.2.2.4.1 RADIATION PROTECTION OF THE PERSONNEL

The site is divided into three zones:

- → Administrative zone;
- → Operative/exploitation zone;
- → Disposal zone.

In the controlled zone of the NDF the radiological conditions can result in external radiation beyond 6 mSv/a (**category A personnel**) **– Figure 7.2-4**.

In the supervised zone the dose rate is within the boundaries between 1 and 6 mSv/a (category B personnel) **– Figure 7.2-4**.

7.2.2.4.2 SUPERVISED AREA

In order to ensure optimal radiation protection of the personnel (also, indirectly of the population) the following measures are implemented:

- → Safe remote control of the containers’ transportation (the RAW packages) in the reception zone, the buffer zone and the disposal in the cells;
- → Installation of the protective mobile roof over the cells in operation;
- → Covering of the cell during closure;
- → Classification of the premises and protection planning;
- → System for radiation monitoring and setting of an appropriate alarm thresholds;
- → Lack of gaseous and liquid emissions;
- → The protection during the design and operation of the NDF should provide correspondence to the dose boundaries or the dose limits for workers (and population):
    - 0.1 mSv/a for the population;
    - 6 mSv/a for a worker during the whole operation (dose limit);

The radiation from the RAW containers without protection is limited for a short period of time during the preparation and sample taking for beta contamination control. The transport operations with the crane will be carried put remotely, so that a significant dose loading of the personnel is eliminated.

All premises where activities with radiation risk are carried out are well-lit to make the process fast and easier. Additional portable lightning is provided, if necessary.

The disposal cells and the buffer zone are equipped with concrete protection, which is 50 cm thick, and there are additional 10 cm from the package’s walls. This guarantees that each worker who is outside the building for buffer storage is exposed to a maximum of $7x10^{-5}$ mSv/h beyond the background. This value is of the order of the natural background.

The disposal cells are also protected by a concrete with thickness of 25 cm which is cast preliminarily, before the cells are closed. Television cameras are installed in the areas where visual observation is required.

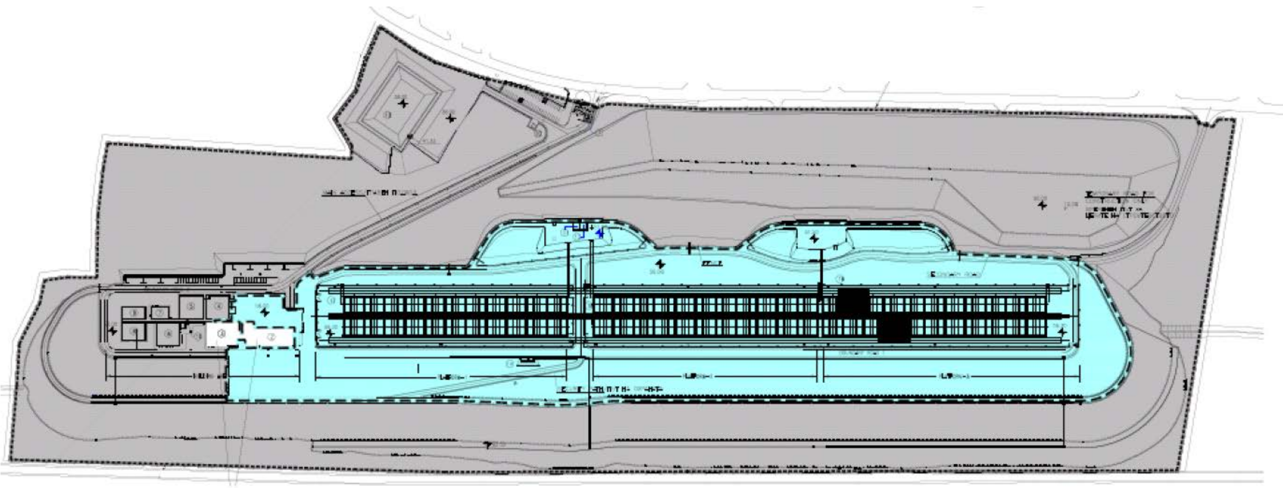


FIGURE 7.2-4 SUPERVISED AREA (GREY) AND CONTROLLED AREA (BLUE AND WHITE) OF THE NDF

The investment proposal of the NDF, which includes technological and laboratory radiation control and a programme for radiation protection, guarantees that the radiation on the workers will be in accordance with ALARA principle and will be limited within the limits set in the Regulation on basic norms of radiation protection, 2012.

Due to the nature of the conducted activity and the possibility for the implementation of the ALARA principle, the expected actual dose impacts will be below the limits set in the Regulation on basic norms of radiation protection, 2012.

In accordance with the Investment proposal, the radiation protection of the personnel working in the NDF will be ensured through:

- → Suitable screening (protection), which will prevent the increase of the permissible limits for the exposure;
- → Continuous radiological monitoring with alarm devices;
- → Minimization of the time for work, repair and maintenance in radioactive environment;
- → Zone division of the NDF premises;
- → Controlled access to the premises within the NDF controlled zone (CZ);
- → Dosimetry control of the personnel;
- → Prescription of personal protection means during risk assessment of the conducted activity and the necessity of their utilization.

In order to minimize the dose from external radiation, the management of the cranes used to position the containers, close the cells and place the covering panels of the mobile roofing is done remotely from a panel situated in the control room and an internal TV surveillance system .

7.2.2.5 DEFINING OF ZONES FOR EMERGENCY PLANNING IN THE VICINITY OF THE NDF SITE

Regarding the safety in cases of emergencies, under the Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies, SG № 94/11.2011, the NDF is classified below third category but it is conservatively classified as a nuclear facility of third category regarding the risk of emergency situations.

As a condition for receiving an approval of the Technical design and obtaining a building permit for the NDF, an Interim Safety Analysis Report (ISAR) [25] [25]was elaborated and it contains a detailed analysis of the possible design basis and beyond design accidents during the operation and after the closure of the repository. An emergency plan of the NDF is elaborated for managing the accidents and the respective radiological consequences. In cases when criteria are reached for setting into action of an Emergency Plan, all potential radiological consequences are analysed and intervention criteria are implemented to prevent the exceeding of the permissible dose criteria.

The intervention criteria are provided in the Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies, 2011. In accordance with article 39:

(2) An intervention is not taken when:

1. annual effective dose for the population, less or equal to 1 mSv in which the dose received from the natural radiation background of the area is not included;

2. annual effective dose for the population, less or equal to 5 mSv under *special circumstances* – only in case if in the next 5 consequent years the annual effective dose will not exceed 1 mSv (= 1000 μSv).

(3) In case of finding contaminations with radioactive substances as a result of previous emergency or activity’s consequences when the annual effective dose for the population is higher than 5 mSv, protective measures are implemented or it is advised restriction of access. The intervention is implemented after justification when annual equivalent dose for the population is 100 mSv, including the doses received from all possible radiation impacts and from the natural radiation background of the area, in exception of cases for which the Minister of health has not defined that the implementation of the intervention is not justified.

These requirements listed in the Regulation are included in the Emergency Plan of the NDF and are strictly observed in case the intervention levels are reached.

According the analysis in the ISAR, due to its radiation risk, the NDF should be classified as risk category 3. According to the Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies, article 2 (2) the risk category 3 includes nuclear facilities and sites with radioactive sources in which postulated on-site emergency events could lead to an irradiation or radioactive contamination of the environment above the permitted thresholds, which requires implementation of urgent protective measures **only within the boundaries of the site**.

In accordance with article 4 (4) for nuclear facilities or sites referred to a risk category III only Precautionary protective action planning zone is defined (a protected zone).

The special status areas are created around nuclear facilities and site with ionizing emissions to reduce the radiation of the population is cases of emergencies analysed in the design, during normal operation and for radiation monitoring of the population and the environment. In accordance with article 104, paragraph of the Act on the Safe Use of Nuclear Energy the following special status areas are created for the NDF:

[25] Interim Report on Safety Analysis (IRSA), R5-NDF-ISA_Rev1, Consortium Westinghouse – DBE Technology – ENRESA. March 11, 2013

1. Precautionary action zone (PAZ);
2. Supervised zone (SZ).

The precautionary action zone is a territory around facilities and sites where during normal operation the annual limits (0.1 mSv) may be exceeded for the radiation of the population or the individual annual effective dose in cases of design accidents may be exceeded (5 mSv).

The supervised zone is the territory outside the boundaries of the precautionary action zone, in which a radiation monitoring of the population and the environment is conducted. The monitoring is necessary for the purposes of the radiation protection. The values of the effective dose, mentioned above for the precautionary action zone, will not be exceeded in the supervised zone.

The levels of the dose rates beyond the fence of the repository should be below 0.01 μSv/h, so that the requirement for 100 μSv per year is fulfilled, allowing the continuous presence of people on the external side of the fence (8760 people). As it is described in the ISAR, the distances from the potential sources of ionizing radiation to the external NDF’s territory, from the screened walls of the building for accepting and temporary storage of packages, as well as the distances from the disposal cells should be designed so that the requirements for maximum values, which were mentioned above, are fully observed. Also, the consequences of a design basis accident at any point of the site outside the fence are below 5 mSv.

In accordance with those criteria the precautionary action zone (PAZ) of the NDF is limited within the boundaries of the site (it reaches the boundaries of its fence), and **the supervised zone around the NDF is less than 4 km and it does not reach to the Bulgarian bankside of the Danube River**.

7.2.2.6 ESTABLISHED EMERGENCY PLANNING ZONE AROUND THE KOZLODUY NPP SITE

The Radiana Site is located in the immediate vicinity of the Kozloduy NPP, so below are described the special status areas around the site of the power plant. The establishment of the special status areas necessitates the creation of a tool for planning and management of the site’s territory in accordance with the laws and regulations of the country and the European standards for safety and security, as required by Article 104, paragraph 1 of the Law for Safe use of Nuclear Energy (State Gazette No 63 2002, last amend. SG 82, 2012). The following emergency planning zones have been established around the Kozloduy NPP:

- → **Precautionary action zone (PAZ) - Zone № 2**, with a radius of 2 km. The area of the zone is occupied by the production site of the Kozloduy NPP, on-site storage and processing of radioactive waste area of SE “RAW Kozloduy” and the Radiana Site. Its purpose is to limit exposure in case of radiation accidents.
- → **Urgent protective action planning zone (UPAPZ)** [26]**- zone № 3** with a conditional 30 km radius around the Kozloduy NPP. Its role is to facilitate the control as necessary for radiation protection purposes **– Figure 7**.2-5 and **Figure 7.2-6.**

As it can be seen, the special status areas around the Kozloduy NPP are much larger than the special status areas of the NDF. The design of the NDF provides that the precautionary action zone (PAZ) is within the boundaries of the facility’s site, i.e. within the boundaries of the site’s fence, and the Surveillance zone is below 4 km.

The NDF, which is situated at the Radiana Site, is located within the boundaries of the 2-km PAZ of the Kozloduy NPP as well as within the boundaries of the 30-km UPAPZ of the Kozloduy NPP.

[26] The 30-km UPAPZ is defined for the purposes of emergency planning. The same 30-km zone is called „Monitored zone“ (MZ) for the purposes of the radiation monitoring.

About 40 populated areas situated within the territory of Bulgaria are located within the 30km zone in the vicinity of the Radiana Site, as shown on **Figure 7**.2-5.

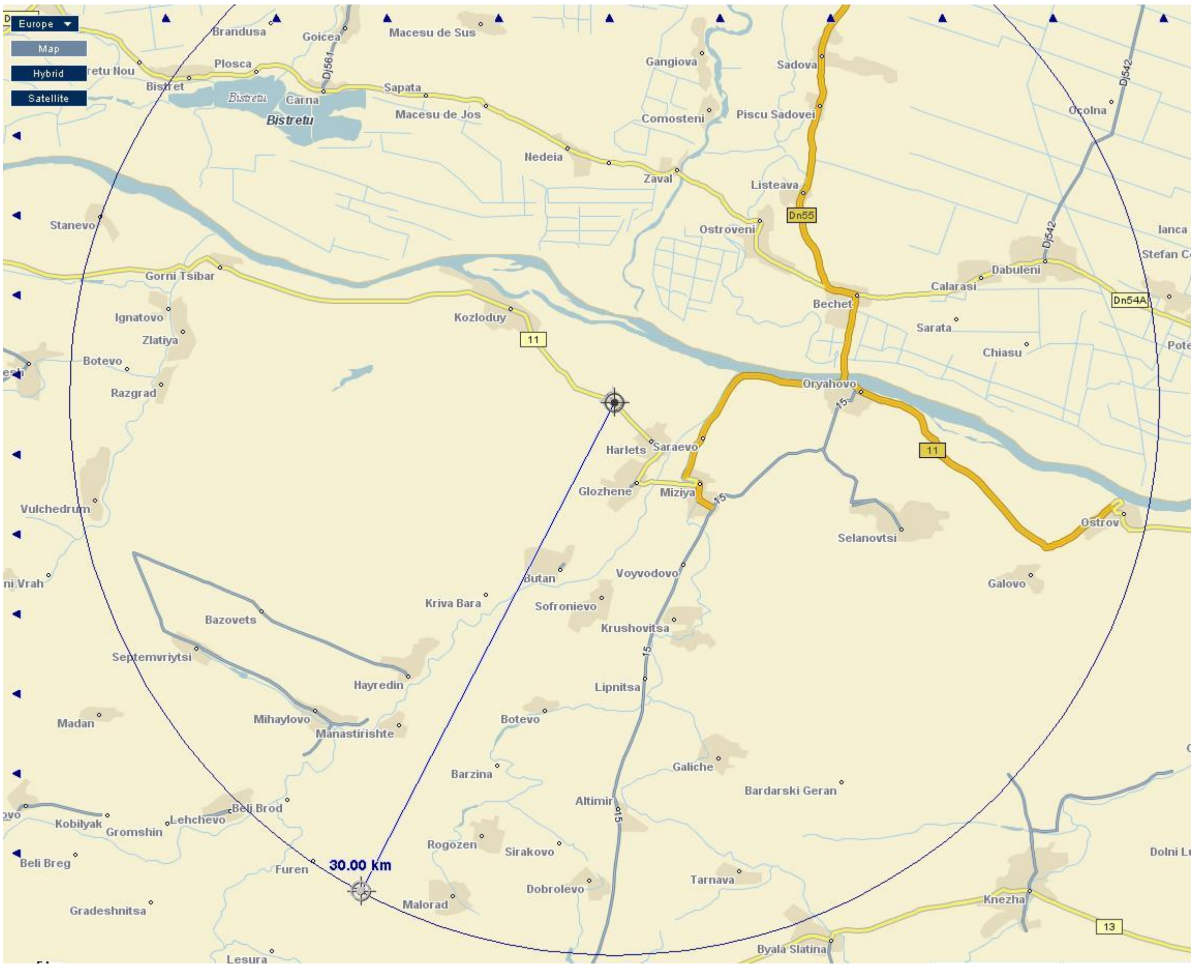


FIGURE 7.2-5 POPULATED AREAS IN THE 30KM ZONE AT THE TERRITORY OF THE REPUBLIC OF BULGARIA

About 23 unevenly distributed populated areas fall within the site's 30km area at the territory of the Republic of Romania. Neither of them is situated at a distance less than 12km, which can be seen at **Figure 7.2-6**.

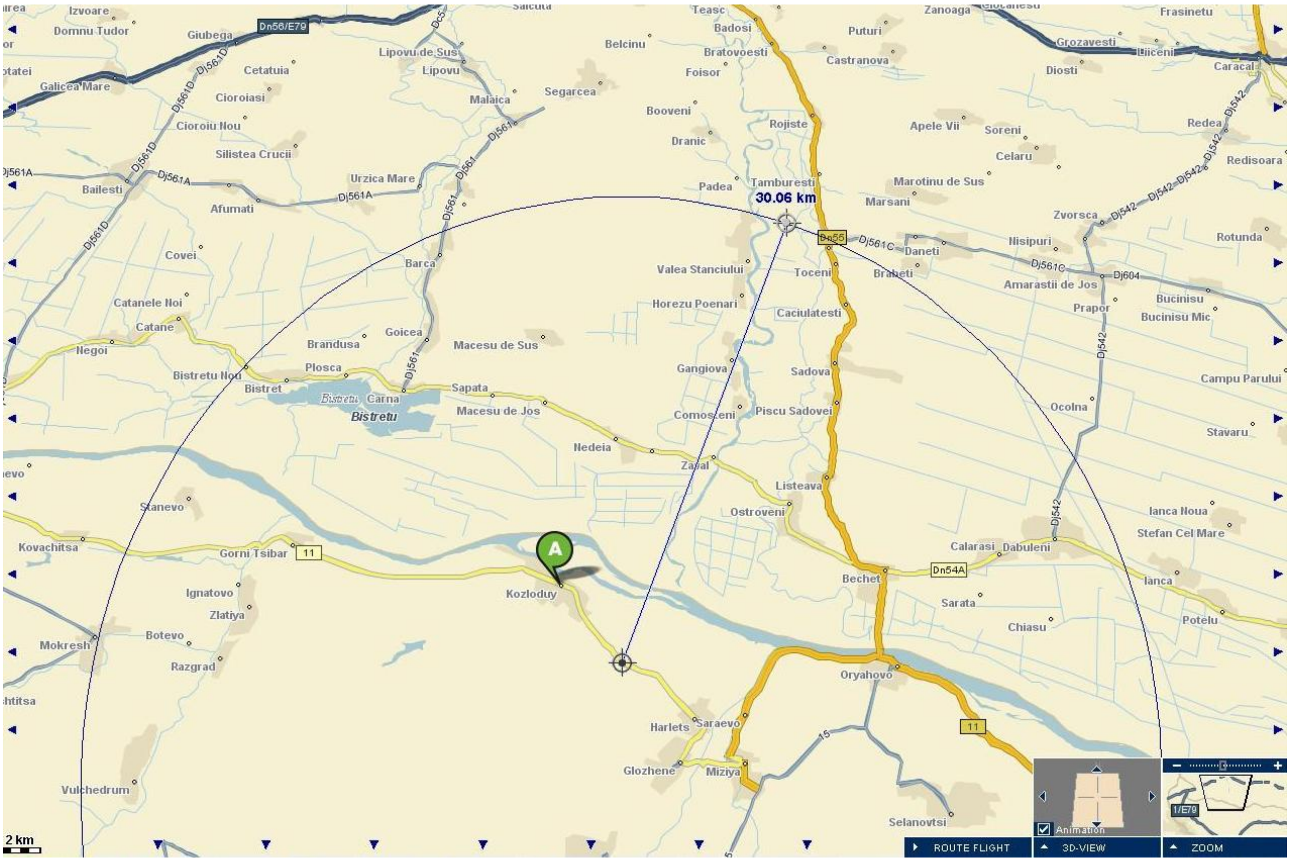


FIGURE 7.2-6 POPULATED AREAS IN THE 30KM ZONE AT THE TERRITORY OF THE REPUBLIC OF ROMANIA

7.3 DESCRIPTION OF THE COMPONENTS AND FACTORS OF THE ENVIRONMENT IN THE 30 KM ZONE AT THE TERRITORY OF THE REPUBLIC OF ROMANIA

Under article 3 of the Espoo Convention a decision was made to notify the Republic of Romania about the IP “Construction of a national disposal facility for low and intermediate level radioactive waste – NDF” which has been fully in the prerogative of the Minister of the environment and waters because the boundary between the Republic of Bulgaria and the Republic of Romania is situated near the site.

Under the above-mentioned, the 30 km surveillance zone around the Kozloduy NPP is always considered in **transboundary context**. This is a special status area around a nuclear facility at the territory of the Republic of Bulgaria and it also affects the territory of the Republic of Romania. The Radiana Site also falls within the zone, thus the components and factors of the environment in transboundary context are assessed there.

It should be emphasized that the Supervised zone of the future NDF is below 4000 m and it does not affect the territory of the Republic of Romania.

7.3.1 CLIMATE CONDITIONS

The reviewed area around the Radiana Site is located in the western part of two climatic zones according to Bulgaria’s climatic zoning – north and middle region of the Danube hilly plain of the moderate continental climate subarea.

The climate in this region is characterized as exceptionally continental because of the sharp contracts between the winter and summer thermal conditions. The average annual temperature of the air varies between 24.5°C and 26.2°C – this is the largest amplitude in the country. The annual precipitation is in the range from 540 mm and 580 mm – the maximum is in June and the minimum is in February. However, the summer rainfalls are grouped in separate days and there often are droughts, especially in the second half of the summer. In summer and autumn there are average 4-5 periods without precipitation which last over 10 days and their average duration is 16-20 days. Even longer drought periods can often occur.

7.3.1.1 TEMPERATURE

The average air temperature in the research area is in the range from 11.5° C to 12° C, decreasing with increasing altitude. The annual course of monthly maximum temperatures are observed in July (from 23ºC to 24ºC) and the minimum in January (from 0ºC to -0.5° C). The average temperature in winter is around 0.9° C and in summer from 21ºC to 22° C. The autumn is warmer than the spring, with the difference increasing with increasing altitude.

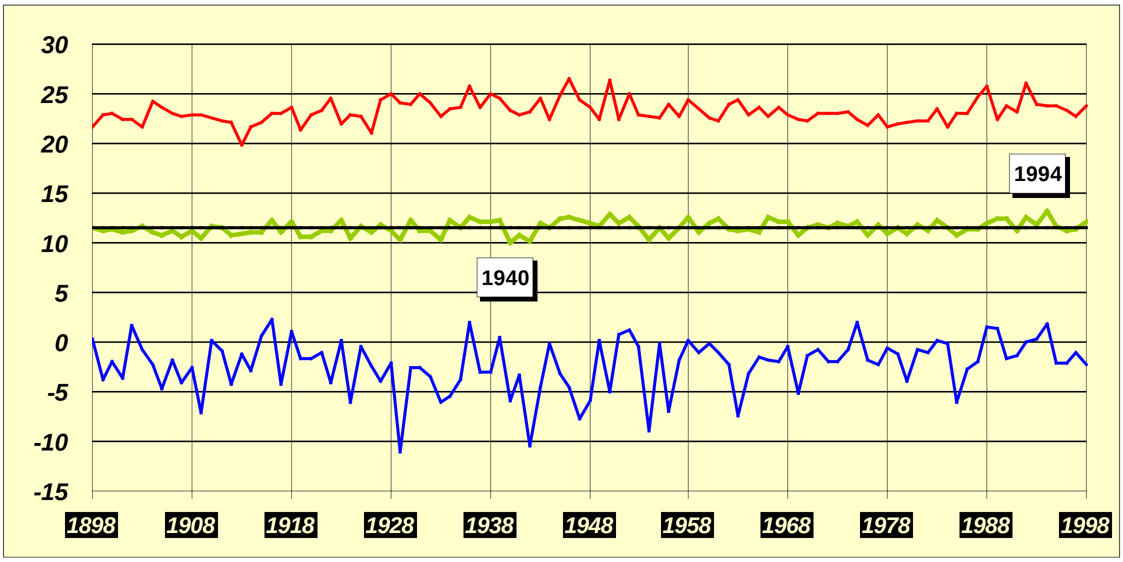


FIGURE 7.3-1 AVERAGE MONTHLY MAXIMUM, MINIMUM AND AVERAGE MONTHLY TEMPERATURE AT LOM STATION FOR 100 YEARS

The lowest average monthly temperature at Lom observation station[27] was registered in 1940 (10.017ºC) and the highest in 1994 (13.25ºC) – **Figure 7.3-1.** The average monthly temperature is 11.5° C – the black line in the figure.

Figure 7.3-2 shows a comparison of the average annual temperatures registered at Bechet observation station during the period 1961-2011, at Lom station for the period 1961-1998 and the data provided by the Investor from the local observation stations at the Kozloduy NPP site for the period 1997-2011. The Figure shows that the average annual temperatures at Lom and Bechet have the same trend and the temperatures at Lom are higher than those at Bechet. The temperatures at the Kozloduy NPP are also higher.

[27] **National Institute of Meteorology and Hydrology, Registry of the average monthly temperatures**

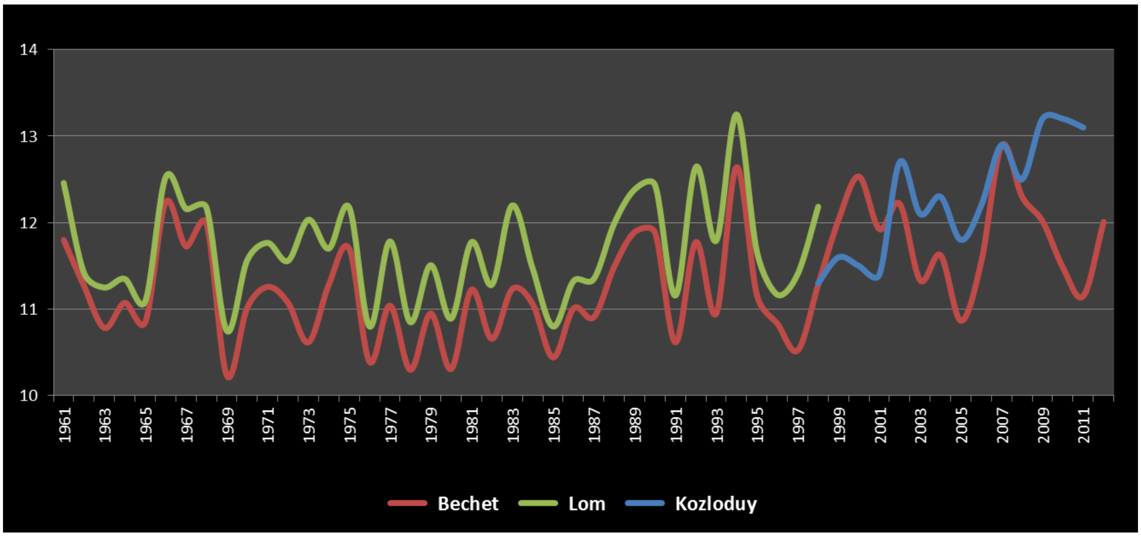


FIGURE 7.3-2: AVERAGE ANNUAL TEMPERATURES AT BECHET, LOM AND KOZLODUY NPP OBSERVATION STATIONS

The World Meteorology Organisation (WMO) has defined the climate norm as the average value of a given climate elements for a fixed basic period of 30 years. The currently accepted basic periods are 1901-1930, 1931-1960, 1961-1990.

Figure 7.3-2 shows that the climate norm at Lom for the last climate period (1961-1990) is 11.6°C, and for Bechet it is 11.1°C, with a difference of 0.5°C.

7.3.1.2 WIND

The dynamics of the air flow in the surface layer is characterized by the wind rose. The proximity of the Danube River, which is viewed as a large aeration channel, as well as the disjoint nature of the relief are of great importance for the local climate. The aeration channel causes the occurrence of significant heterogeneousness in the fields of the meteorological elements, especially of elements, such as temperature and surface layer wind, which are extremely sensitive to the shape and the location of the terrain.

Until the year 1997 the climate characteristics of the region is based on data determined on the basis of statistics obtained by the climate observations at Kozloduy observation station conducted in the period 1970-1982 and at Lom station. After the year 1997 real meteorological data is used which is obtained from three meteorological stations of class III that are combined in an automatic system for meteorological monitoring (ASMM). The first one is installed at a representative for the region site for external radiation control (AIS-ERC), while the other two are located respectively in the Blatoto area and in the village of Harlets.

Figure 7.3-3 shows the average annual rose for gradation of wind speed for the period 1998-2011 form the automatic system for meteorological monitoring (ASMM).

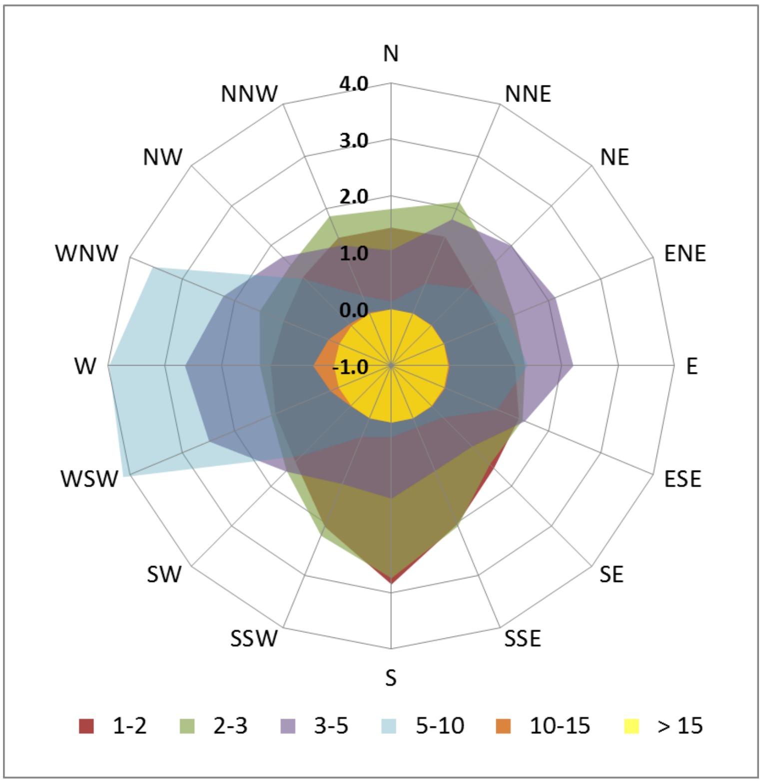


FIGURE 7.3-3 GRADATION ROSE WIND FOR THE PERIOD 1998-2011

During this period, in 27.34% of the cases the winds are from the west, south-southwest and north-northwest; 18.41% are from a 45° southern horizon and 17.43% of the winds are from the 45° eastern horizon.

The extremely values for the wind speed are presented in **Table 7.3-1**. It is indicative that during the period these values **are always only for north winds**[28].

TABLE 7.3-1 EXTREME WIND SPEEDS FOR THE PERIOD 2009-2013

Year	Maximum	Date [hour: minute]
2009	34.6 m/s from direction 357º (north)	21.03.2009 [12:10]
2010	26.0 m/s from direction 357º (north)	09.12.2010 [22:35]
2011	23.5 m/s from direction 357º (north)	28.11.2011 [14:58]
2012	23.0 m/s from direction 357º (north)	04.12.2012[01:09]
2013	28.4 m/s from direction 357º (north)	22.03.2013[11:25]

Figure 7.3-4 shows the rose with for Becher station. The average wind speed calculated according to the one-hour data registered in the interval 2002-2012 is 2.0. The largest portion is of the winds up to 3 m/s.

[28] Reports on: Local meteorological conditions in the vicinity of the Kozloduy NPP, years 2009, 2010, 2011, 2012 and 2013.

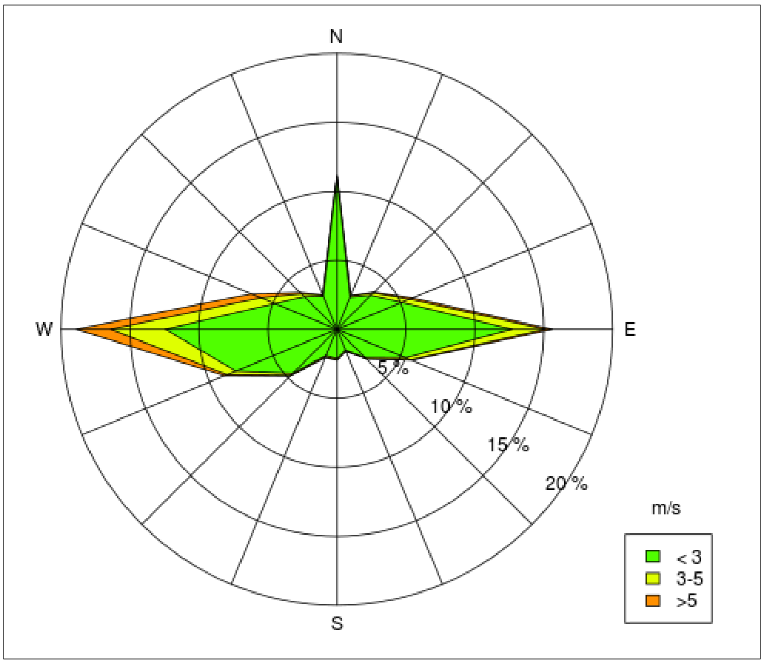


FIGURE 7.3-4: ANNUAL WIND ROSE – BECHET STATION

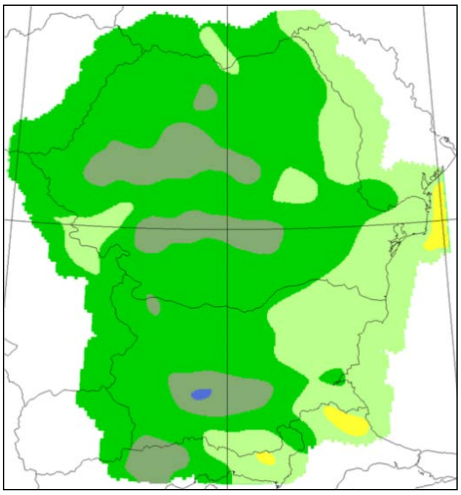
The wind rose follows the zonal west-east flow, which is characteristic of our geographic location, and the main frequency of the wind is from the west (18.9%). The percentage of the so-called quiet time – the number of cases when the wind speed is below 1 m/s is 11.1% of the number of all measurements for the period, which means that there is a low potential for contamination of the lower atmospheric layers due to the proximity of the Danube River.

7.3.1.3 WIND CAPACITY

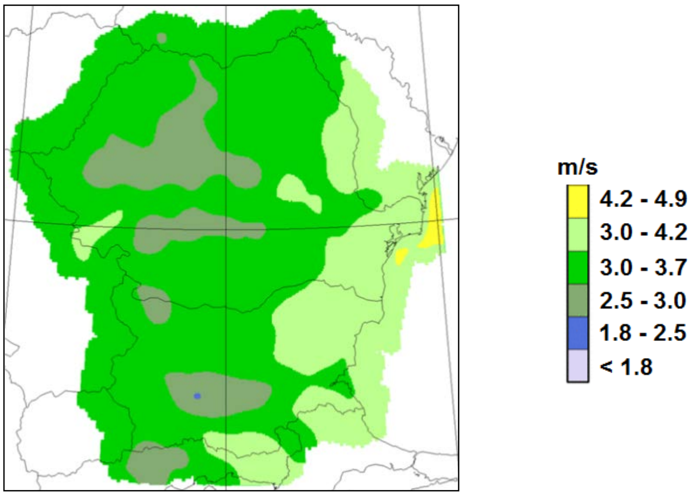
The Meteosim Truewind company[29], which operates in the field of renewable energy sources, has examined the wind-energetic parameters at the territories of Bulgaria and Romania in relation to the assessment of their wind capacity.

Figure 7.3-5 shows the maps of the average field of the wind speeds for the years 2008, 2009, 2010 and 2011. As it can be seen, in the vicinity of the Kozloduy NPP the prevailing average winds speeds do not exceed 3.7 m/s, which means that the capacity of the wind field for distribution of pollutants at great distances is rather low.

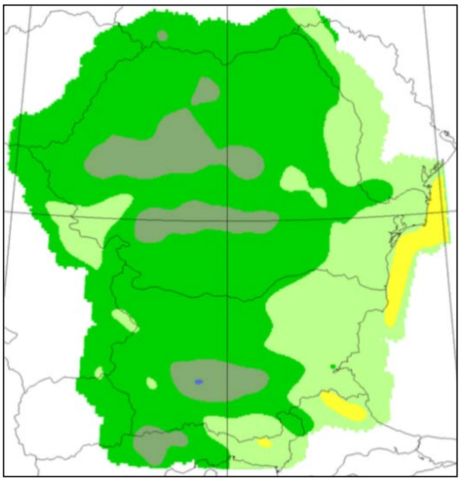
[29] http://windtrends.meteosimtruewind.com/wind_anomaly_maps.php?zone=RBG



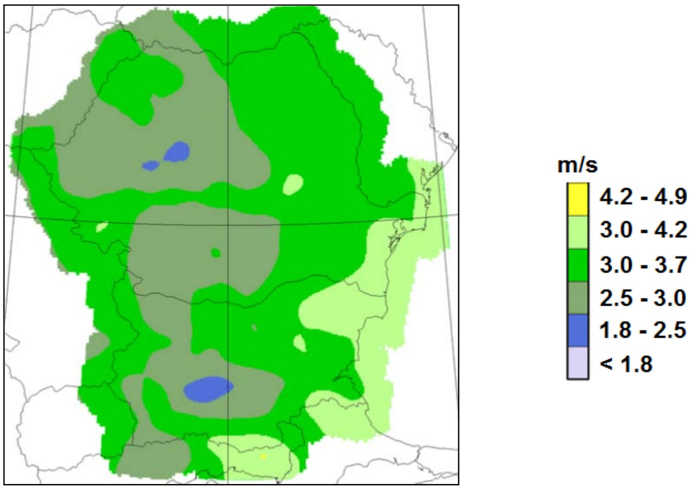
2008



2009



2010



2011

FIGURE 7.3-5: AVERAGE POTENTIAL WIND FIELDS IN BULGARIA AND ROMANIA

It can be concluded that <u>there are no climate prerequisites for transboundary contamination.</u>

7.3.2 BOWELS OF THE EARTH

The Mizia platform in the region of the NDF is characterized by sub-horizontal buried geological formations without substantial tectonic and neo-tectonic anomalies during the last 2.5 million years. The cover of the slightly folded fundament of the platform consists of sediment rocks with various lithological compositions, mainly clays and sands in the upper parts. There are no proven occurrences of karst formation, diapirism (salt tectonics) as well as a potential possibility for occurrences of volcanism.

The comparison between the geological construction at Bulgarian and Romanian territory[30] states that there is no danger of transboundary contamination of the region’s most significant aquiferous horizon in the Archar formation. The main argument for this conclusion is that the Archar aquirefous horizon from the Romanian territory is located at a higher elevation than in Bulgaria.

[30] Report on Technical Requirements for Implementation of the Project for Upgrading for the Nuclear Capability of NPP “KOZLODUY”. 2013. NATIONAL INSTITUTE of RESEARCH-DEVELOPMENT for LAND RECLAMATION I.N.C.D.I.F. - „ISPIF” – BUCHAREST – B: Risk Engineering. 2013. Studying and selection of the location for a new nuclear capacity at the Kozloduy NPP site.

The direction of movement of the underground waters is from the north to the south, and the waters are also drained at Bulgarian territory **– Figure 7.3-6, Figure 7.3-7** and **Figure 7.3-8**.

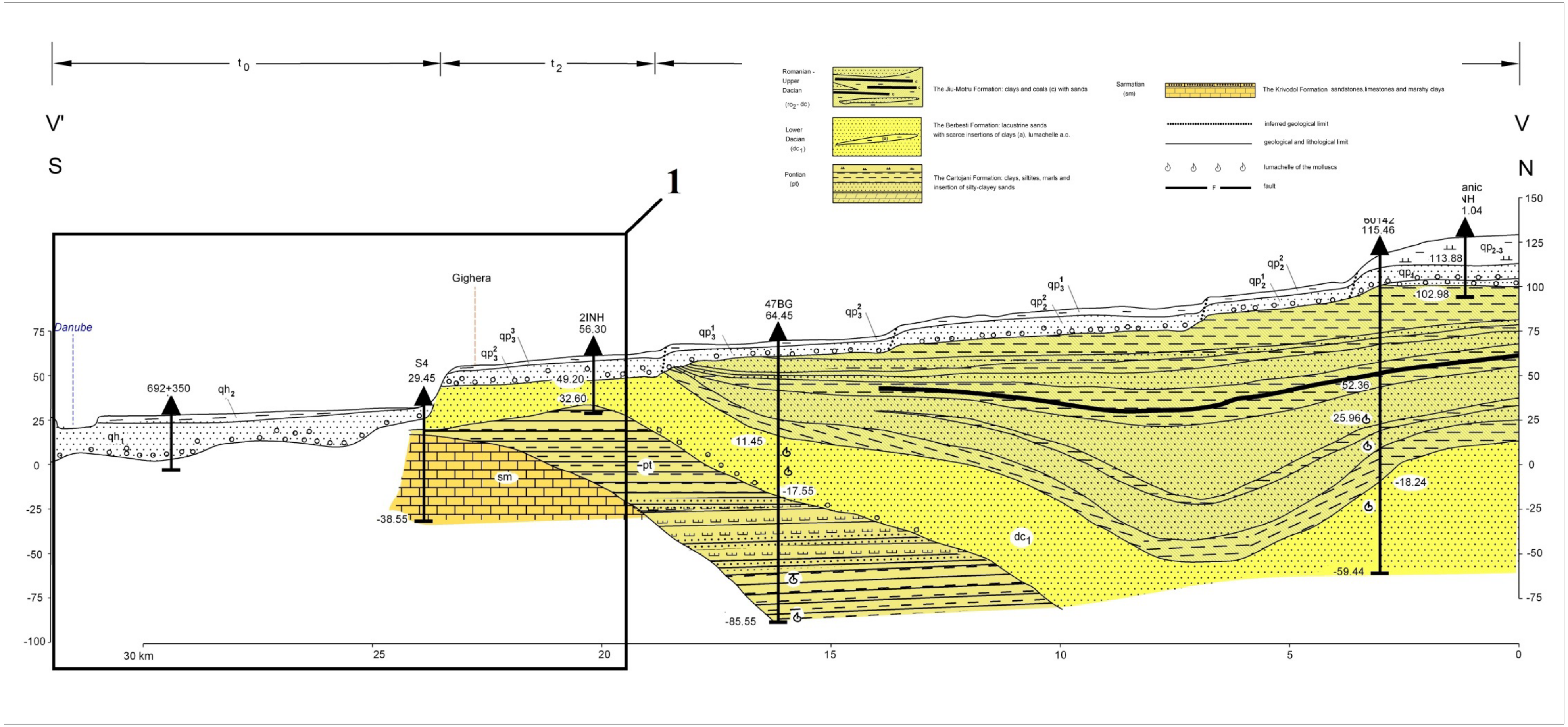


FIGURE 7.3-6 SECTION V-V′ALONG THE LINE S-N: DRANIC- GHIGERA-DANUBE

(In a rectangle 1 it is shown a part of the profile used to aggregate profile Archar retinue both sides of the river Danube - Figure 7.3-7)

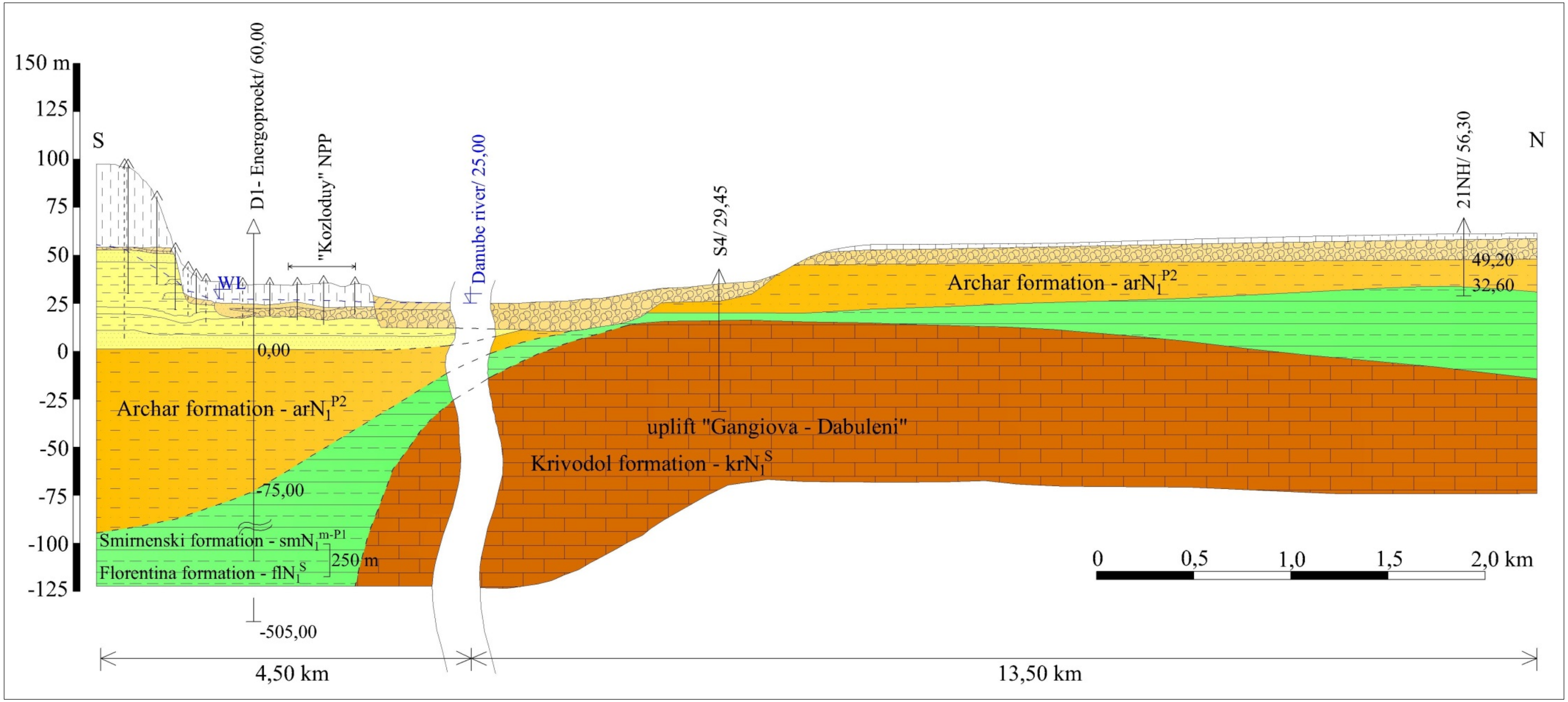


FIGURE 7.3-7 SUMMARIZED PROFILE OF THE ARCHAR FORMATION ON BOTH SIDES OF THE DANUBE RIVER

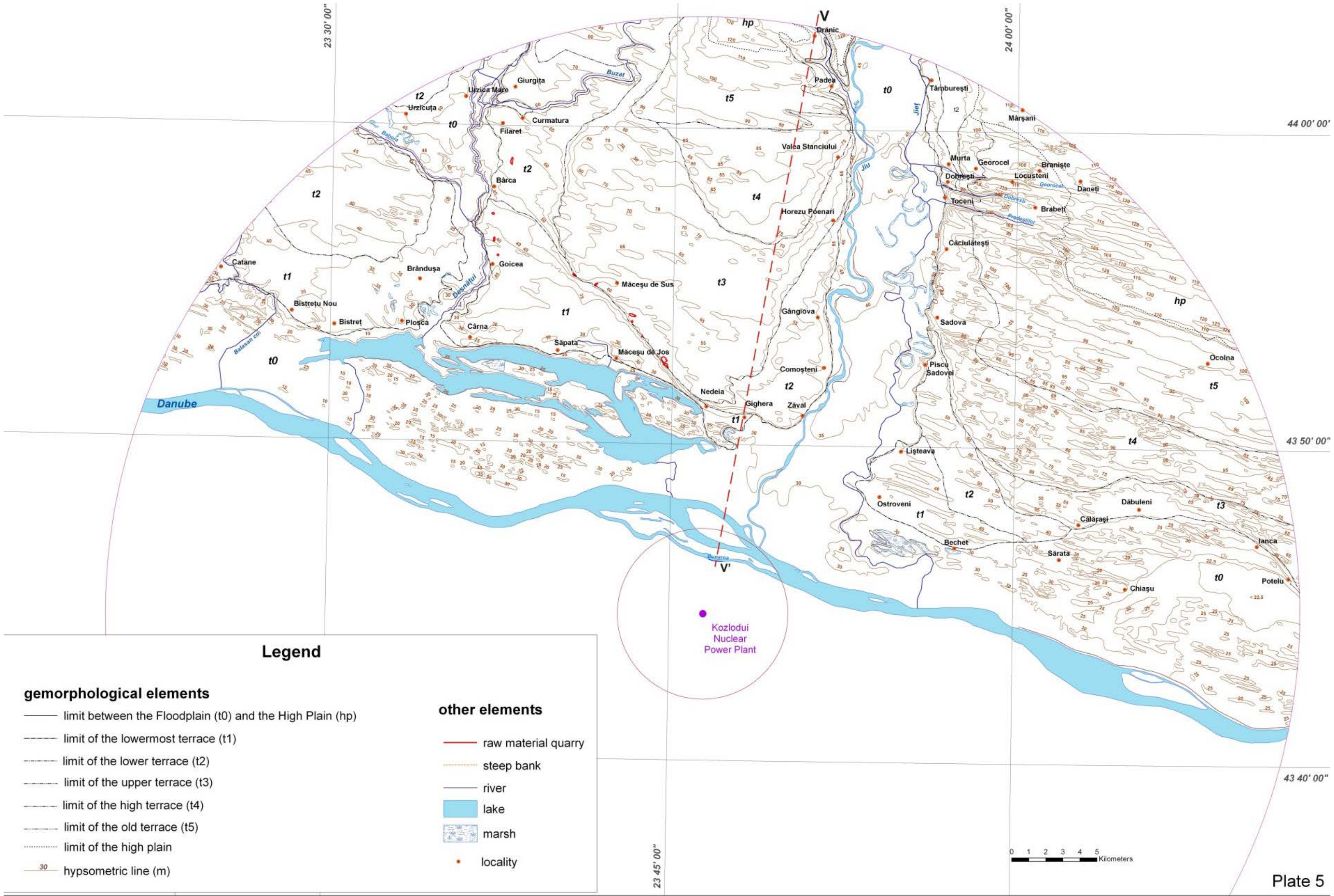


FIGURE 7.3-8 GEO-MORPHOLOGICAL MAP OF THE 30 KM ZONE AT ROMANIAN TERRITORY

At the same time, the potential risk of transboundary contamination of the underground waters in the flood terrace of the Danube River does not exist, because the model analyses of the radionuclides’ migration from the NDF has found that when the radionuclides reach the level of the underground waters, they activities are tens of times lower than the „Limit on the average annual volumetric activity of potable water“ for the given radionuclide (Table 7 of the Regulation on basic norms of radiation protection, 2004) [31].

Another potential transboundary impact may be caused by the realization of a seismic event on active faults. The last geo-tectonic analyses of the terrain have shown that both on Romanian and Bulgarian territory there are no active faults within the 30 km zone[32].

In conclusion, the geological construction within the 30 km zone is favourable because of the presence of a number of nature features which reduce the migration of potential pollutants. There are no conditions for transboundary impact during all stages of the construction, operation, closure and the following institutional control of the NDF.

7.3.3 SEISMIC RISK

For the purposes of this EIA Report for the „Construction of national disposal facility for low and intermediate level radioactive waste – NDF“ in a transboundary context has been also used the additional analysis of the seismic activity, which is based in seismic activity data provided by Romanian sources and is conducted in the EIA Report for the construction of a new nuclear power unit at the Kozloduy NPP site[33] – **Figure 7.3-9.**

Two catalogues have been analysed containing mainly Romanian earthquakes – one of them consists of historical and modern earthquakes in the sub-regional 160 km zone around the Kozloduy NPP, in which the Radiana site is also located, and the second catalogues includes historical and modern earthquakes in the Vrancea seismic zone, which is located in the north-east periphery of the regional 320 km zone around the Kozloduy NPP.

The epicentre distribution of the earthquake included in the first catalogue is presented in **Figure 7**.3-9**.** This catalogue contains data for 285 earthquakes during the period of years 1965-2013. The lowest magnitude of the earthquakes (M=2.0) is determined with tools and concerns the earthquakes registered during the last years. The highest magnitude (M=5.3) is determined in a macro-seismic way and it concerns seismic activities realized in the year 1879 in the region of Požarevac (Northeast Serbia). The earthquakes generated in the 160 km region around the Kozloduy NPP site during the considered period are realized in the upper part of the earth’s crust at a depth mainly up to 20 km (there are only about twenty events at a greater depth – up to 42 km). The picture of the epicentre distribution in **Figure 7**.3-9 shows that the NDF site is located in the **calmest seismic area** of the Mizia platform and there are no earthquakes in the 30-km local zone. A lack of any Romanian earthquakes is observed up to the 50-km boundary and earthquakes with a magnitude M > 5.0 are registered as far as the periphery of the 160-km zone, near the Serbian boundary.

[31] Model studies of the risk of contamination of the geological fundament and ground waters by the designed NDF near the Kozloduy NPP. Year book of the University of Mining and Geology „St. Ivan Rilsky“, Volume 55, Geology and Geophysics, pp.140-145

[32] Identification and revision of the active faults in relation to the implementation of a Project „Studying and selection the location for a site for investment proposal about construction of a new nuclear capacity at the Kozloduy NPP site“. 2013. GI-BAS. – I: Risk Engineering.2013. Risk Engineering. 2013. Studying and selection the location for a new nuclear capacity at the Kozloduy NPP site.

[33] Report on the environmental impact assessment (EIA Report) of the investment proposal „Construction of a new nuclear power unit at the Kozloduy NPP site“, „Kozloduy NPP – New Build“ Ltd, Consortium „Dicon-Acciona Ing.“, 2013г.

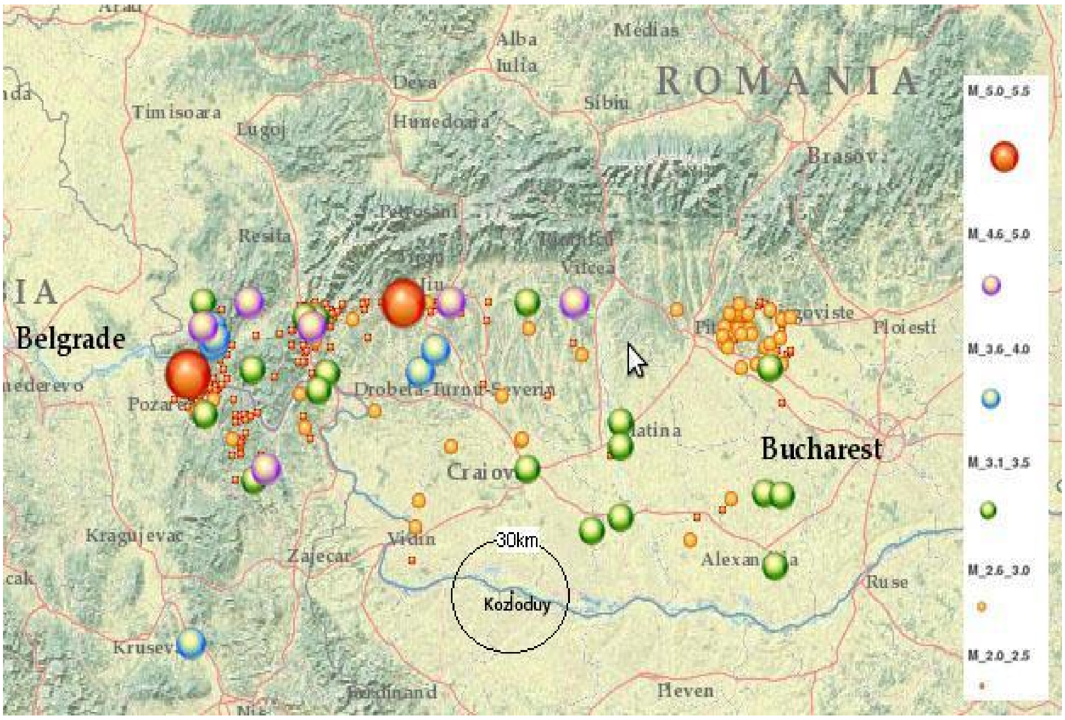


FIGURE 7.3-9 EPICENTRE DISTRIBUTION OF THE EARTHQUAKES ON THE BASIS OF ROMANIAN DATA AT THE SUB-REGIONAL 140-KM ZONE AROUND THE KOZLODUY NPP

The picture of the spatial distribution of the earthquakes with magnitude over 4.0 in the 320-km region around the NDF site is presented in **Figure 7**.3-10**.** An aseismic region is clearly outlined in the central part and the Radiana site is located in this region.

The results from the studies mentioned above once again confirm that from a seismic point of view the local 30-km and the sub-regional 50-km zone around the NDF site belong to the calmest territory at the central part of the Balkan Peninsula.

Most of the monitored seismic events in the 320-km region (**Figure 7**.3-10) can be attributed to the six well-known seismic zones: Sofia, Maritsa, Gorna Oryahovitsa, Kresna, Negotinska Krajina (in Serbia and near the Romanian boundary) and Kampuling-Vrancea (in the northeast periphery of the regional 320-km zone around the Kozloduy NPP). In all zones, excluding the Vrancea, are generated shallow earthquakes in the earth’s crust, mainly at a depth up to 20 km. The earthquakes in the Vrancea zone are intermediate-focus and are generated at a depth interval of 60-190 km. These earthquakes have the greatest seismic impact on the NDF site. The strongest macro-seismic effect on the region of the site was caused by the earthquakes in the years 1802, 1940 and 1977, and it is I=6 MSK.

The Sofia seismic zone is closer to the NDF and it is located at a minimal distance of 80 km. The observed maximal effect on the region of the site caused by earthquakes in the Sofia zone is with an intensity of 3-rd degree according to the Medvedev–Sponheuer–Karnik macro seismic scale (MSK), or I_{koz}=3 MSK. The observed maximal macro seismic effects caused by earthquakes realized in the other for lithospheric seismic zones on the Radiana site are: I_{koz}=6 MSK by Kresna, I_{koz}=6 MSK by Gorna Oryahovitsa, I_{koz}=5 MSK by Maritsa and I_{koz}=3 MSK by Negotinska Krajina. The macro seismic impact caused by the earthquake in Dulovo in 1892 with a magnitude M=7.0 is I_{koz}=5 MSK. The other shallow seismic sources located outside the defined seismic zones have insignificant macro seismic impact. The observed macro seismic effects on the site caused by those sources are below or equal to 3 MSK.

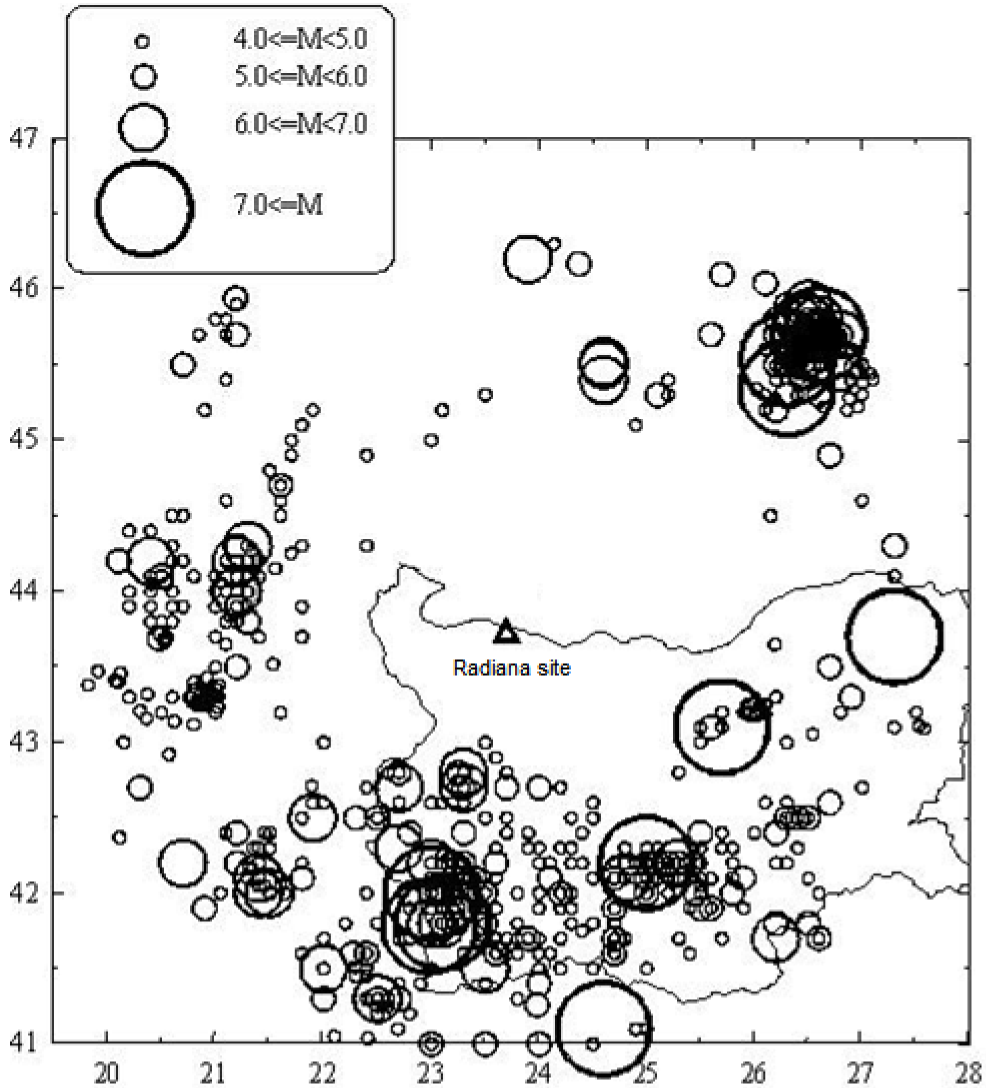


FIGURE 7.3-10 SEISMIC ACTIVITY IN THE 320-KM REGION (M≥4.0)

7.3.4 BIODIVERSITY

7.3.4.1 INPUT INFORMATION

For the purposes of this EIA Report for the „Construction of national disposal facility for low and intermediate level radioactive waste – NDF“ in a transboundary context has been also used the data provided in the Report on the environmental impact assessment (EIA Report) for the construction of a new nuclear power unit at the Kozloduy NPP site, 2013.

7.3.4.1.1 FLORA

Over 90% of the autochthonic vegetation in the Dolj County (especially in its southern part) is replaced by agricultural crops, among which there are certain areas dominated by various species of oak (*Quercus*). The grass communities in this area are steppe and they consist of various drought-resistant species. A characteristic feature of the studied territory is that after the cleaning of the forests and especially on sand lands the wind activity can activate sand dislocation, which will create favourable conditions for the development of the plant species White acacia (*Robinia pseudoacacia*) and Black acacia (*Amorpha fruticosa*). A protective forest belt exists around the following populated areas: Maglavit,Ciuperceni, Poiana Mare,Desa, Piscu Vechi, Ghidici and on the left side of the Jiu River in: Rojistea, Apele Vii, Celaru, Amarasti, Piscu Sadovei), Bechet, CălărașiandDabuleni.

The vegetation in the valley parts around the Danube and Jiu rivers is adapted to sands, higher levels of the near-surface water layer and the presence of wet nuances. Various groups of Willow (*Salix spp.*), Poplar (*Populus spp.*), and Purple Willow (*Salix fragilis*) are represented and they create sprout formations along the shoreline. A characteristic feature is the dominance of various species of Oaks (*Quercus spp.*), Hazel (*Corylus avelana*), Dog Rose (*Rosa sp.*), Hawthorn (*Crataegus monogyna*), etc. Hydrophilic vegetation develops near the lakes and in the humid areas, including Bulrush (*Schoenoplectus lacustris*), Reed (*Fragmites australis*), White Waterlily (*Nymphaea alba*), Common Rush (*Juncus spp*.), Water Lens (*Lemna minor*), etc.

7.3.4.1.2 Fauna

The existence of grass species and mainly cereals (*Graminaceae*) provides favourable habitats for various small mammals and mouse-like rodents Rodentia, as well as Ground Squirrel (*Spermophilus citellus*), small predators, such as Black Polecat (*Mustela putorius*), Weasel (*Mustela nivalis*), and bigger animals, including Fox (*Vulpes vulpes*) and European hare (*Lepus europaeus*).

The ornitofauna in the examined area has been studied by Ridiche (2011)[34], who has found 170 species of birds in the region of Calafat-Chupercheni and 126 species along the Jiu River up to its flowing into the Danube River. Seven species that are natural monuments have been found: Rosy Pelican (*Pelecanus onocrotalus*), Dalmatian Pelican (*Pelecanus crispus*),Great White Heron (*Egretta alba*), Small white heron (*Egretta garzetta*), Eurasian Spoonbill (*Platalea leucorodia*), Common Shelduck (*Tadorna tadorna*), Black-winged Stilt (*Himantopus himantopus*).

The birds that are characteristic of the region include: Common Quail (*Coturnix coturnix*), Gray Partridge (*Perdix perdix*), Common Skylark (*Alauda arvensis*), Common Starling (*Sturnus vulgaris*). The birds that build nests in the meadows, near the rivers and in the reed massifs are wild ducks and geese; other birds that find food in these wet areas are White Stork (*Ciconia ciconia)*, Common Tern (*Sterna albifrons*) and various species of herons.

A characteristic feature of the ornitofauna in the examined surveillance zone both on Bulgarian and Romanian territory is the spatial distribution of the water-loving birds and the small birds of prey. The species of these groups use the unpopulated Danube islands with sandspit, which are located in the Danube river bed, to build nests, to sleep and to rest during their migration and winter passing. They use for feeding the swamps, lakes, micro reservoirs, fisheries and other wet areas with still or flowing water along the two costs of the Danube River. When searching food, some of the species move tens of kilometres away from the river and use the flows of the rivers Jiu, Tsibritsa, Ogosta and Skat as bio corridors. This behaviour is typical of the Sea Eagle (*Haliaeetus albicilla*), Dalmatian Pelican (*Pelecanus crispus*), Great Cormorant (*Phalacrocorax carbo*), Greater White-fronted Goose (*Anser albifrons*), Mallard (*Anas platyrhynchos*) and other water-loving birds.

7.3.4.1.3 Amphibians and Reptiles

The herpetofauna at the Romanian territory of the 30-km supervised zone is very similar to the one at the Bulgarian territory. According to Cogalniceanu et al. (2013) the following species of amphibians have been found on the UTM squares: Common Newt (*Lissotriton vulgaris*), Northern Crested Newt (*Triturus cristatus*), European fire-bellied toad (*Bombina bombina*), Common Spadefood (*Pelobates fuscus*), Syrian Spadefood (*Pelobates syriacus*), European Toad (*Bufo bufo*), European Green Toad (*Bufo viridis*), European Tree Frog (*Hyla arborea*), Agile Frog (*Rana

[34]Ridiche M. 2011. Protection of the Avi fauna from the Danube floodplain in Calafat – the Jiu sector (Dolj county, Romania) Muzeul Olteniei Craiova. Oltenia. Studiişi comunicări.Ştiinţele Naturii. Tom. 27, No. 1/2011 ISSN 1454-6914 179.

dalmatina), Marsh Frog (*Pelophylax ridibundus*) и Common Water Frog (*Pelophylax kl. esculentus*). Two of the species (the Northern Crested Newt and the European fire-bellied toad) are included in Appendices II and IV of the Directive 92/43/EEU, 6 species are listed in Appendix IV of the same Directive and two species are included in Appendix V. The reptiles are not studied in detail and there are no contemporary publications about the species and their distribution in this region of the country. However, considering the maps provided in the works of Fuhn & Vancea (1961)[35]and Gasc et al. (1997)[36], it can be concluded that the following species of reptiles are found in this region of Romania: European Pond Turtle (*Emys orbicularis*), Hermann’s Tortoise (*Testudo hermanni*), European Green Lizard (*Lacerta viridis*), Balkan Wall Lizard (*Podarcis tauricus*), Caspian whipsnake (*Dolichophis caspius*), Blotched Snake (*Elaphe sauromates*), Water Snake (*Natrix natrix*), Dice Snake (*Natrix tessellata*) and Aesculapian snake(*Zamenis longissimus*). Three of the species (European Pond Turtle, Hermann’s Tortoise and Blotched Snake) are listed in Appendices II and IV of the Directive 92/43/EEC and five species are included in Appendix IV of the same Directive.

7.3.5 PROTECTED AREAS UNDER NATURA 2000

As a separate appendix to the EIA Report is attached a Report on the assessment of the degree of impact (RADI) of the IP, and its subject and aims are protection of the protected areas located on the nearest protected areas that are part of the European Ecological Network Natura 2000 at the territory of Bulgaria **– Figure 7**.3-11.

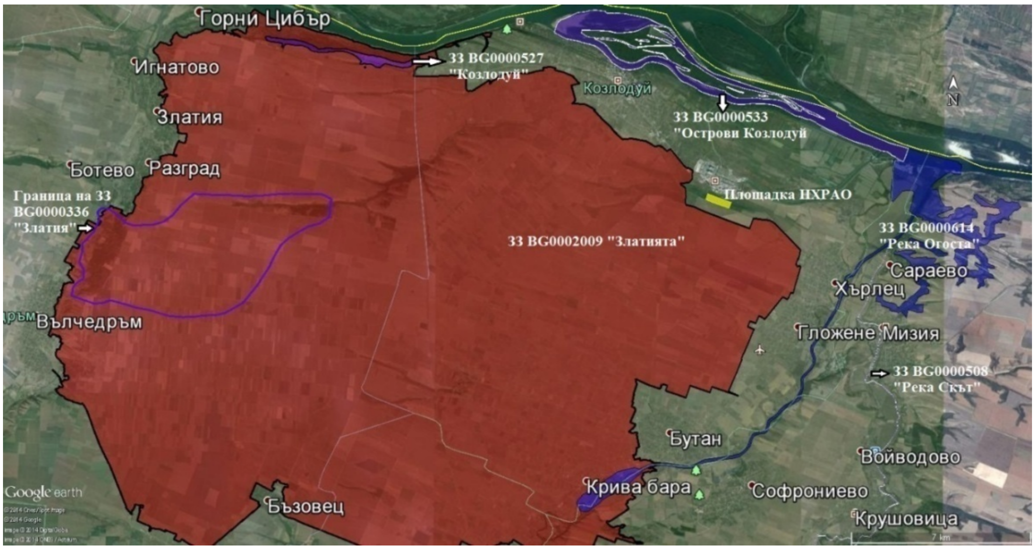


FIGURE 7.3-11 PROTECTED AREAS AROUND THE NDF SITE IN THE REPUBLIC OF BULGARIA

These areas include:

→ *Zlatiyata Protected Area identified by code BG0002009 declared under the Directive 2009/147/EC on the conservation of wild birds* - The area is located at0.45 south and west from the NDF site.

[35]Fuhn, I.E., Vancea, Şt. (1961): The fauna of the People’s Republic of Romania. vol. XIV, Fascicola II. Reptilia. Ed. Acad. R.P.R., Bucureşti. (in Romanian).

[36]Gasc, J.P., Cabella, A., Crnobrnja-Isailovic, J., Dolmen, D., Grossenbacher, K., Haffner, P., Lescure, J., Martens, H., Martínez-Rica, J.P., Maurin, H., Oliveira, M.E., So. anidou, T.S., Veith, M., Ziuderwijk, A. (Eds) (1997): Atlas of Amphibians and Reptiles in Europe. Paris, Societas Europaea Herpetologica and Muséum National d’Histoire Naturelle (IEGB/SPN).

- → *Kozloduy Islands Protected Area identified by code BG0000533 declared under Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora* - The area is located at 3.8 km north from the NDF site.
- → *Ogosta River Protected Area identified by code BG0000614 declared under Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora* - The area is located at 6 km north from the NDF site.
- → *Skat River Protected Area identified by code BG0000508 declared under Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora* - The area is located at 6.3 km east from the NDF site.

In the elaborated assessment of the impact caused by the IP's implementation on these PA at the territory of Bulgaria it concluded that if the design technologies for the construction and operation are observed as well as the mitigation measures listed in the assessment are observed, the implementation of the NDF **does not presume any direct or indirect impacts and it does not cumulate** with other impacts on the Bulgarian areas.

In the Republic of Romania, on the other side of the Danube River, at 5.5 km and 18 km west of the NDF site, there are 3 more protected areas under Natura 2000, one of which overlaps the other two. These are:

1. PA ROSCI0045 „Coridorul Jiului" declared under Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora;
2. PA ROSPA0023 „Confluenţa Jiu – Dunăre" declared under the Directive 2009/147/EC on the conservation of wild birds;
3. PA ROSPA0010 Bistreț declared under the Directive 2009/147/EC on the conservation of wild birds;

Map with the location of the zones in the Republic of Romania towards the NDF site is presented in **Figure 7.3-12**.

FIGURE 7.3-12 NEAREST PROTECTED AREAS AROUND THE NDF AT THE TERRITORY OF THE REPUBLIC OF ROMANIA

In view of the conclusion in the elaborated assessment of the degree of impact by the implementation of the IP on the nearest PA at the territory of Bulgaria, which was cited above, if the design technologies for the construction and operation are observed as well as the mitigation measures listed in the assessment are observed, the implementation of the NDF **does not presume** any direct or indirect impacts and it does not cumulate with other impacts on the Bulgarian areas. **No negative transboundary impact can be expected on the nearest PA upon Natura 2000 in the Republic of Romania.**

This conclusion is also enforced due to the fact that the nearest Bulgarian areas, on which no impact is expected, are at located at the respective distance away from the Radiana Site: (1) – PA BG0002009 Zlatiyata (protection of birds) situated 0.45 km to the west and south, and (2) PA BG0000533 (protection of the natural habitats, and flora and fauna) situated 3.8 km to the north, i.e. in the direction of the Romanian areas. As the Romanian areas are further away and considering the fact that most of the habitats and species subjected to protection in the Romanian areas are the same as those in the two Bulgarian areas, it can be reasonably concluded that **no transboundary impact is expected** on the nearest PA under the European Ecological Network Natura 2000 at the territory of the Republic of Romania.

7.3.6 SUMMARY OF THE RADIOECOLOGICAL CONTROL IN ROMANIA WITHIN THE 30 KM SURVEILLANCE ZONE[37]

TABLE 7.3-2: RADIOECOLOGICAL CONTROL IN ROMANIA WITHIN THE 30 KM ZONE FROM THE KOZLODUY NPP

Sample	Date	Region	Location	Unit	Total beta	Radiochemistry		
						Cs-137	Sr-90	Ra-226
Open well	2008	Dj	Ghighera	Bq/l	0.57±0.23	-	-	-
Covered well	2008	Dj	Ghighera	Bq/l	0.42±0.17			
Open well	2009	Dj	Ghighera	Bq/l	0.51±0.2	-	-	-
Covered well	2009	Dj	Ghighera	Bq/l	0.5±0.2	-	-	-
Open well	2010	Dj	Ghighera	Bq/l	0.67±0,25	-	-	-
Covered well	2010	Dj	Ghighera	Bq/l	0.4±0.17	-	-	-
Deposition	2008	Dj	Ghighera	Bq/m2	20.1±5	-	-	-
Deposition	2009	Dj	Ghighera	Bq/m2	19.8±4.8	-	-	-
Deposition	2010	Dj	Ghighera	Bq/m2	21.8±7.8	-	-	-
Aerosols	2008	Dj	Ghighera	Bq/m3	0.44±0.14	-	-	-
Aerosols	2009	Dj	Ghighera	Bq/m3	0.42±0.13	-	-	-
Aerosols	2010	Dj	Ghighera	Bq/m3	0.45±0.14	-	-	-
Milk	15.12.2008	Dj	Ghighera	Bq/l	38.1±4.7	0.13 ±0.04	0.022 ±0.009	0.0056 ±0.002
Milk	14.12.2009	Dj	Ghighera	Bq/l	41.1±6.5	0.041 ±0.01	0.039 ±0.01	0.0054 ±0.003
Milk	13.12.2010	Dj	Ghighera	Bq/l	41.1± 1,5	0.044 ±0.01	0.035 ±0.015	0.0049 ± 0.003
Wheat	15.12.2008	Dj	Ghighera	Bq/kg	89.9±7.2	0.41 ±0.16	0.18 ±0.069	0.029 ±0.008
Wheat	14.12.2009	Dj	Ghighera	Bq/kg	81.2±6.7	0.34 ±0.008	0.13 ±0.04	0.028 ±0.007
Wheat	12.11.2010	Dj	Ghighera	Bq/kg	79.5±7.2	0.33 ±0.014	0.11 ±0.043	0.023 ±0.001
Apples	15.12.2008	Dj	Ghighera	Bq/kg	37.1±4.9	0.039 ±0.013	0.019 ±0.005	0.0064 ±0.0028
Apples	14.12.2009	Dj	Ghighera	Bq/kg	34.7±5.1	0.035 ±0.014	0.014 ±0.001	0.003 ±0.001

[37]Report on the environmental impact assessment (EIA Report) of the investment proposal „Construction of a new nuclear power unit at the Kozloduy NPP site“, „Kozloduy NPP – New Build“ Ltd, Consortium „Dicon-Acciona Ing.“, 2013г.

Sample	Date	Region	Location	Unit	Total beta	Radiochemistry		
						Cs-137	Sr-90	Ra-226
Apples	13.12.2010	Dj	Ghighera	Bq/kg	39.3±3.8	0.037 ±0.01	0.016 ±0.007	0.0028 ±0.001
Potatoes	15.12.2008	Dj	Ghighera	Bq/kg	132.7±6.7	0.047 ±0.016	0.014 ±0.006	0.022 ±0.009
Potatoes	14.12.2009	Dj	Ghighera	Bq/kg	129.9±9.7	0.035 ±0.015	0.003 ±0.001	0.006 ±0.01

7.3.7 SUMMARY OF THE DEMOGRAPHIC AND HEALTH STATUS OF THE POPULATION WITHIN THE 30 AND 100 KM ZONES

The number of inhabitants in the settlements within the 30km zone on the territory of Romania is 78 323 inhabitants in the Dolj and Olt departments, in 23 settlements. [38]

Approximately 65 994 inhabitants in 45 settlements live within the 30km zone on the territory of Bulgaria.

The demographic potential within the 100km zone, respectively the 30km zone, around the Radiana site is low. The average population density is 61.5persons/km², which is considerably lower than the limiting condition of 100persons/km² envisaged in the Bulgarian legislation and the IAEA guidelines for the deployment of nuclear facilities. Within a100km radius there are 1289 settlements (546 in Bulgaria and 743 in Romania), and within a 30km radius – 74 settlements (42 in Bulgaria and 23 in Romania). Most of the settlements are small villages (54.8% of all villages) and very small towns (57.4% of all towns). Within the 30km zone, the largest settlements are the following: the town of Kozloduy (13000 inhabitants),the town of Oryahovo (5000 inhabitants), and on the territory of Romania –the town of Dabuleni (12000 inhabitants) and the town of Bechet (3400 inhabitants).

The dynamics of such a key demographic indicator as the total mortality is similar for both countries. For Romania in 2009 it was1141.9‰, and in 2010–1142‰.

Studies conducted by Romanian specialists present a similarity in the level of total mortality in the country and that of the town of Becket (**Figure 7**.3-13), situated within the 30km zone from the Kozloduy NPP site. The trend of total mortality for the two countries is similar.

[38] Report on the environmental impact assessment (EIA Report) of the investment proposal „Construction of a new nuclear power unit at the Kozloduy NPP site“, „Kozloduy NPP – New Build“ Ltd, Consortium „Dicon-Acciona Ing.“, 2013г.

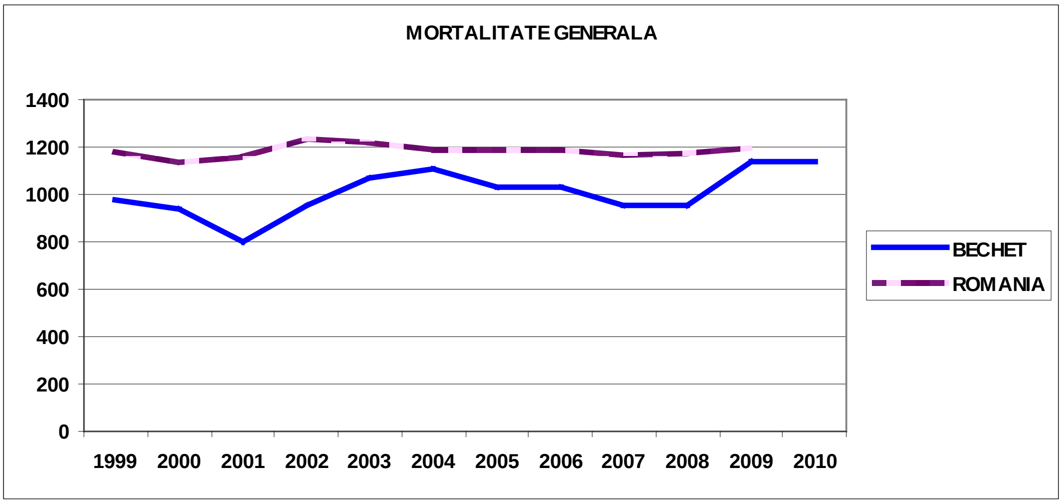


FIGURE 7.3-13: TOTAL MORTALITY RATE IN THE AREA OF THE TOWN OF BECHET FOR THE PERIOD 1999-2010

(*1/100 000 INHABITANTS*)

Incidence of malignant neoplasms, and in particular leukemia, for the same period is within the same range for both countries, and very similar.

In Romania in 2009 the incidence of malignant neoplasms was 224‰, and for 2010–177.1‰; and the incidence of leukemia for 2009 and 2010 was 17.1‰ – **Figure 7.3-14**.

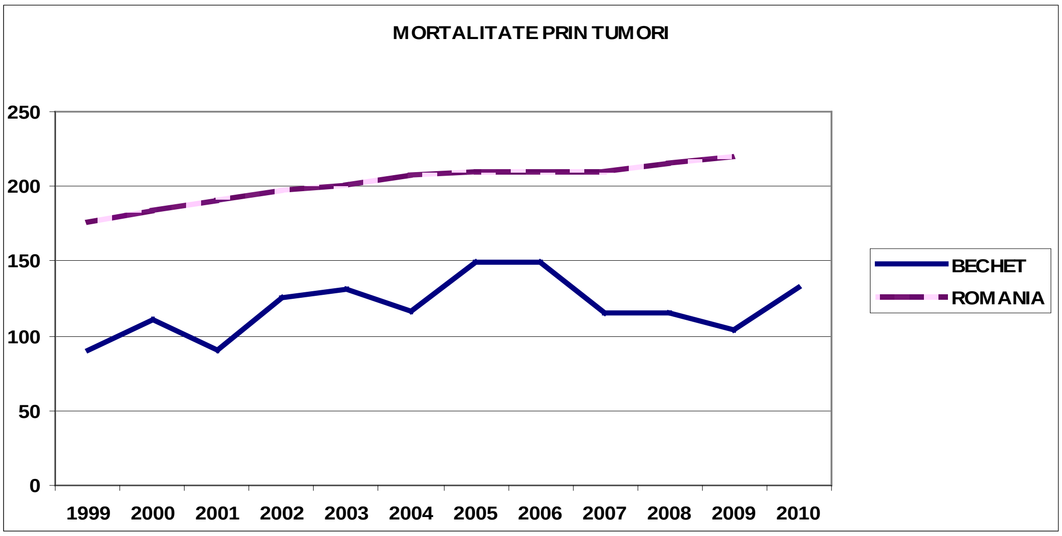


FIGURE 7.3-14: MORTALITY RATE FROM MALIGNANT NEOPLASMS IN THE AREA OF THE TOWN OF BECHET FOR THE PERIOD 1999-2010

Similar studies in the area of the town of Becket in Romania present a relatively higher incidence of the senosological units, including for recent years. Studies in both countries in similar settlements within the 30and 100km zones indicate the same trend for Bulgaria as well.

The potential impact zone of the NDF is limited within the fence of the facility (140-150 m) and this territory is defined as a precaution action zone (PAZ) of the NDF. This area is inaccessible to the general public. The supervised zone of the NDF (less than 4000 m),

which is an urgent protective action planning zone (UPAPZ) does not extend beyond the national borders of the Republic of Bulgaria and no potential impact is expected in this zone. Therefore, no transboundary impact is expected.

7.4 SUMMARY ASSESSMENT OF THE POTENTIAL IMPACT AT THE TERRITORY OF THE REPUBLIC OF ROMANIA

7.4.1 ATMOSPHERIC AIR

As a result of the detailed analysis elaborated in the EIA Report, it can be concluded that **no transboundary impact is expected** regarding the component „atmospheric air“.

7.4.2 SURFACE WATERS

As a result of the detailed analysis elaborated in the EIA Report, it can be concluded that **no transboundary impact is expected** regarding the component „surface waters“.

7.4.3 GROUND WATERS

The ground water bodies in the vicinity of the NDF form a joint underground flow, which is fed by the aquifer horizons to the south of the Radiana Site and by area infiltration. Its discharge is carried out in the drainage canals, in the Danube River is cases of low water surface elevations, and through the existing water intake facilities. In cases of high water surface elevations in the river the ground flow is directed from the river to the drainage canals. The water quantity that drains in the first above floodplain terrace (T1) within the borders of the NDF site is just 15.5 l/s. This circumstance as well as the fact that it is not foreseen the construction of a water intake facility, and that it is not expected an impact on the chemical composition of the ground waters, **exclude a transboundary impact on the ground waters**. This conclusion is also supported by the geological and hydro-geological resources at Romanian and Bulgarian territory.

7.4.4 BOWELS OF THE EARTH

The expected impacts on the bowels of the earth, including the most significant one – the reinforced concrete cells for disposal of the RAW containers – are limited only within the borders of the investment proposal at Bulgarian territory. **No transboundary impact is expected**.

7.4.5 LANDS AND SOILS

The data provided by the Romanian country regarding the soils do not offer any information about contamination of the lands caused by the existing nuclear power units in the 30km and the 100km impact zones. We only have information about the long-term land use. The 100-km zone covers a large territory but the provided information is about six counties (DOLJ, GORJ, MEHEDINTI, OLT, TELEORMAN и VALCEA), which occupy an area of 1 338 332,3 ha. .[39]

The agricultural lands used for farm production, amount to a total of 1 009 693,6 ha and are divided into the following categories:

- areas for complex growth; areas occupied by fruit trees and strawberry plantations;
- agricultural lands combined with areas with natural vegetation, or these are probably areas under NATURA 2000;
- unirrigated agricultural lands;
- pastures, rice fields (which occupy a limited area) and vineyards.

[39] Report on the environmental impact assessment (EIA Report) of the investment proposal „Construction of a new nuclear power unit at the Kozloduy NPP site“, „Kozloduy NPP – New Build“ Ltd, Consortium „Dicon-Acciona Ing.“, 2013г.

These areas are presented in **Table 7.4-1** and **Figure 7.4-1** divided into counties and type of land use.

The information regarding artificial areas is much improved. These areas amount to approximately 340 000 ha and they include airports, discontinuous urban structure, dumping grounds or storehouses, urban parks, industrial or commercial units, mines, road and railway networks and the adjacent land, as well as sport and recreation facilities. The urbanized territory and its structure amount to 95 210,31 ha. The natural pastures and meadows, as well as the mixed forests and bushes occupy 183 743,86 ha. The water bodies and riverbeds are 26 210,07 ha, and the internal marshlands occupy almost the same territory – 23 474,55 ha.

The DOLJ county occupies the largest total area (739811.43ha) and as agricultural land (563 178,78 ha). The next largest county is OLT, with a total area of 408 528.94 ha, and 332 219,23 ha agricultural land. The MEHEDINTI county hasatotalareaof148753.96ha and the agricultural lands are114 257,11ha.The remaining three counties have relatively similar areas – about 20000 ha (GORJ), 37 000 ha (VALCEA) and about 98000ha (TELEORMAN).
The figure clearly shows (as well as the legend) the different types of land use in colours that correspond to the colours used in the attached **Table 7.4-1**.

The land use at Romanian territory within the described area include mainly agricultural land amounting to 106 976 ha falling into various categories and forest territories, such as forests, bushes and thorny weeds, protective screens, forest nurseries, etc. with a total amount of 9328 ha. Being an area of meadows and level relief, it has lower altitude above sea level ranging between 20 m in the southern part and 122,5 m in the northern par, as a result of which the average altitude is 70 m. The populated areas included in the established zone occupy an area of 7225 ha.

The following 23 populated areas in the Dolj and Olt Counties are situated within the thirty kilometre zone: Bechet, Nedeia, Gighera, Zaval, Ostroveni, Sarata, Călăraşi, Dabuleni, Listeava, Piscu Sadovei, Sadova, Gângiova, Măceşu de Jos, Măceşu de Su, Sapata, Plosca, Bistret, Brandusa, Goicea, Barca, Horezu Poenari, Toceni, Valea Stanciului.

The geography relief of the Dolj County consists of the meadows along the Danube River, plains and hills. The altitude above sea level increases from 30 m to the south to 350 m to the north. It is worth mentioning that the largest sand region in the county is located in the south part of the Dolj County, together with an impressive number of lakes formed by the overflow of the Danube River and the precipitation.

TABLE 7.4-1 AREAS IN THE 100 KILOMETRE ZONE

Counties	Agricultural land	Artificial surfaces	Forests and semi-natural areas	Water bodies	Wet areas
			ha		
Dolj Total	563 178.78	48 720.69	94 832.91	13 193.50	19 885.55
Gorj Total	10 328.13	1 706.40	7 701.76	340.18	572.47
Mehedinti Total	114 257.11	7 653.91	23 048.81	1 625.75	2 168.38
Olt Total	332 219.23	29 438.10	37 205.86	8 931.71	734.03
Teleorman Total	83 528.41	5 312.30	7 779.09	1 655.12	96.57
Valcea Total	20 439.09	2 378.91	13 175.43	463.81	17.55
TOTAL For the 100 km zone	**1 123 950.75**	**95 210.31**	**183 743.87**	**26 210.07**	**23 474.56**
in %	**77.38%**	**6.55%**	**12.65%**	**1.80%**	**1.62%**
			1 452 589.55		

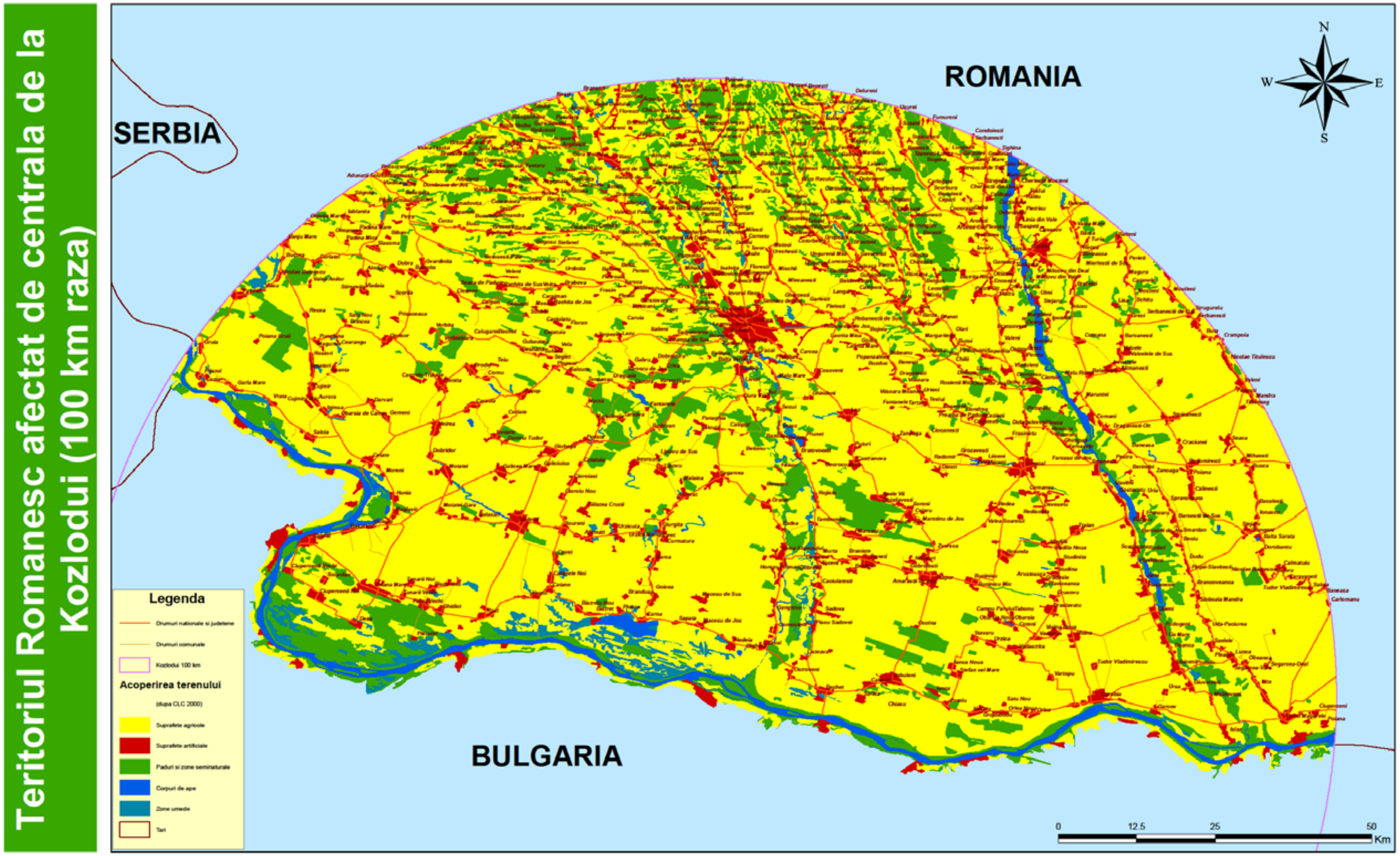


FIGURE 7.4-1 TERRITORIAL SCOPE OF THE ONE HUNDRED KM IMPACT ZONE OF THE KOZLODUY NPP

7.4.6 LAND USE

Over 90% of the local vegetation in the Dolj County (especially in its southern part) is replaced by agricultural crops, which here and there are interpolated by communities of Quercus pubescens (downy oak) or various species of the Quercus genus. The grass areas in this zone are steppe and they consist of various drought-resistant species. The plain in the southern part of the Dolj County, being part of the above-mentioned steppe, includes certain plant communities with Forest Glade (Quercus pubescens (downy oak) or other species of the Quercus genus, which go down near the meadows along the river.

After the cleaning of the forests and especially on sand lands the wind activity can activate sand dislocation. A protective forest belt consisting of Robinia SPP has been created around the following populated areas: Maglavit,Ciuperceni, Poiana Mare,Desa, Piscu Vechi, Ghidici and on the left side of the Jiu River in: Rojistea, Apele Vii, Celaru, Amarasti, Piscu Sadovei), Bechet, Călărași and Dabuleni.

The vegetation in the Danube plain and the Jiu plain covers sand lands with higher level of underground water, which causes the formation of wet deposits.

There are also found groups of willow (Salix), poplar (Populus) and purple willow (Salix fragilis), which form sprout river communities – Riverside in the region of the dry plain. Here are also found Quercus SPP, hazel, wild rose, thistle, etc.

In the lakes and the wet zones grows hydrophilic vegetation, including: bulrush, reed, nutmeg, white waterlily, common rush, Scirpus maritimus, Ranunculus, clover, etc.

On the basis of the radiological status of the soils within the 30 km zone around the Kozloduy NPP at Bulgaria territory we can assume that the implementation of the NDF **is not expected to cause an impact on the land use and agriculture at the territory of the Republic of Romania.**

7.4.7 BIODIVERSITY. PROTECTED TERRITORIES, PROTECTED AREAS

The activities associated with the IP implementation during the period of construction, operation and closure **are not expected to have an impact on the protected territories, protected areas and object situated at Romanian territory.**

7.4.8 WASTE

As a result of the detailed analysis elaborated in the EIA Report, it can be concluded that **no transboundary impact is expected** regarding the component „non-radioactive waste“.

7.4.9 HAZARDOUS SUBSTANCES

As a result of the detailed analysis elaborated in the EIA Report, it can be concluded that **no transboundary impact is expected** regarding the component „hazardous substances“.

7.4.10 NOISE

As a result of the detailed analysis elaborated in the EIA Report, it can be concluded that **no transboundary impact is expected** regarding the component „noise“.

7.4.11 TANGIBLE AND CULTURAL HERITAGE

As a result of the detailed analysis elaborated in the EIA Report, it can be concluded that **no transboundary impact is expected** regarding the tangible and cultural heritage.

7.5 CONCLUSION

During the construction and operation of the NDF will be observed the existing national and international standards for ensuring nuclear and radiation safety of the environment and people. The Radiana Site, which is selected for the construction of the NDF, is situated in the zone of the Kozloduy NPP that is examined in detailed and is under surveillance.

As a result of the detailed analysis elaborated in the EIA Report, it can be concluded that the impact on the people and environment at the territory of the Republic of Bulgaria and the Republic of Romania caused by the construction, operation and closure of the National disposal facility for containers with conditioned RAW is below the norms defined under the national and international requirements.

It can be concluded that during the construction, operation and closure, as well as during the period of institutional control of the NDF **NO TRANSBOUNDARY IMPACT IS EXPECTED regarding the components and factors of the environment**, which is also demonstrated by the mathematical models, which are described in detail in the EIA Report, and by the experience gained by the operation of identical facilities in other countries.

No **TRANSBOUNDAY IMPACT** is also expected regarding the conservation of the biodiversity because both on Bulgarian and Romanian territory no changes are expected in the structure, function and fragmentation of the plant and animal species and natural habitats caused by the NDF implementation because there is no contamination of the air, waters and soils, and there is no radioactive and light contamination.