ENVIRONMENTAL IMPACT ASSESSMENT REPORT

for Investment Proposal:

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

CHAPTER 9: MONITORING

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9 MONITORING

Monitoring, as a mechanism, is directly linked to the management, development and decision making related to the activities of every economic entity. Environmental monitoring, as a part of the remaining management programs, is a proven tool within the modern concept of good planning and efficient operation of every production facility.

9.1 NON-RADIATION MONITORING

The Kozloduy NPP has successfully implemented and functioning: internal non-radiation monitoring, radioecological monitoring and supervisory institutional environmental monitoring. The purpose of the non-radiation monitoring is to ensure full compliance with regulatory requirements and the fulfilment of the terms and conditions envisaged in the permits issued by the MEW, the BEEA, the BDWMDR and the Vratsa RIEW.

FIGURE 9.1-1: LOCATION OF NPP "KOZLODUY" MONITORING POINTS

Kozloduy NPP does not perform non-radiation monitoring of the atmospheric air due to lack of organized point sources emitters of conventional pollutants.

Non-radiation monitoring subject of this programme includes all measurements and laboratory analyses to the main ecological components of the ground, surface and waste water that are envisaged in the terms and conditions of the environmental permits.

Non-radiation water monitoring is divided into two parts – mandatory non-radiation monitoring and in-house control.

The mandatory own non-radiation monitoring at "Kozloduy NPP" EAD covers all mandatory measurements and analyses resulting from the regulatory requirements and

the terms and conditions for the issuance of the company's permits for water intake and the use of water bodies, and includes:

- Measuring the quantity of utilized water from the Danube River and the concentration of contaminants therein;
- Measuring the quantity of waste water and the concentration of contaminants therein for which specific individual emission limits have been set in the permits issued to the Company under the Water Act;
- Measuring the quantity of extracted groundwater;
- Monitoring water levels and the chemical status of the underground water bodies used for water extraction.

In-house control covers additional frequent water analyses performed at the NPP laboratories of and include the following tests:

- Utilized water from the Danube River;
- Waste water;
- Waste water from external organizations (EO) that is contractually discharged into the sewerage of "Kozloduy NPP" EAD;
- Ground water of the industrial site, incl. within the territory housing the buildings and facilities of the specialised units "Decommissioning" and "RAW" of SE RAW.

9.1.1 FREQUENCY OF NON-RADIOACTIVE WASTE WATER TESTING

TABLE 9.1-1: WASTE WATER DISCHARGED IN MAIN DRAINAGE CHANNEL AND IN THE DANUBE RIVER THROUGH HC-1 AND HC-2

STREAM discharged in		**Main drainage channel of the Kozloduy draining system**				**Danube River**
№ discharged through		**STREAM 1 Trapezoidal open canal (TOC)**	**STREAM 2 Sewerage collector ø 300**	**STREAM 3 Sewerage collector ø 1000**	**STREAM 4 Sewerage collector 130/195**	**HC-1 HC-2**
STREAM formed of		domestic, industrial and rain water from EG-1, 2	domestic waste water from EG 2	industrial and rain water from EG 2	domestic and rain water from outdoor switchgear	
Unit of measurement		**FREQUENCY**				
Water temperature	°C	-	-	-	-	3m.
Total beta activity	mBq/dm³	1m.	3m.	3m.	3m.	3m.
Insoluble substances	mgO_2/dm^3	3m.	3m.	3m.	3m.	3m.
BOD_5	mg/dm³	3m.	3m.	-	-	
COD(bichromatic)	mg/dm³	3m.	3m.	3m.	3m.	3m.
Total phosphorus(PO_4)	mg/dm³	3m.	3m.	3m.	3m.	-
Residual chlorine	mg/dm³	3m.	3m.	3m.	3m.	3m.
Oil products	mBq/dm³	3m.	3m.	3m.	3m.	3m.

STREAM discharged in		Main drainage channel of the Kozloduy draining system				Danube River
Total nitrogen	mg/dm³	3m.	3m.	3m.	3m.	3m.
Detergents	mg/dm³	3m.	3m.	3m.	3m.	-
Extractable substances	mg/dm³	1y.	1y.	1y.	1y.	-
Sulphate ions	mg/dm³	1y.	1y.	1r-	1y.	-
Active reaction	-	3m.	3m.	3m.	3m.	3m.
Zinc	mg/dm³	3m.	3m.	3m.	1y.	3m.
Boron	mg/dm³	3m.	3m.	3m.	1y.	3m.
Cobalt	mg/dm³	3m.	3m.	3m.	1y.	3m.
Manganese (total)	mg/dm³	3m.	3m.	3m.	1y.	-
Nickel	mg/dm³	3m.	3m.	3m.	1y.	-
Iron (total)	mg/dm³	3m.	1y.	1y.	1y.	3m.
Arsenic	mg/dm³	1y.	1y.	1y.	1y.	-
Cadmium	mg/dm³	1y.	1y.	1y.	1y.	-
Copper	mg/dm³	1y.	1y.	1y.	1y.	-
Lead	mg/dm³	1y.	1y.	1y.	1y.	-
Strontium 90	mg/dm³	1y.	1y.	1y.	1y.	-
Tritium	mBq/dm³	1y.	1y.	1y.	1y.	-
Gamma spectrometry	mg/dm³	1y.	1y.	1y.	1r.	-

Key: ***1y*** *– once per year;* ***1 m (3m)*** *– once per month (per 3 months)*

TABLE 9.1-2: FREQUENCY OF ADDITIONAL MONITORING OF WASTE WATER DISCHARGED INTO MAIN DRAINAGE CHANNEL AND IN THE DANUBE RIVER THROUGH HC-1 AND HC-2

STREAM discharged in		Main drainage channel of the Kozloduy draining system				Danube River
№ discharged through		**STREAM 1 Trapezoidal open canal (TOC)**	**STREAM 2 Sewerage collector ø 300**	**STREAM 3 Sewerage collector ø 1000**	**STREAM 4 Sewerage collector 130/195**	**HC-1 HC-2**
STREAM formed of		domestic, industrial and rain water from EG-1, 2	domestic waste water from EG 2	industrial and rain water from EG 2	domestic and rain water from outdoor switchgear	
	Unit of measurement	**FREQUENCY**				
Active reaction	-	1м.	1м.	1м.	1м.	1м.
Insoluble substances	mg/dm³	1м.	1м.	1м.	1м.	1м.
Oil products	mg/dm³	1м.	1м.	1м.	1м.	1м.
COD	mg/dm³	1м.	1м.	1м.	1м.	1м.
Total phosphorus	mg/dm³	1м.	1м.	1м.	1м.	-
Detergents	mg/dm³	1м.	1м.	1м.	1м.	-
BOD_5	mg/dm³	1м.	1м.	-	-	-
Residual chlorine	mg/dm³	-	-	-	-	1м.

Key: ***1 м****– analysed once per month*

The results, which are presented and analyzed in detail in section 3.2.1 and section 3.2.2 of this EIA Report, indicate that there is no upward trend in the values of the controlled parameters and no significant excesses of the limit values are registered. The values are comparable for the recent years. Annual reports are submitted to EEA and RIEW of Vratsa.

The mandatory own monitoring of extracted groundwater according to the permits for water use (No. 11530127/30.05.2008, No. 11530128/30.05.2008 and No. 11590203/30.05.2008) includes measuring the extracted quantities, monitoring of water levels and chemical status of groundwater bodies used for water extraction. Measured are

- ✓ Water levels and quantities extracted through shaft-type well "Valyata";
- ✓ Water levels and quantities extracted through collector well "Raney-5";
- ✓ Water levels and quantities extracted through shaft pump stations 1÷6.

Sampling and testing of water from SW "Valyata", CW "Raney-5" and SPS 1 ÷ 6 for determining the chemical status of groundwater bodies is performed by accredited laboratories.

TABLE 9.1-3: ORGANISATION AND FREQUENCY OF MONITORING QUANTITIES AND CONCENTRATIONS OF CHEMICAL INDICATORS

№	Indicator	Frequency								Laboratory
		SW Valyata	CW Raney-5	SPS 1	SPS 2	SPS 3	SPS 4	SPS 5	SPS 6	
1.	Active reaction	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	Engineering Chemistry Section, Quality Division
2.	Electroconductivity	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	External Laboratory
3.	Concentration of dissolved O_2	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	External Laboratory
4.	Ammonium ion	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	External Laboratory
5.	Nitrates	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	External Laboratory
6.	Chlorides	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	External Laboratory
7.	Sulphites	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	External Laboratory
8.	Total hardness	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
9.	Nitrites	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
10.	Phosphates	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
11.	Fluorides	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
12.	Cyanides	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
13.	Mercury	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
14.	Cadmium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
15.	Copper	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
16.	Nickel	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
17.	Lead	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
18.	Selenium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
19.	Chromium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry

№	Indicator	Frequency								Laboratory
		SW Valyata	CW Raney-5	SPS 1	SPS 2	SPS 3	SPS 4	SPS 5	SPS 6	
										Section, Quality Division
20.	Aluminium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
21.	Iron	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
22.	Calcium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
23.	Magnesium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
24.	Manganese	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
25.	Zinc	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
26.	Sodium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
27.	Boron	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
28.	Antimony	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
29.	Arsenic	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Engineering Chemistry Section, Quality Division
30.	Natural uranium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
31.	Benzo(b+k)fluoranthene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
32.	Benzo(a)pyrene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
33.	Indeno(1,2,3-cd)pyrene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
34.	Benzo(ghi)perylene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
35.	α – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
36.	HCB	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
37.	β – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
38.	γ – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
39.	δ – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
40.	ε – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
41.	Heptachlor	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
42.	Aldrin	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
43.	op' DDE	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
44.	pp' DDE	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
45.	Dieldrin	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
46.	op' DDD	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
47.	Endrin	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
48.	op' DDT	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
49.	pp' DDD	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
50.	pp' DDT	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
51.	Methoxychlor	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
52.	Benzene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
53.	1,2 – Dichloroethane	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
54.	Trichloroethylene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
55.	Tetrachloroethylene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
56.	Atrazine	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
57.	Simazine	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory
58.	Propazine	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	External Laboratory

TABLE 9.1-4. VOLUME AND FREQUENCY OF TESTING GROUNDWATER IN THE REGION OF KOZLODUY NPP

Boreholes (piezometers) in the region of NPP

Number	Location
114	– north of TH – unit 1, 2;
122	– **Chemical Water Cleanup Facility** – unit 1÷4 ;
127	– neutralization pits for **Chemical Water Cleanup Facility** – units 1÷4 ;
135	– next to transport corridor of RB – unit 1, 2;
213	– north of TH unit 3 – 4;
237	– next to transport corridor of RB – 3, 4 блок;
334	– Auxiliary building -1;
442	– Auxiliary building -2;
512	– next to reactor building of unit 5;
614	– next to reactor building of unit 6;
735	– **Chemical Water Cleanup Facility** – unit 5, 6;
944	– before Landfill for non-radioactive municipal and industrial waste, at the site of **Radioactive waste storage facility**
CP-3	– neutralization pits for на **Chemical Water Cleanup Facility** – unit 5, 6, oil tank and waste water pit – unit 5, RAW storage;
CW-4	– oil and diesel facility department " **RAWTF**";
P – 1	– north of outdoor switchgear;
P – 2	– in the Fire Protection Service yard;
P –3	– south of information centre

	Unit of measurement	Frequency
Unsoluble substances	mg/l	3 m
Total β-activity	Bq/l	3 m
Electrical conductivity	$\mu S/cm^{-1}$	2 y
Ammonium ion	mg/l	3 m
Nitrates	mg/l	3 m
Sulphates	mg/l	3 m
Chlorides	mg/l	3 m
Nitrites	mg/l	3 m
Phosphates	mg/l	2 y
Permanganate oxidisability Permanganate oxidisability	mgO_2/l	3 m
Total hardness	mgeqv/l	2 y
Fluorides	mg/l	2 y
Cyanides	mg/l	2 y
Boron	mg/l	2 y

Key: ***2 y*** *– analysed once every 2 years;* ***3 м*** *– analysed at every 3 months*

The in-house control is performed through regular internal patrols and inspections. Institutional control of non-radiation monitoring is carried out during the year by the authorities of the MEW, Danube River Basin Directorate and the RIEW of Vratsa.

Under a schedule approved by the Ministry of Environment and Water for automatic mobile stations (AMS) for further measurements in areas where there is none or a limited

number of fixed points, the Pleven Regional Laboratory takes measurements for air quality monitoring in ROUKAV North / Danube of Kozloduy Municipality every few years – the latest measurements were taken in 2008 and in 2011.

9.2 RADIATION MONITORING

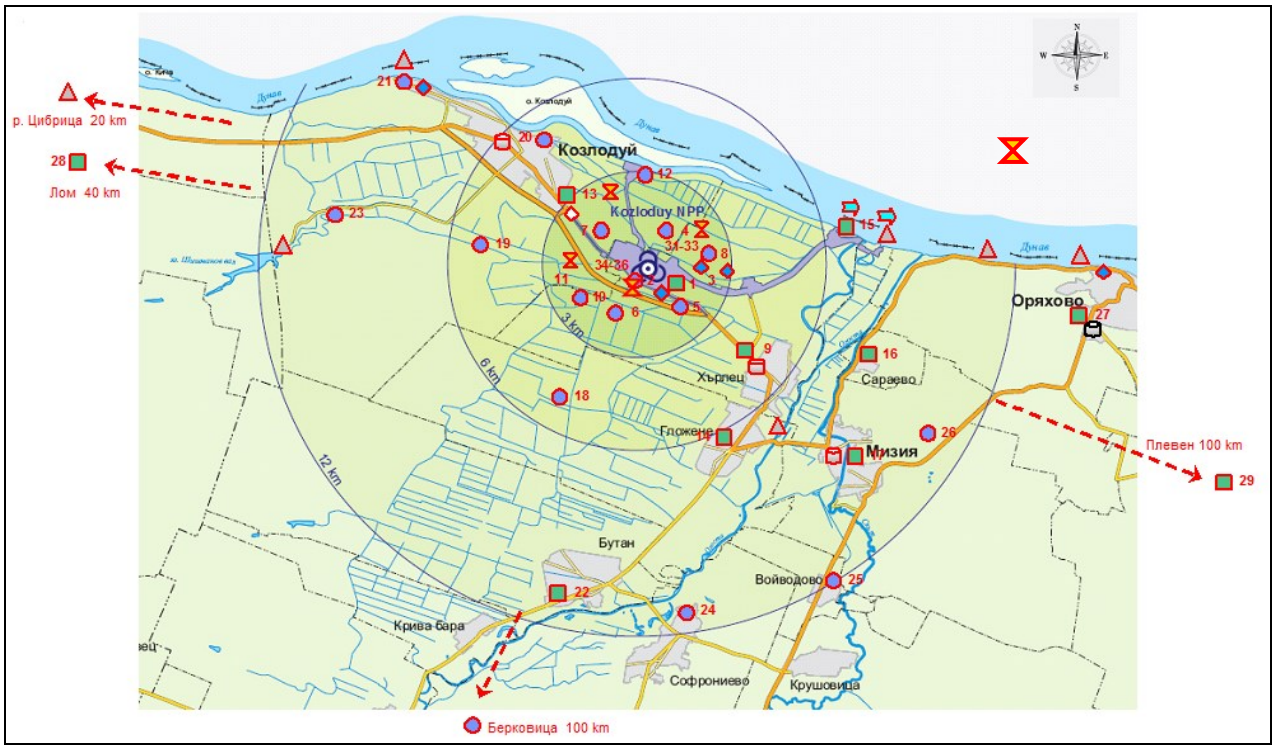
The radioecological monitoring performed by "Kozloduy NPP" EAD covers all environmental components – air, water, topsoil, vegetation, crops, typical foods produced in the area, etc.

European requirements for the application of Article 35 of the Euratom Treaty for monitoring levels of radioactivity in the environment for the assessment of radiation exposure of the population as a whole are regulated by the European Commission Recommendation 2000/473/Euratom, 08.06.2000. This recommendation is essential for standardization and unification of the applied practices of radioecological monitoring in EU member states. It defines the concepts and general requirements regarding the types of monitoring, monitoring networks and sampling (dense and diluted), frequency of testing, volume of monitoring and requirements for sampling and analysis of the main controlled objects of the environment. Regulated are also the volume of the supporting information to the sample, the management and communication of monitoring data.

9.2.1 INSTITUTIONAL RADIATION MONITORING

The institutional radiation monitoring of the environment is governed by the long-term environmental radiation monitoring programme of "Kozloduy NPP" EAD. The program is based on the legal requirements in this sector, as well as on international best practice and the operational experience of the Radiation Monitoring Department. The program is coordinated by the Ministry of Environment and Water (MEW), the Ministry of Health (MH) and the Nuclear Regulatory Agency (NRA) and is in line with international recommendations in the field, namely Article 35 of the Euratom Treaty and Recommendation 2000/473/EURATOM. To ensure independent control, radiation monitoring programmes are implemented by the control authorities of the EEA/MEW and NCRRP/MH.

To locate and assess the possible impact of Kozloduy NPP on the environment and the population around the plant there are two distinct zones of control with different radii: Precautionary Protective Action Planning Zone – the area of specific protection measures (2 km); and Surveillance zone (30 km). The monitoring covers also the industrial site. Sampling and measurements are carried out for comparison at reference points within up to 100 km around KNPP, where no influence of the plant operation is expected. Laboratory and automated control is performed on the environmental components.



Key:

- monitoring post type "**A**": aerosols, atmospheric fallouts, topsoil, vegetation, gamma background (TLD) – 11 units
- monitoring post type "**B**": atmospheric deposition, topsoil, vegetation, gamma background (TLD) – 15 units
- monitoring post type "**C**": water, sediments, algae, gamma background – 7 units

food chain products: – drinking water; – milk; – fish; – cereals

FIGURE 9.2-1: LOCATION OF RADIATION MONITORING POINTS AROUND KOZLODUY NPP

In the 30 km Surveillance zone there are 36 monitoring posts for terrestrial ecosystem and 7 posts for the water ecosystem, where sampling for laboratory analysis and measurement of the activity of technogenic/man-induced radionuclides in the samples are performed. Samples of the air, topsoil, vegetation, water and bottom sediments are analysed and the background gamma radiation is measured. Beyond those points, samples of drinking water, milk, fish, agricultural grain crops and fodder crops in the region are analysed. The location and type of monitoring posts is given in **Figure 9.2-1**:

Besides radioecological monitoring within the 100 km zone around Kozloduy NPP radiation measurements are performed at the industrial site. Subject to control are background gamma radiation, groundwater, air, atmospheric fallouts, vegetation and topsoil.

Water samples from more than 115 boreholes are analysed four times a year for total beta activity and tritium content.

Radiation monitoring during normal operation of Kozloduy NPP is based on conservative approach in accordance with the following main rules:

- ✓ measurements and/or sample collection should be done at potentially unfavourable points in terms of NPP impact;

- ✓ parallel measurements should simultaneously be made, or samples taken, from reference points where no impact from the power plant is expected;
- ✓ the analyzed samples should cover the main ecological components, and elements of the radioactivity distribution chain leading to the human body;
- ✓ the samples from foods should be characteristic to the area around the power plant;
- ✓ the examined radionuclides should be typical for WWER-type nuclear reactors and should include the key radionuclides pursuant to the Recommendation of EU's Euratom 2004/2;
- ✓ at the same time reference radionuclides with a natural origin and contained in a relatively consistent quantity in the samples (for instance ^{7}Be for air, ^{40}K for soil and biota) should also be taken;
- ✓ the detectable minimum values should be low enough, so that they would allow determining the background activities from the global deposition of technogenic radionuclides and allow the registering, at a very early stage, of even the smallest changes to the radiation environment.

The frequency of sampling, the points of sampling and the types of measurements (or determinable radionuclides) are described in the "Programme for Radiation Control of the Environment during Operation of Kozloduy NPP.

The frequency of sampling is consistent with the design requirements and the longlastingexperience in radioecological monitoring of Kozloduy NPP and the international practice of other countries.

The analysed reference radionuclides are fission products and activated corrosion products whose ingestion through the ambient air, drinking water and food or through objects fallen into the environment (as part of the food chain) would cause additional internal exposure of the population.

The methods used are standardised and validated by practical methods, such as gamma spectrometry, low background radiometry of total beta activity and radio chemically isolated radiostrontium, liquid scintillation spectrometry of tritium and alpha spectrometry of trans-uranium elements. Generally, these are methods well tested in practice, organised in analytical procedures for environmental samples used by leading laboratories worldwide and recommended by IAEA.

Practice shows that the results of radioecological monitoring have values significantly lower than those established by the regulations. For this reason, the current results are compared against those obtained from previous years of operation, and the results obtained before putting the NPP into operation. This approach allows recording and analysing even the smallest change in the trends of radiation background.

Implementation of the radiation monitoring program has been verified by selfassessment criteria – fulfillment of the pre-set volume, with guaranteed reproducibility and accuracy of results. The accuracy of the analyses is verified repeatedly in national and international prestigious laboratory comparisons of the World Health Organisation (WHO), the Federal Office for Radiation Protection of Germany (BfS), the International Atomic Energy Agency (IAEA) and the National Physical Laboratory in the UK (NPL). The results of the

institutional radiation monitoring are verified annually by independent research of MEW and NCRRP (MH). The main findings are available for the general public.
In pursuance of the provisions of Article 15 of the Regulation on conditions and procedure for establishing of special-statutory areas around nuclear facilities and facilities with sources of ionizing radiation, approved by Decree of the Council of Ministers № 187 of 28.07.2004, Kozloduy NPP has built an automated information system for **radiation monitoring of settlements within the 30 km surveillance zone of the plant** (AISRM). Within the system are covered 13 urban areas and at appropriate public places stationary information boards are placed to indicate in real time the dose rate of local gamma background. Local measuring stations (LMS) are located in urban areas: the town of Kozloduy, village of Harlets, village of Glozhene, village of Butan, town of Mizia, village of Oryahovo, village of Selanovtsi, village of Tarnava, village of Hayredin, village of Mihaylovo, town of Valchedrum, village of Zlatiya and village of Stanevo. The data is automatically transmitted via a GPRS channel to the server at Kozloduy NPP, which manages and archives information and provides access for visualization and reports to the NPP (Radiation Monitoring Department) and to the Executive Environment Agency (EEA) at the Ministry of Environment and Water (MEW).

In 2012 were analysed a total of 2242 samples of various components of the environment: air, water, soil, vegetation, milk, fish, agricultural crops, etc. A total of 4145 analyses of radioactivity in samples were performed. A total of 1315 measurements were made of the background gamma radiation at the control posts and along the routes with portable dosimetric devices and fixed thermoluminescent dosimeters.

In 2012 no technogenous activity different from the one of ^{137}Cs was registered at any of the monitoring posts within the region of the Kozloduy NPP .

The results of the monitoring carried out in 2012 and previous years provide valid assessment of the negligible impact of Kozloduy NPP on the aerosol activity of the air. Practically this indicator has not been influenced by the operation of the power plant. The concentration of the technogenous radionuclides are with background levels.

The radiation purity of the air fully corresponds to the regulatory requirements.

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

The results of analyses of the atmospheric fallouts in 2012 were fully comparable with the ones in previous years and with the data for the region before putting the NPP into operation.

The results of the automated information system for radiation monitoring (AISRM) of urban settlements within the 30 km surveillance zone around the plant indicate a gamma background within the normal range of natural background radiation for the region.

The institutional aerosol monitoring of Kozloduy NPP includes testing of the radioactivity of atmospheric air twice a month at 11 control posts of the 100 km zone around the NPP and in 3 control points at the industrial site. Radioactivity of atmospheric air is controlled by a new generation of high-tech devices for continuous aerosol sampling with high capacity (80÷100 m^3/h), numerical control and information storage. For comparability results are recalculated to standard atmospheric conditions.

Analysed aerosol filters for large volumes of the ambient air (10,000 ÷ 20,000 m_3) show results well below the established standards (Regulation on basic norms of radiation protection – 2012). Technogenic radioactivity of ^{137}Cs in aerosols of control posts within the 100 km area is with background values below the minimum detectable activity (MDA) – an average of 2.8 μBq/m^3.

Registered radioactivity of ^{137}Cs in the air is about $10^5 \div 10^6$ times lower than the reference values (Average annual concentration limit for ^{137}Cs according to Regulation on basic norms of radiation protection – 2012 is 3.2 Bq/m3). Until April 2009 the total beta activity of aerosol samples was also tested. For 2009, average total beta activity in long-lived aerosols for individual posts was in the range 0.50 ÷ 0.68 mBq/m3. The results are comparable in a narrow range over the years.

Radioactivity of atmospheric deposition (sludge) is tested monthly in 33 control posts within the 100 km zone around the NPP.

In 2011, total beta radioactivity of atmospheric deposition for all 33 posts ranged 0.058 ÷ 1.96 Bq/(m2.d), with an average value of 0.43 Bq/(m2.d). The measured values by sectors and reference posts within the 100 km zone are very low, in the range of 0.1 x 1.8 mBq/(m2.d), with an average value of 0.7 mBq/(m2.d) for all 33 posts. The gamma spectrometric measurements show values for background levels of radioactivity of ^{137}Cs up to 0.024 Bq/(m2.d).

In general, the radioactivity of atmospheric air (aerosols and fallouts) within the 30 km surveillance zone and in the 100 km zone has normal background levels.

In 2012 technogenic activity other than 137Cs was not registered at any control post in the environment of Kozloduy NPP.

The results of the aerosol monitoring performed in 2012 and in previous years provide valid assessment of the negligible impact of Kozloduy NPP on the aerosol activity of the air. Practically this indicator has not been influenced by the operation of the power plant. Concentrations of the technogenous radionuclides have background levels.

The radiation purity of the air fully corresponds to the regulatory requirements.

9.2.1.1 RADIOLOGICAL MONITORING OF TOPSOIL

MEW performs tests on the surface, arable topsoil layer (0 – 5 cm) at quarterly intervals to determine the specific activity of natural and technogenic radionuclides at 26 control posts in the surveillance zone of the plant. The measured specific activity of technogenic radionuclide ^{137}Cs in the surface layer at these points ranged from 0.5 Bq/kg (town of Mizia) to 51.2 Bq/kg (village of Selanovtsi) and is estimated to be a result of the global deposition after the Chernobyl accident. During the year there was no presence of other technogenic radionuclides.

A comparison with monitoring from previous years and with points from other regions of the country indicates that no impact on the radiation status of topsoil has been registered resulting from the operation of the plant.

Radioactivity of the soil in the area of Kozloduy NPP has been subject to detailed and systematic studies since putting the plant into operation in 1974 to date. According to the **institutional Radioecological Monitoring Programme within the 100 km zone soil sampling and analysis is performed from 36 control posts.** Samples are taken in the immediate proximity to the control posts, possibly from non-arable land, from the 5 cm surface layer. The content of long-lived technogenic radionuclides typical for WWER reactors is tested – ^{90}Sr, ^{134}Cs, ^{137}Cs, etc. on air-dry weight (a.d.w.).

For 2011, the results for ^{90}Sr were within the limits of 0.22 ÷ 3.97 Bq/kg a.d.w., while the annual average content for all 36 control posts was 1.33 Bq/kg a.d.w. The activity of 137Cs in the studied topsoil ranged from 1.55 to 45.4 Bq/kg a.d.w., with an average value for 2011 of 13.1 Bq/kg a.d.w. It was observed that at some of the control posts, the 137Cs content was significantly lower than the average. This occurs when the land is partially or fully cultivated. The registered technogenic activity in the environment in the area of 100 km is of a transboundary origin due to the global depositions and is relatively low compared to other regions in the country. This is a result of natural self-cleansing of the atmosphere following nuclear weapons tests and the accident at the Chernobyl NPP.

In 2012 and in the recent years no ^{134}Cs was measured in the samples, while the average MDA is 0.74 Bq/kg.

The measured in previous years activities of radio cesium (^{134}Cs and ^{137}Cs) and their ratios proved definitely its transboundary origin in the soil of 100 km zone – mainly transfer from the accident at the Chernobyl NPP in 1986.

Generally, the content of ^{90}Sr and ^{137}Cs in the soil from the area of NPP is lower than that measured in the other regions of the country.

9.2.1.2 RADIOLOGICAL MONITORING OF VEGETATION

Vegetation (grass) is tested four times a year at the outposts in the town of Kozloduy, the village of Harlets and the town of Oryahovo (gamma spectrometry and ^{90}Sr), twice a year at the NPP site (gamma spectrometry) and at the posts in the towns of Lom, Pleven and Berkovitsa (gamma spectrometry, ^{90}Sr – once a year). Samples are taken in the immediate proximity to the places of soil sampling. Samples are analysed on air-dry weight (a.d.w.).

In 2011, the results obtained for the content of ^{90}Sr in vegetation were within 0.23 ÷ 1.15 Bq/kg a.d.w., with an average value of 0.54 Bq/kg a.d.w. The activity of ^{137}Cs in vegetation in 2011 was within 0.78 <MDA <2.55 Bq/kg a.d.w. Radioactivity in samples was within normal rates for these plant species.

The results obtained for the content of ^{90}Sr in vegetation **in 2012** were in the range 0.20 ÷ 2.11 Bq/kg a.d.w., with an average of 0.93 Bq/kg adw The results are comparable to the measured in previous years. Maximum value was registered on P.13 (town of Kozloduy).

The observed differences are due to the different types of vegetation over the years and the seasonal characteristics. For example, in the event long-term drought, sampling of fresh grass is not possible and samples are often taken from dry vegetation (stems) which contain more cellulose.

9.2.1.3 RADIOECOLOGICAL MONITORING OF SURFACE WATER

The institutional radioecological monitoring examines the radioactivity of water along the Danube River and inland rivers and water basins near the nuclear power plant – Ogosta, River, Tsibritsa River and Kozloduy dam. As receiving water of the liquid releases from the NPP, particular attention is paid to the Danube River, where along its course are placed 4 control points – 1 upstream before the NPP and 3 downstream after the nuclear power plant.
Weekly sampling of water is done from the three control points along the course of receiving water of the Danube River and then pooled monthly samples are analysed. Samples from the neighbourhood of Batatovets along the course of the Danube are taken twice a year, and from inland water basins – annually.
The results are within normal limits typical of natural water basins: total beta activity <0.012 ÷ 0.15 Bq/l, annual average – 0.056 Bq/l, activity of ^{90}Sr – 0.9 ÷ 3.9 mBq/l, annual average – 1.8 mBq/l, activity of ^{3}H – <4.0 ÷ 22.3 Bq/l, annual average – 7.2 Bq/l, activity of ^{137}Cs – <0.3 ÷ 1.1 mBq/l, annual average – 0.6 mBq/l. The total beta activity measured in the open water reservoirs is only 30% of the control level (0.5 Bq/l, Regulation № N-4/2012). For the water of Danube River, the maximum measured value is 0.087 Bq/l.

Table 9.2-1: Summarised data on surface water monitoring for 2012

NATURAL WATER	✓ Weekly sampling along the Danube River ✓ Annual sampling from Ogosta, River, Tsibritsa River and Kozloduy dam ✓ Taken: 50 **samples** and **176 analyses** performed (*50 gamma spectrometric, 50 radiometric for total beta activity, 26 radio chemistry of strontium and liquid scintillation of tritium*) **RESULTS:** ✓ **Within normal limits typical of natural water basins** ▪ total beta activity <0.018 ÷ 0.084 Bq/l, annual average – 0.043 Bq/l ▪ activity of ^{90}Sr – 0.9 ÷ 8.4 mBq/l, annual average – 2.3 mBq/l ▪ activity of ^{3}H – <3.3 ÷ 33.0 Bq/l, annual average – 9.0 Bq/l ▪ activity of ^{137}Cs – <0.2 ÷ 0.9 mBq/l, annual average – 0.6 mBq/l
SUMMARY: The results are comparable to those from previous years. Impact of the NPP on the water ecosystem in the region has not been reported.	

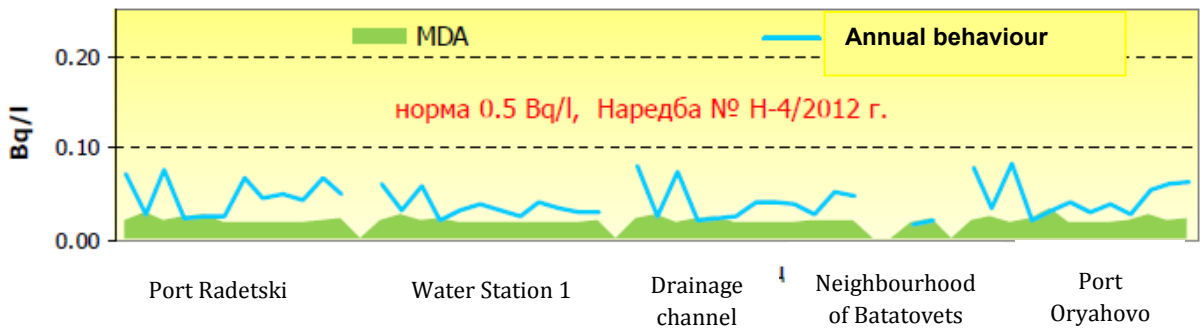


FIGURE 9.2-2:TOTAL BETA ACTIVITY (BQ/L)OF DANUBE RIVER WATER

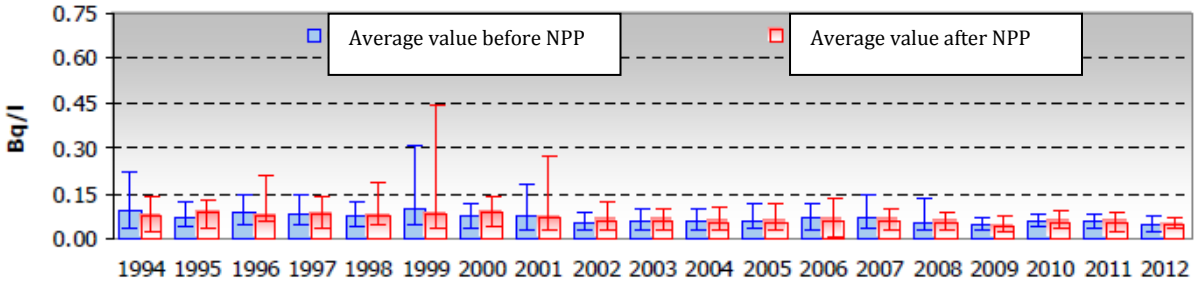


FIGURE 9.2-3:SUMMARISED RESULTS FOR TOTAL BETA ACTIVITY (BQ/L) OF DANUBE RIVER, 1994- 2012

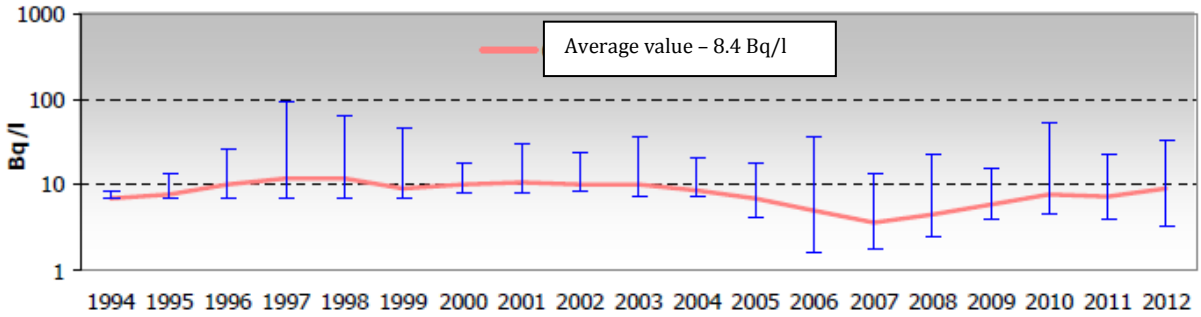


FIGURE 9.2-4: SUMMARISED RESULTS FOR ^{3}H(BQ/L) IN DANUBE RIVER AFTER NPP FOR 1994-2012

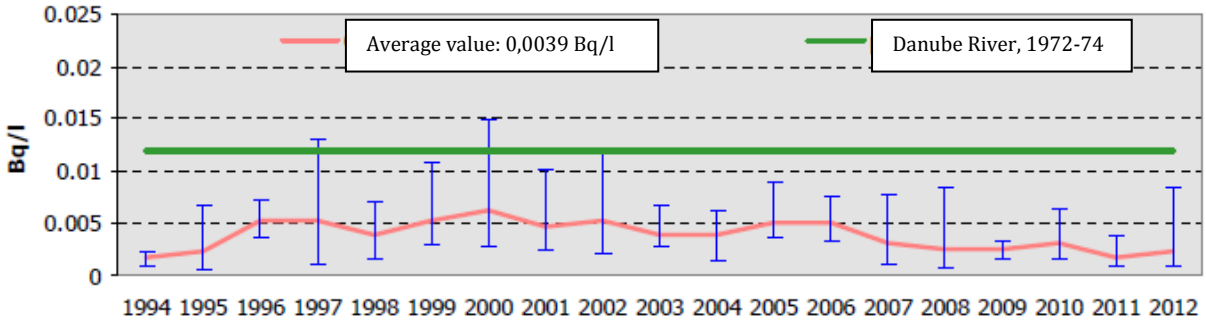


FIGURE 9.2-5: SUMMARISED DATA FOR ^{90}SR(BQ/L) IN DANUBE RIVER FOR 1994-2012

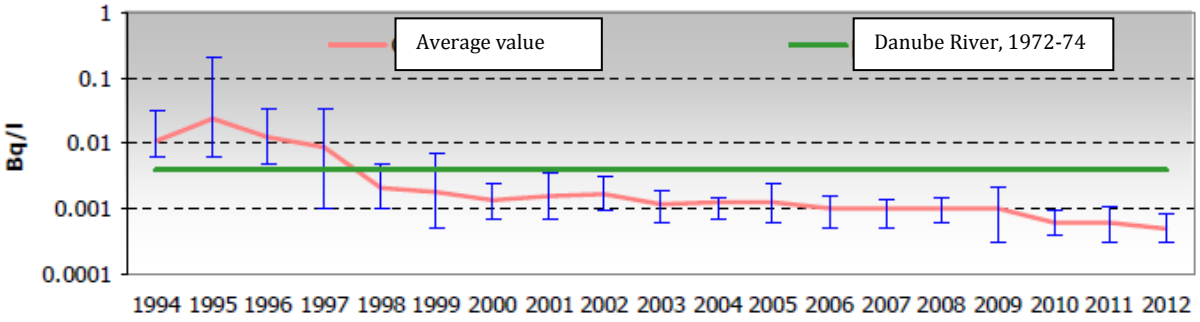


FIGURE 9.2-6: SUMMARISED DATA FOR ^{137}CS(BQ/L) IN DRAINAGE CHANNEL OF NPP FOR 1994-2012

Operation of Kozloduy NPP have had no perceptible impact on the radioecological status of the water of the Danube River and other water basins in the area. The results are within normal limits for natural water basins, many times below the established norms.

9.2.1.4 RADIOLOGICAL MONITORING OF DOMESTIC WASTE WATER IN 2012

In 2012 water form the combined sewerage for domestic waste water and water from the drainage channel were analyzed monthly for tritium and gamma spectrometry for radionuclide composition (mainly ^{134}Cs and ^{137}Cs). The content of ^{90}Sr was analysed once a year.

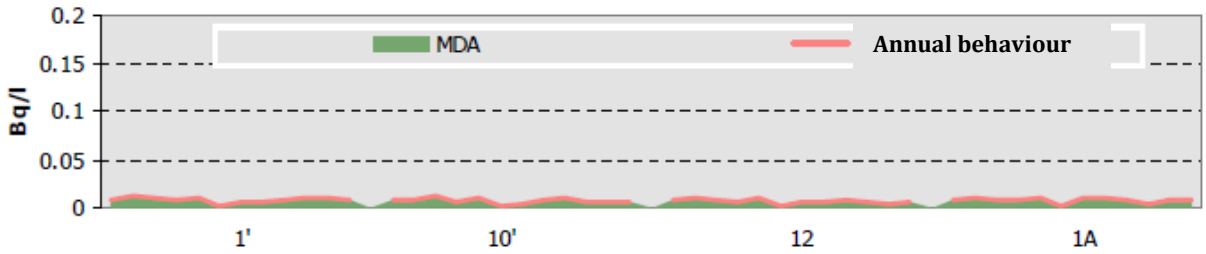


FIGURE 9.2-7: ACTIVITY OF ^{134}CS (BQ/L) IN THE DOMESTIC WASTE WATER SEWERAGE OF NPP FOR 2012

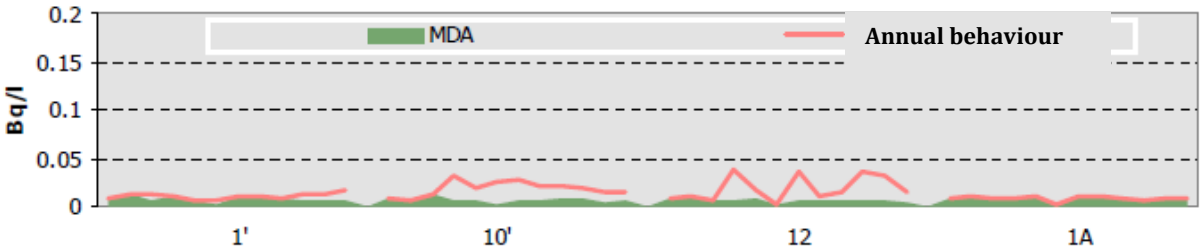


FIGURE 9.2-8:ACTIVITY OF ^{137}CS (BQ/L) IN THE DOMESTIC WASTE WATER SEWERAGE OF NPP FOR 2012

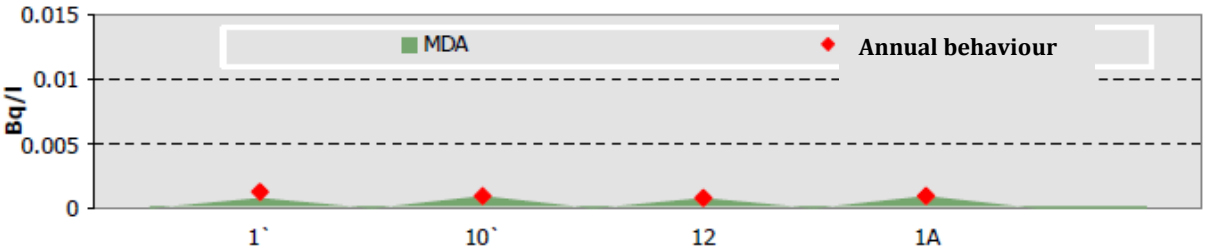


FIGURE 9.2-9: ACTIVITY OF ^{90}SR (BQ/L) IN THE DOMESTIC WASTE WATER SEWERAGE OF NPP FOR 2012

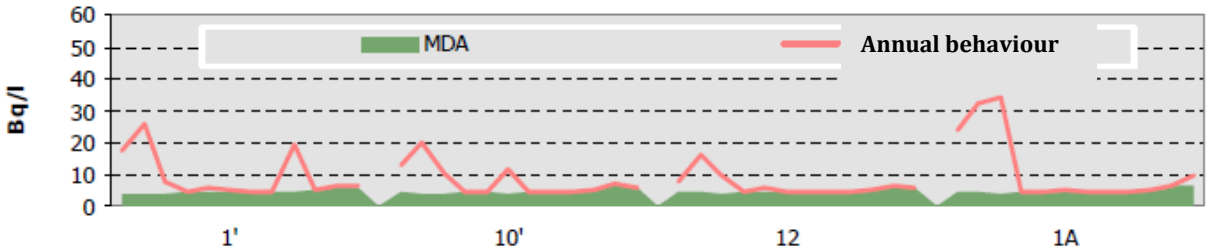


FIGURE 9.2-10: ACTIVITY OF ^{3}H (BQ/L) IN THE DOMESTIC WASTE WATER SEWERAGE OF NPP FOR 2012

The data in **Figure 9.2-10** show that the content of tritium in the water discharged through the sewerage for domestic waste water throughout 2012 was lower than the MDA (4.1 ÷ 6.8 Bq/l), which is even below the norm for drinking water – 100 Bq/l. The maximum activity of ^{3}H is 34.2 Bq/l at point 1^{a} in March.

The specific activity of ^{90}Sr measured in all water samples was below the MDA 0.0008 ÷ 0.0010 Bq/l. These are typical values for natural water basins.

Waters, discharged from point 1^{a} (power unit 5 and 6) throughout the year have been with specific activity of ^{134}Cs and ^{137}Cs, as follows: for ^{134}Cs – <0.0023 ÷ <0.013 Bq/l, for ^{137}Cs <0.0019 ÷ 0.038 Bq/l.

The analysis of these data shows that released sanitary water from high security zone -2 through the year has been with background activity below MDA. The highest content of ^{137}Cs in water from domestic waste water sewerage in 2012 was measured at point 12 and the maximum measured value was 0.038 Bq/l (April). The results for ^{134}Cs for point 1'to point 12 are below MDA (<0.0023 ÷ 0.013Bq/l).

The measured levels of technogenic activity do not endanger the ecological situation in the area of the neighbourhood of Blatoto.

9.2.1.5 DRINKING WATER

Special attention is paid to the drinking water sources in the area of the NPP. Drinking water for the town of Kozloduy, the village of Harlets, Kozloduy NPP and the town of Oriahovo is tested monthly for total beta activity and tritium. Twice during the year are determined ^{90}Sr and ^{137}Cs in the catchment wells at Kozloduy, the NPP, II-nd pumping station at NPP and Harlets, and four times a year – in the water supply network of the town of Oryahovo.

The results for total beta activity in drinking water through 2012 are within the range 0.031 ÷ 0.075 Bq/l, an average of 0.048 Bq/l.

In all samples analyzed in 2012, the activity of tritium varied in the range of MDA from <3.9 ÷ <6.4 Bq/l, average 4.8 Bq/l. Values are much lower than the permissible limits for drinking water: 2 Bq/l total beta activity and 100 Bq/l for tritium – Regulation № 9/16.03.2001. The results obtained are similar and comparable to those of the previous years.

In all samples analyzed in 2012, the activity of ^{137}Cs is below MDA (<0.4 ÷ <0.8) mBq/l).

Activity of ^{90}Sr in drinking water in 2012 varied in the range of <0.8 ÷ 2.6 mBq/l.

The results are similar to those of previous years and are about 1,000 times lower than the legal norms (Regulation on basic norms of radiation protection – 2012).

Radiation status of drinking water sources in the region is not affected by the operation of Kozloduy NPP and fully complies with sanitary norms.

9.2.1.6 RADIOLOGICAL MONITORING OF AGRICULTURAL PRODUCTION

The institutional monitoring of Kozloduy NPP covers testing of major types of grain and fodder crops produced within the 3km zone –barley, wheat, corn, sunflower, etc. All samples were subject to separate analyses of grain and straw (heads, cobs). The analysis methodology is similar to that used in the analysis of vegetation. Higher values measured in silage (straw, heads, cobs) than in the grain core of the analysed products is determined by the distribution of radio nuclides in different parts of the crops.

In 2012, 14 samples from cereals were analyzed, on which were performed 34 analyses – 14 gamma spectrometric, 14 radiometric for total beta activity and 6 for ^{90}Sr. Total beta activity dominates in straw (heads, cob) and varies within normal range: 105 Bq/kg a.d.w. in grains of corn to 1,692 Bq/kg a.d.w. – in heads of sunflower.

The results of the gamma spectrometric measurements show that the registered total beta activity in the samples is almost entirely due to natural ^{40}K – average 550 Bq/kg a.d.w.
In 2012, like in previous years, excessive background activity of ^{137}Cs and other technogenic radionuclides was not reported (the norms for ^{137}Cs are 0.31 <MDA <4.82 Bq/kg a.d.w.). Registered activity of ^{90}Sr was in the range of 0.089 ÷ 1.72 Bq/kg a.d.w. The results obtained for 2012 are comparable to data from previous years for the same types of crops. The radiation status of crops has typical natural levels.

9.2.1.7 RADIOLOGICAL MONITORING OF MILK, MEAT AND FISH

Milk as a typical food product is an indicator of a possible radioactivity absorption in the food chain.
In accordance with the institutional radioecological monitoring programme, in **2011** was tested the monthly radioactivity of cow's milk from three farms in the region of Kozloduy NPP –in the town of Kozloduy, and in the villages of Harlets and Mizia. Samples were analysed for total beta activity and gamma spectrometry for radionuclide content.
The total beta activity in samples of cow's milk varies in the range of 20 ÷ 55 Bq/l, with an average content of 37.8 Bq/l. With an average potassium content per liter of cow's milk of 1.3 g/l, the specific activity of ^{40}K is about 40 Bq/l. Results show that virtually all measured total beta activity is due to the natural isotope ^{40}K.
Gamma-spectrometric measurements of milk in 2011, like in previous years, indicated no activity of ^{137}Cs and the results were in the range of (0.048 <MDA <0.13 Bq/l). In 2011, the activity of radiostrontium varied in the range of 4.6 ÷ 18 mBq/l, an average of 8.9 mBq/l.

Milk is a typical food product for the region and is a reliable indicator of possible intake of radioactivity by humans through the food chain. Analyses of milk samples had been performed already before putting of NPP into operation and are part of the monitoring programme. In 2012 was tested the monthly radioactivity of cow's milk from three farms in the region of Kozloduy NPP –in the town of Kozloduy, and in the village of Harlets and the town of Mizia.

In 2012 a total of 34 samples were analysed. The number of analyses performed was 80 – 34 gamma spectrometric, 34 for total beta activity and 12 with radiochemical separation of

strontium, and the activity of ^{90}Sr was determined on a quarterly basis after radiochemistry of the composite sample.

The average value for 2012 as a total of the three farms was 41.7 Bq/l. The average annual total beta activity in milk from the region of Kozloduy NPP for the period 1972 -1974 was 44.0 ± 1.5 Bq/l. With an average potassium content per liter of cow's milk of 1.3 g/l, the specific activity of ^{40}K is about 40 Bq/l. Results show that virtually all measured total beta activity is due to the natural isotope ^{40}K.

The total activity measured is within typical natural limits and is entirely due to the natural isotope ^{40}K.

Radiation purity of milk from the region is not affected by the operation of Kozloduy NPP .
Pork samples were analysed at the local pig-breeding farm in the town of Kozloduy in the period 1993-1999. Afterwards, due to the farm's closure analyses of this kind of samples was suspended. Samples were gamma spectrometry identified per fresh weight (f.w.). Technogenic radioactivity was in the range of MDA (^{137}Cs: 0.06 ÷ 1.04 Bq/kg f.w., average 0.42 Bq/kg f.w.).
Sampling is carried out of the **ichthyofauna in the area of BPS** (bank pumping station). Catches are taken at the access of the cold intake cannel (before the NPP) and at the exit of the hot outlet channel (after the NPP) along the Danube river. The aim is to analyse the impact of liquid releases from Kozloduy NPP on fish in the area. Fish bones and meat are analysed separately; for meat sub-samples gamma spectrometric analyses identify radiocesium and bone sub-samples are analysed for ^{90}Sr. The analysed samples of fish **in 2011** showed radiocesium activity in meat respectively: ^{137}Cs in the range 0.09 ÷ 0.29 Bq/kg f.w., with average of 0.15 Bq/kg f.w., and ^{134}Cs below MDA (<0.07 ÷ <0.17 Bq/kg f.w.). The activity of ^{90}Sr in bones varied in the range of 0.42 ÷ 0.84 Bq/kg f.w.

The radiocesium activity in meat in the analysed samples of fish **in 2012** varied in the range of MDA, while ^{134}Cs was below MDA (<0.08÷<0.27 Bq/kg f.w.). The activity of ^{90}Sr in fish bones varied in the range of <0.39÷1.03Bq/kg f.w.

Activity of ^{90}Sr and ^{137}Cs in fish caught in the Danube River in the period 1972 – 1974 before putting the NPP into operation was respectively: fish meat – 4.44 ± 1.70 (^{137}Cs); fish bones: – 1.48 ± 0.20 (^{90}Sr).

Therefore, the radioactivity in the food chain is with low background levels.

There is no assessable effect of the operation of NPP on the radiological status of the ichthyofauna in the Danube River basin. Fish in the area of the BPS is clean.

9.2.1.8 ADDITIONAL RADIATION EXPOSURE TO THE POPULATION IN THE 30 KM SURVEILLANCE ZONE AROUND KOZLODUY NPP

For the calculation of the additional radiation exposure to the population caused by radioactive emissions from NPP in the environment are used verified and validated model evaluation programs based on the adopted by the European Union (EU) CREAM

methodology and adapted to the geographical and hydrological characteristics of the region Kozloduy NPP .
For 2011, the overall assessment of the maximum individual effective dose to the critical group of the population from liquid releases and gaseous and aerosol emissions into the atmosphere, taking into account the contribution of ^{14}C and ^{3}H, was 7 μSv/a, which is negligible compared to the rate for the population per year (1,000 μSv) according to BNRP-2012. The collective dose to the population within the 30 km surveillance zone around Kozloduy NPP is 0.039 manSv. Normalized collective dose of 0.022 manSv/GW.a is comparable to the average indicators for PWR reactors worldwide. Over the past five years the value of the maximum individual effective dose to the population varied in the range 4 ÷ 7 μSv/a, which is below the control margin of 10 μSv/a for regulatory clearance under BNRP-2012. Additional radiation exposure to the population in the 30 km surveillance zone is on average 500 times lower than that received from natural background radiation (2400 μSv).

In 2012, the estimated maximum individual effective dose to the population, total gaseous (with ^{14}C and ^{3}H) and liquid releases from Kozloduy NPP in the environment was 5.82 μSv/a. This is only 0.25% of the exposure from natural background radiation in the country (2.33 mSv/a) and 0.58% of the rate for the population (1 mSv / a) BNRP-2012.

Low values of the the releases with treated water discharges from Kozloduy NPP in 2012 and previous years determine low levels of exposure of population in the area. The released in 2012 tritium activity – **24.1 TBq**, represents 13% of the admissible level and 93% of the control level for the period. In the past decade this parameter remained stable in the range of 7 to 13% of the admissible level. Total activity (excluding tritium) of liquid releases is 411 MBq, which is only 0.28% of the control level of the NRA approved limit for the period.

Collective dose of liquid radioactive releases in the 30 km zone in 2012 was estimated to be 4.710^{-3}man.Sv/a. Normalized collective dose per unit of generated electric power amounts to **$2.61.10^{-3}$ man.Sv/GW.a.** This exposure is only 13% of the average value for PWR reactors worldwide: 2.10^{-2} man.Sv / GW.a. (UNSCEAR2000).

The maximum individual effective dose within the 30 km zone is identified to be $6.37.10^{-7}$ Sv/a, while to a representative of the critical group of the population along the Danube river valley (town of Orqhovo, villages of Leskovets, Ostrov and Gorni Vardim) is **$4.49.10^{-6}$ Sv/a. This radiation is negligible and represents less than 0.5% of the annual limit on the effective dose of 1 mSv (BNRP -2012) and hundreds of times lower than the exposure from natural background radiation (2.33 mSv/a). Compared to the administrative quota, which is 0.05 mSv/a, the received maximum dose of liquid releases was 9%.**

9.2.1.9 INTER-DEPARTMENTAL MONITORING

The Ministry of Environment and Water performs inter-departmental non-radiation monitoring in the 30 km zone around KozloduyNPP.

9.2.1.9.1 Inter-departmental non-radiation monitoring

The control and operational non-radiation monitoring performed in 2012 by EEA/ RL- Vratsa and RL- Montana at the monitoring stations of NSEM has found that all tested surface water indicators comply with its design category with the exception of the "nitrite nitrogen". For the water of Skat River in the point after the town of Byala Slatina is maintained the trend from previous years for continuous exceeding of concentration admissible limit values /MAC/ for "nitrite nitrogen"**.** The maximum recorded value of 0.410mg/dm^3 was in July at a rate of 0.06 mg/dm^3 for this indicator for III-category water body such as river. The above-the-standard levels of "nitrite nitrogen" in Skat River after the town of Byala Slatina are mainly due to the discharge of untreated wastewater from urban sewerage of the town of Byala Slatina. For all other tested indicators the river in this section complies with its category. At the point on the Skat Rver after the town of Mizia there is not a single exceeding of the "nitrite nitrogen" registered.

All specific parameters tested are less than the quantification limit of the method.

From the control monitoring performed in 2012, for the point at the river-mouth of Ogosta River, there are no indicators that do not meet the category of water body. For many of the studied indicators established concentrations correspond to a higher category.

In 2012 control monitoring was performed of the dams, "Asparouhov val", "Barzina" and "Tri kladentsi." No excedence of tested indicators was found.

Laboratory control of the DanubeRiver water is performed every two months at the point of NSEM, in the territory of RIEW-Vratsa at the town of Oryahovo. Tested indicators are within permissible concentrations and the river meets its intended category in all tested parameters.

There is a steady trend of improvement in the quality of surface water in the region in terms of BOD_5 and dissolved oxygen.

- ✓ **Information from non-radiation monitoring of surface water intended for drinking and domestic water supply by RL-Montana in the 100 km. zone of Kozloduy NPP .**

In connection with the implementation of the requirements of Regulation № 2/2002 on the quality requirements for surface water intended for drinking and domestic water supply, BDWMDR and the authorities Ministry of Health have defined jointly the categories that are met by surface water catchments in the region. 29 water catchments have been identified, of which 10 are of category A-1 (highest) and the rest are of category of A-2. According to specific monitoring programs for these water sources, RL performs sampling and testing of 27 physicochemical parameters, organochlorine and nitrogen-containing pesticides and polycyclic aromatic hydrocarbons (PAH). All catchments are tested monthly for water quality. The largest source of drinking water in the region is dam "Srechenska bara" with code BG1OG00744MS041D2, according to the RBMP of the Danube basin water management. From this source of category of A-2 (need for mechanical and chemical water treatment and disinfection, i.e. the presence of a drinking water treatment plant (DWTP))

samples are taken monthly from two levels: surface sample and a sample from 5 m depth. Water quality in all tested indicators meets the defined category. There is no data on pollution caused by the operation of the NPP. For the radiological indicators of water for drinking purposes apply the requirements of Regulation № 9/2001, which defines the health authorities controlled parameters such as total beta activity – 1Bq/l, tritium – 100Bq/l, alpha activity – 0.5Bq/l, natural uranium – 0.03mg/l.

✓ **Data from EEA on biological monitoring of rivers Ogosta, Skat and Tsibritsa for the period 2010 to 2012**

TABLE 9.2-2: HYDROBIOLOGICAL MONITORING BY NSEM OF RIVERS OGOSTA, SKAT AND TSIBRITSA FOR THE PERIOD 2010-2012

River basin	Point	Value BI-2010	Value BI -2012	Value BI-2012	BI based assessment of ecological status
Ogosta	v. Kobilyak	3-4	3-4	3-4	good
Ogosta	After town of Montana	2-3	3	3	Moderate
Ogosta	Town of Montana after dam Ogosta	3	3	3-4	Moderately good
Ogosta	v. Gorno Tserovene before dam Ogosta	3	3	3-4	Moderately good
Ogosta	Skat River after town of Miziya	2-3	2-3	3	Moderate
Ogosta	Skat River after town of Byala Slatina	3-4	3	3	moderate
Ogosta	Skat River at v. G. Peshtene	3-4	3-4	3-4	good
Rivers west of Ogosta	Tsibritsa River before Razgrad; since 2012 – before v. Dolni Tsibar	4	3-4	3	good
Rivers west of Ogosta	Tsibritsa River at v. Yakimovo	3-4	3-4	3-4	good

Source: EEA

Analysis data was obtained with the BI (biotic index) methodology according to Order № РД 591/26.07.2012. The assessment is based on the same order and on macrozoobenthos as biological quality element.

9.2.1.10 INTER-DEPARTMENTAL RADIATION MONITORING

The radiological monitoring consists of continuous and periodic monitoring of the following indicators:

- → Background gamma radiation;
- → Atmospheric radioactivity;
- → Content of technogenic radionuclides in non-arable topsoil;
- → Radiological indicators in surface water in the 30km surveillance zone around Kozloduy NPP and treated water discharges from the plant;

→ Content of technogenic radionuclides in sediments.

9.2.1.10.1 Continuous measurements of background gamma radiation

Background radiation data is obtained in real time from local monitoring stations of the National automated system for continuous monitoring of background gamma radiation.

Data from the Unified National System for Radiation Monitoring of gama-background (UNSRM) at the Ministry of Environment and Water (MEW) is presented in **Figure 9.2-11**.

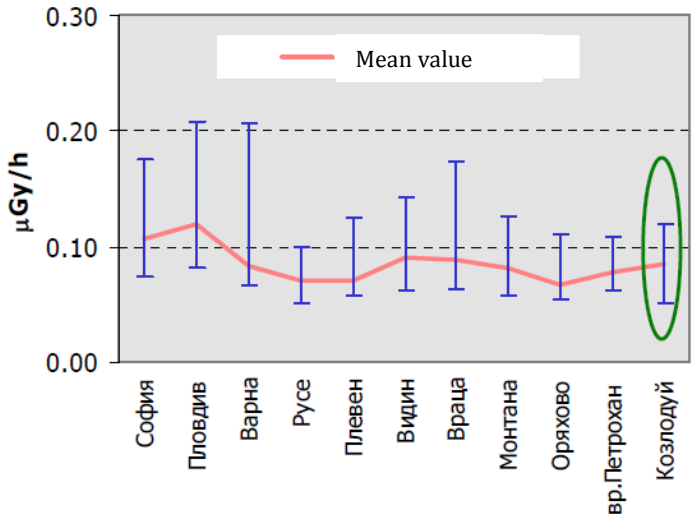


FIGURE 9.2-11: BACKGROUND GAMMA RADIATION IN LARGER CITIES AND TOWNS IN THE COUNTRY, 2012 /UNSRM-MEW/, μGY/H

The system has integrated 8 automatic stations from the external dosimetric control of Kozloduy NPP , located within 1.8 km radius from the plant, thus ensuring continuous monitoring of the background radiation levels in the region.
Monitoring of stations within the 30 km zone: Hayredin, Valchedram, Oryahovo and within the 100 km zone of Vratsa, Montana and Knezha, shows that the average monthly values of the dose rate in 2009 ranged from 67 nGy/h (Oryahovo) to 99 nGy/h (Vratsa) and did not exceed the background levels typical for the respective points.

In order to monitor the presence of radionuclides in the air (mBq/m3) in 2012 were taken 25 aerosol filters from the fixed station in Vratsa. The results of the records[1] are shown in **Figure 9.2-12**.

[1] Records from testing aerosol filters in 2012 – RIEW-Vratsa

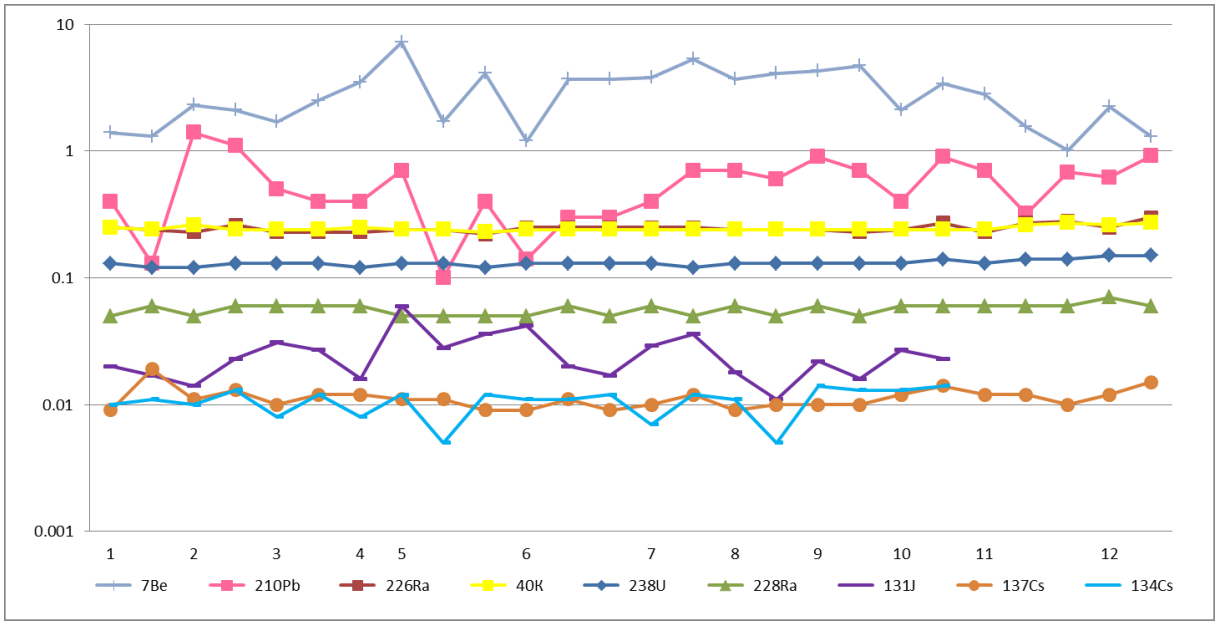


FIGURE 9.2-12: ATMOSPHERIC ACTIVITY IN MBQ/M³, POINT IN TOWN OF VRATSA, 2012

The radiation situation in the region is stable and unchanged by the operation of Kozloduy NPP .

9.2.1.10.2 Determining the atmospheric radioactivity

MEW measures twice a month aerosol samples (volume> 900 m³), obtained by way of automatic sampling in Vratsa and Montana to analyse the volume specific radioactivity of long-lived radionuclides (LLA).

The analysis of data from automatic stations **has not found** above-background values of measured radionuclides typical of the surface air in this geographical area, and the data for technogenic ^{137}Cs is within the range of MDA. No presence of other technogenic radionuclides has been found.

The Executive Environment Agency receives monthly reports of ongoing institutional monitoring of gaseous and aerosol releases in the environment from Kozloduy NPP .

9.2.1.11 INTER-DEPARTMENTAL RADIOECOLOGICAL MONITORING

The inter-departmental radioecological monitoring of MEW monitors the radiological parameters in the water of the following rivers: Danube, Osam, Iskar, Leva, Ogosta, Timok, Tsibritsa flowing within the 100 km zone of the plant.

In 2012, RL-Vratsa performed control measurements of surface water in the region of NPP in five points:

- new channel "Valyata" – Main Draining Channel;
- old channel "Valyata" – not in use;
- intake channel from Danube River;
- Danube River at the town of Kozloduy – port;
- Danube River at the town of Oryahovo – port.

During the year were performed 57 samplings for total beta activity of water in the respective points. The results thereof are presented in **Table 9.2-3**.

TABLE 9.2-3: TOTAL BETA ACTIVITY –SURFACE WATER IN 2012 OF KOZLODUY NPP, BQ/L

№	Point	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1=	New channel "Valyata"	0.082	-	0.088-0.089		0.103	0.094	0.059-0.054	0.126		0.163	0.092	0.095
2.	Old channel "Valyata"	0.11	-	0.094-0.104		0.114	0.182	0.035-0.045	0.143		0.165	0.088-0.126	0.086
3.	Intake channel	0.075	-	0.068-0.090		0.049	0.062	0.067-0.076	0.09		0.085	0.088-.096	0.082
4.	Danube river at Kozloduy	0.102	-	0.078-0.088		0.069	0.048	0.055-0.080	0.09		0.103	0.109	0.071
5.	Danube river at Oryahovo	0.091	-	0.095-0.086		0.050	0.073	0.059-0.125	0.071		0.077	0.096	0.084

Source: EEA – RL – Vratsa

In May and August / high water and low water / samples were taken also from Ogosta River before it flows into the Danube and the respective values for total beta activity were: 0.091 Bq/l and 0.104Bq/l.

The results show that the values of the sampled water are far below the permissible limit specified by law – 750Bq/l (according to Regulation 7/1986, repealed in SG, No. 22 of 03.05.2013).

During the year 7 samples for cesium-137 were taken. All the results were below the quantification limit of the method.

Control measurements of wastewater from Kozloduy NPP have been made during the year at the following points:

- → Units 5 and 6 clean zone;
- → Units 1÷4 of Kozloduy NPP;
- → Outlet channel.

During the year were performed 33 samplings in these points. The results thereof are presented in

Table 9.1-4.

TABLE 9.2-4: TOTAL BETA ACTIVITY – WASTEWATER IN 2012 OF NPP "KOZLIDUY", BQ/L

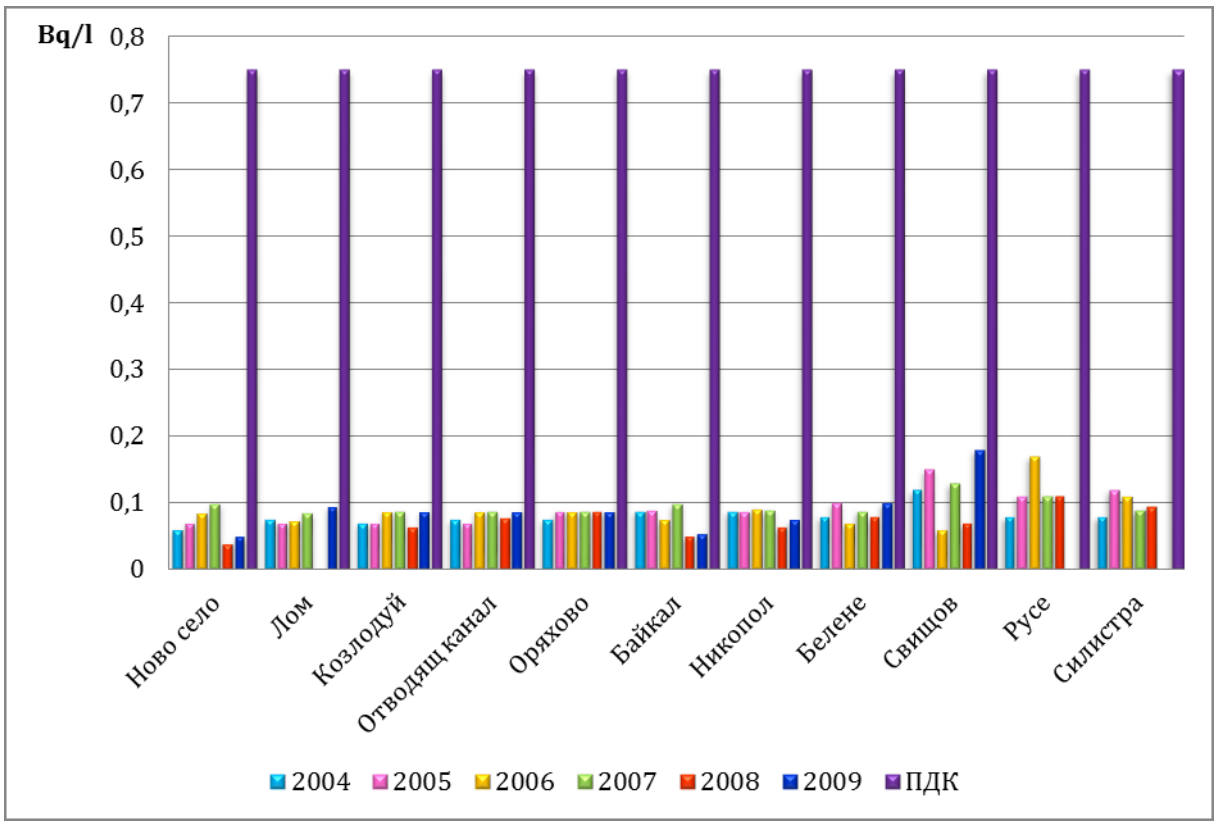
№	Point	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	Units 5-6 clean zone	0.076		0.065-0.099		0.067	0.073	0.072-0.154	0.074		0.103	0.086	0.114
2.	Unit 1-4	0.081		0.079-0.090		0.077	0.045	0.081-0.126	0.096		0.118	0.126	0.080
3.	Outlet channel	0.092		0.085-0.080		0.062	0.069	0.061-0.082	0.130		0.131	0.082	0.085

SOURCE: EEA-RL – VRATSA

The results show that the values of the sampled wastewater are far below the permissible by law – 750Bq/l, as well as below the newly set values for characterization of surface water in Regulation № H-4 (SG, No. 22/05.03.2013).

3 water samples for cesium-137 were taken. All the results were below the quantification limit of the method.

For comparison, in 2002, the radiological studies of RL-Vratsa performed in the above points, showed values for Danube River in the range of 0.044 ÷ 0.464Bq/l for total beta activity and in the points of the plant – 0.044 ÷ 0.165Bq/l at a standard of 0.750 Bq/l.
Data analysis for total beta activity of water from the Danube River (from Novo Selo to Silistra), compared with the results of the 'outlet' channel of Kozloduy NPP in the period 2004-2009 (**Figure 9.1-1)** showed values significantly below the limit permissible, specified in the regulations for the quality of surface water (0.750 Bq/l). This conclusion applies also to the other studied rivers in the region.



Source: EEA

FIGURE 9.2-13: *TOTAL BETA ACTIVITY OF THE DANUBE RIVER IN THE PERIOD 2004-2009, BQ/L*

Subject to monthly control are also the treated water discharges from units 5 and 6 – clean and radiologically controlled area, the treated water discharges from units 1÷4, water from the 'intake' and 'outlet' channels, water from the old channel "Valyata", the new channel "Valyata" and water from the Danube River, before and after the plant – at the ports of Kozloduy and Oryahovo.

The Executive Environment Agency receives monthly reports on the size and activities of treated water discharges as a result of the ongoing plant radiological monitoring.

Analysis results are commensurate with data reported in previous years and show no change in the radiological characteristics of the Danube River on Bulgarian territory, due to the activity of Kozloduy NPP .

9.2.1.11.1 Radiological monitoring of sediments

Specific activities of natural and technogenic radionuclides in sediments are identified every three months at outposts located along the Danube River – from Novo Selo to Silistra, including the 'outlet' channel of NPP – at the neighbourhood of "Batatovets." The measured values of the specific activity of the technogenic ^{137}Cs in these samples during the year varied from 0.46 Bq/kg (Baykal) to 12.3 Bq/kg (Oryahovo).

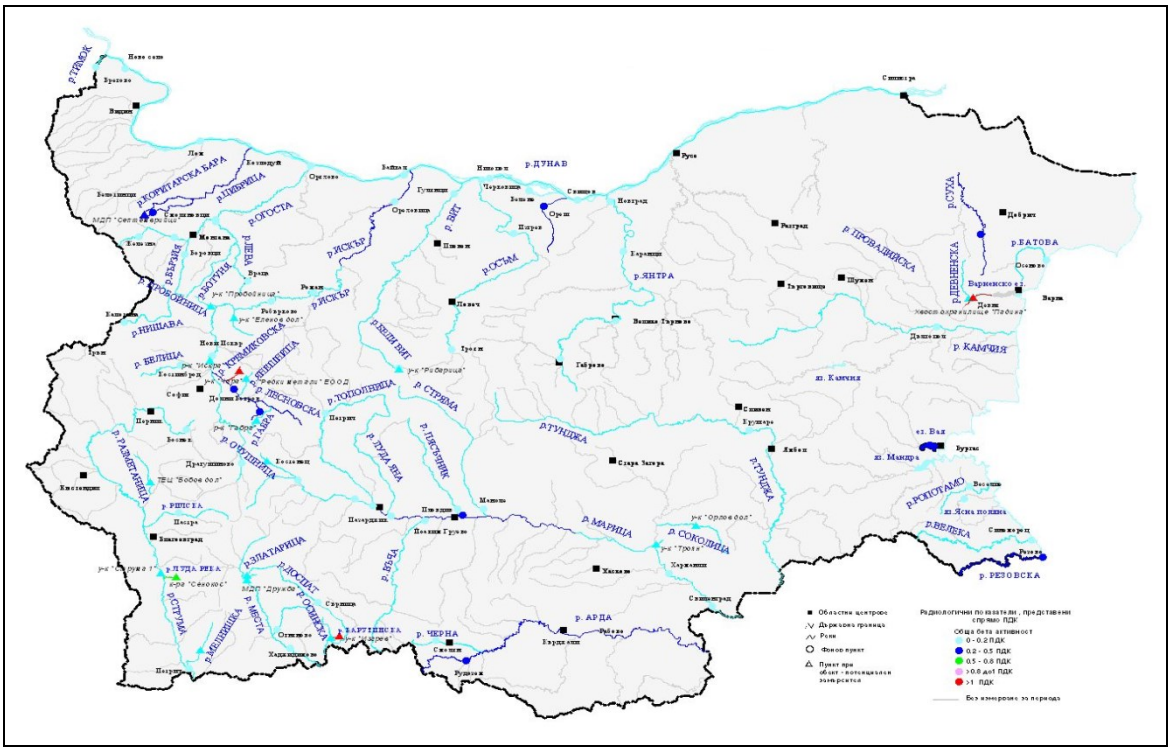
During the year there was no presence of other technogenic radionuclides in sediments.

Data for 2009, compared with the radiological monitoring outcomes from previous years, showed no adverse trends in the radiation and ecological status of the environment resulting from the nuclear plant operation.

In 2010, systematic monitoring of the radiation situation was performed in 84 points in the basins of major rivers and other water bodies in the country and in 8 points along the Danube River.

Data analysis for total beta activity of water in the Danube Rriver and other major rivers, dams and lakes found values significantly below the maximum permissible concentration (MAC) (Regulation № 7/1986 on the indicators and standards for determining the quality of running surface water MAC-0.75 Bq/l).

The trend shows that radiological indicators, as compared to those in previous years, have preserved their values typical of the particular monitoring post in the country. This is indicative of the lack of contamination of this environmental component.



Source: EEA

FIGURE 9.2-14:*TOTAL BETA ACTIVITY OF SURFACE WATER FOR 2011., BQ/L*

Analysis results are commensurate with data reported for previous years and show no change in the radiological characteristics of the Danube River on Bulgarian territory due to the operation of Kozloduy NPP.

In 2010, no presence of other technogenic radionuclides in sediments was observed.

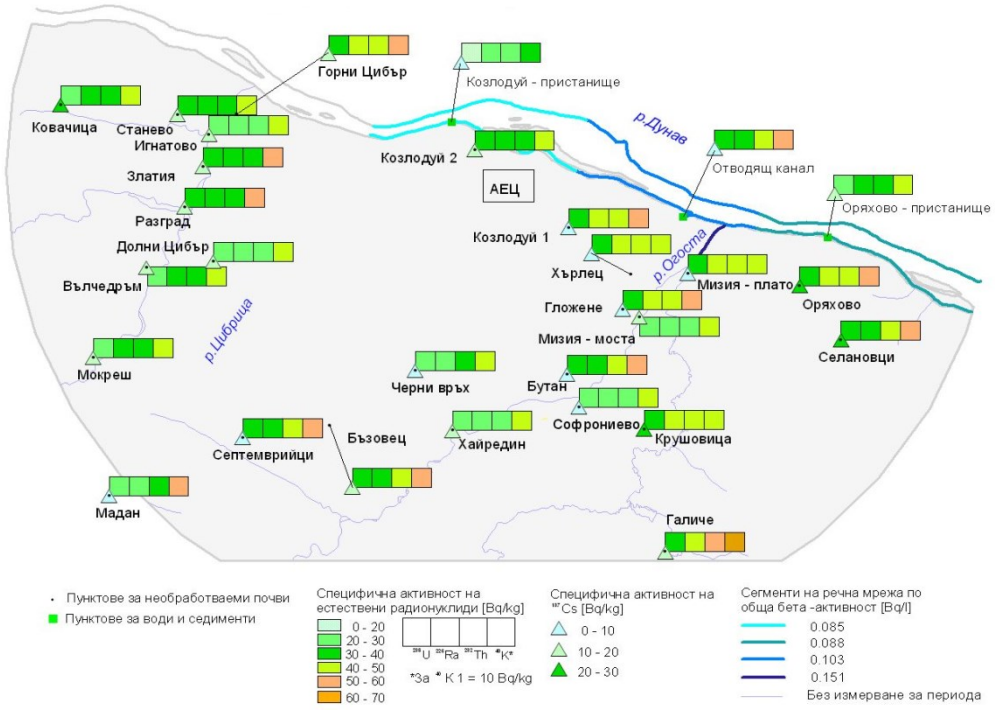
In 2011 systematic monitoring of the radiation situation was performed in 80 points in the basins of major rivers and other water bodies in the country and in 9 points along the Danube River.

Data analysis for total beta activity of water in the Danube River and other major rivers, dams and lakes found values significantly below the maximum permissible concentration (MAC) (Regulation № 7/1986 on the indicators and standards for determining the quality of running surface water MAC-0.75 Bq/l) for points located outside areas of potential pollutants.

Data on radiological parameters of surface water is obtained as a result of the radiological monitoring performed by the EEA in 2011 and is presented in **Figure 9.2-15**.

The trend shows that radiological indicators, as compared to those in previous years, have preserved their values typical of the particular monitoring post in the country.

As a result of the analysis f samples of environmental components in the 30-km zone of Kozloduy NPP performed by the laboratories for radiation measurements of EEA (RL-Vratsa and RL-Montana) the overall radiological status of the environment in this region could be monitored. (**Figure 9.2-15)**.



Source: EEA

FIGURE 9.2-15: RADIOLOGICAL STATUS OF THE ENVIRONMENT IN THE 30 KM SURVEILLANCE ZONE OF KOZLODUY NPP FOR 2011

In addition to the results from the laboratory analyses, EEA has information from the continuous radiological monitoring of the Danube River near the port of Kozloduy and port of Oriahovo since it administers an Automated system for radiation monitoring of water – Danube River in the region of Kozloduy NPP (AISRM). It consists of two local monitoring stations based before and after "hot" channel of the plant. The stations carry out continuous sampling from the river and perform radiological analysis to detect the presence of gamma-emitting radionuclides. In the event of radioactive contamination of the Danube River, system allows to determine definitively whether the source is Kozloduy NPP.

In 2011, AISRM did not report increased levels of technogenic radionuclides cesium-137 and iodine-131.

All available data compared to results from previous years show no adverse trends in the radiological situation and ecological status of the environment resulting from the operation of the nuclear power plant.

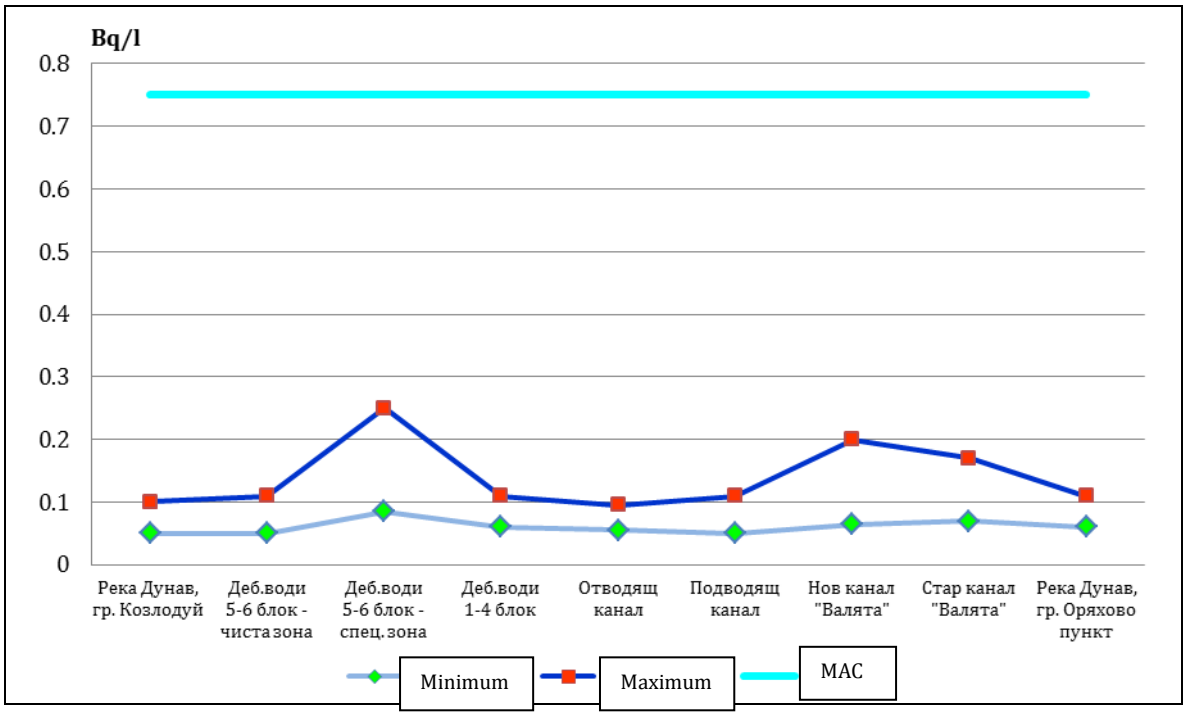
9.2.1.11.2 Radioactive gaseous and aerosol releases.

To assess the impact of gaseous and aerosol releases, objects of the terrestrial ecosystems and the inland river ecosystem in the region of Kozloduy NPP are monitored. For the whole period of observation no noticeable qualitative changes in the radioecological status have been recorded as a result of gaseous and aerosol radioactive releases from the plant. Technogenic radioactivity of environmental objects is due to the presence of ^{90}Sr and ^{137}Cs

at concentrations typical of the natural background due to global atmospheric deposition and contamination of the environment as a result of the Chernobyl accident.

9.2.1.11.3 Liquid radioactive releases.

All the observed deviations from the normal radiation status have been negligible in absolute terms and an upward trend was not reported. In 2010, was not registered any presence of technogenic radionuclides of reactor origin – **Figure 9.2-16**.



Source: EEA

FIGURE 9.2-16: TOTAL BETA ACTIVITY OF TREATED WATER DISCHARGES FROM KOZLODUY NPP FOR 2010, BQ/L

9.2.1.12 PERFORMANCE OF STATE HEALTH MONITORING

The Ministry of Health, through the National Centre of Radiobiology and Radiation Protection (NCRRP) performs state health monitoring for compliance with the requirements for protection of individuals from the effects of ionizing radiation throughout the country in relation to nuclear power plants, nuclear research facilities, facilities for radioactive waste management and sites of former uranium mining. One of the main activities of NCRRP is to monitor and assess radiation and the radiation risk to the population as a whole or to parts of it.

9.2.1.12.1 Assessment of the annual effective dose of exposure over the background of the population due to the operation of "Kozloduy NPP" EAD[2]

Radioactive gaseous and aerosol releases

To assess the impact of gaseous and aerosol releases, objects of the terrestrial ecosystems and the inland river ecosystem in the region of Kozloduy NPP are monitored. For the whole period of observation no noticeable qualitative changes in the radioecological status have been recorded as a result of gaseous and aerosol radioactive releases from the plant. Technogenic radioactivity of environmental objects is due to the presence of ^{90}Sr and ^{137}Cs at concentrations typical of the natural background due to global atmospheric deposition and contamination of the environment as a result of the Chernobyl accident.

Liquid radioactive releases

All the observed deviations from the normal radiation status have been negligible in absolute terms and an upward trend was not reported. In 2011, was not registered any presence of technogenic radionuclides of reactor origin.

The additional exposure over the background of the population caused by liquid radioactive releases from NPP "Kozliduy" is assessed based on the monitoring results by using an approved by IAEA model for dose assessment for screening purposes (*Generic Models for use in Assessing the Impact of Discharges of Radioactive Substances to the Environment*. Safety Reports Series No.19. International Atomic Energy Agency, Vienna; 2001). The model provides a conservative estimate of annual individual dose for a hypothetical critical group of the population that is constantly living the vicinity of the discharge of liquid effluents into surface water of a freshwater basin (river) and uses only agricultural products of local origin.

The assessment of additional exposure over the background of the population for 2011 shows that the screening annual individual effective dose does not exceed a few microsieverts.

9.3 RECOMMENDATIONS FOR NON-RADIATION AND RADIATION MONITORING AFTER THE CONSTRUCTION OF NNU

Kozloduy NPP has successfully implemented and functioning: internal non-radiation monitoring, radioecological monitoring and supervisory institutional environmental monitoring. This established system serves as the basis for the development, expansion and improvement of the new Environmental Monitoring Programme for the NNU in all aspects, including monitoring for impact evaluation of the operation of NNU on population's health within the Urgent Protective Action Planning Zone and in the Surveillance Zone. This program should be in compliance both with the national legislation and European regulations, especially Art. 35 and Art. 36 of the EURATOM Treaty regarding

[2] National Report on the State and Protection of the Environment in the Republic of Bulgaria, 2013.

the monitoring of the level of radioactivity in the air, water and soil, for the purpose of assessing the exposure dose to the population, regulated by the Recommendation of the European Commission 2000/473/Euratom, 08.06.2000. This recommendation is of fundamental importance for the standardization and unification of the practices applied in the area of radioecological monitoring of the EU member-states. It defines the concepts and general requirements regarding the types of monitoring, monitoring networks and samples (dense and diluted), frequency of control, monitoring volume and sampling requirements and analyses of the primary controlled sites of the environment. It also defines the volume of the information accompanying the sample, as well as monitoring data management and transfer.

The structure of the described in detail and analysed existing monitoring system must be updated and optimized to include all the new posts from the site of the new unit for all the aspects of the environment at which they will be measured and from which updated information on the status of the monitored parameters the will submitted for the management of NNU, to the competent authorities and to the general public.

Protection of the environment by restricting, reduction and prevention of harmful emissions from the operation of NNU by the introduction of advanced technologies and facilities is a priority activity of the Client.

Applying a clear policy to protect the environment and human health the monitoring programme should reflect the following:

- ✓ Continuously reducing environmental impact;
- ✓ Reducing to minimal the effects of harmful emissions from the operation of NNU in the periods of construction, operation, decommissioning of the NNU and the occurrence of potential emergency situations;
- ✓ Selection of equipment and technology in line with European standards and ensuring complete safety in terms of radiation effects in the short and long term;
- ✓ Conducting internal monitoring of gasemissions, water, waste and the quality of the working environment in accordance with the regulatory framework;
- ✓ Reducing the use of natural resources;
- ✓ The most efficient use of available raw materials in the region related to the activity of NNU (use of excess land masses, building materials, etc..);
- ✓ Preventing and reducing to "zero risk" the possibility of emergency situations;
- ✓ European standards in the management of environmental components as a result of the analysis of the performed monitoring;
- ✓ To offer risk assessment and management for protection of the environment and human health;
- ✓ Adherence to the strictly specified responsibilities, instructions and control over the implementation of the monitoring programme in all phases of implementation;
- ✓ Ecological status in the region;
- ✓ Compliance with the requirements of the permits;
- ✓ Keeping and maintaining all the compulsory documentation for the performed monitoring;

- ✓ Setting up a database that could serve as a basis for decision making to ensure high quality working and natural environment;
- ✓ To implement leading practices and methodologies in the course of monitoring.

The monitoring programme should facilitate good management practices and support the reporting that is carried out in accordance with national and European legislation for such facilities.

Monitoring before the operation of NNU, performed by Kozloduy NPP provides the baseline to identify any additional changes to the environment that may be associated with releases from new facility.

Monitoring during operation and after decommissioning of the facility is intended to show that the actual measurements in the environment do not invalidate the assumptions and projections of the safety assessment.

9.3.1 RADIATION MONITORING

Regulation of the institutional environmental radiation monitoring should be in accordance with a long-term programme for the NNU, which should be integrated in the currently existing one of Kozloduy NPP for radiation monitoring of the environment. The programme has to be coordinated with the Ministry of Environment and Water (MEW), Ministry of Health (MoH) and the Nuclear Regulatory Agency (NRA) and should fully comply with the recommendations in national legislation, in particular with the Regulation on basic norms for radiation protection (BNRP-2012).

The long-term radiation monitoring programme should be developed taking into account the operational experience of Kozloduy NPP , best practices of other countries operating nuclear power plants and the documents of the International Atomic Energy Agency.

A recommendation for the long-term environmental radiation monitoring programme of the NNU is to provide measurement of the parameters characterizing the radiation status of the new unit and the environment, such as:

- - gamma radiation dose rate and annual dose in the protected zone and the surveillance zone;
- - concentration of radioactive aerosols (including radioactive iodine) in the ground layer of the atmosphere;
- - density of radioactive deposition from the atmosphere;
- -radioactivity of water basins (surface water bodies, hydrobiotes and sediments);
- -radioactivity of soil, vegetation and snow;
- -radioactivity of agricultural production;
- -radioactivity of domestic waste water;
- -liquid radioactive waste /discharged wastewater/.

In structural terms, the external radiation monitoring system of NNU fits into the existing system of Kozloduy NPP .

The auutomated information system for external radiation control, built in the surveillance zone and in the precautionary protective action planning zone for the existing plant will serve also the NNU.

The Central Laboratory for external radiation control will serve the new facility. However, sufficient capacity has to be envisaged in order to take on the testing and analytical activities associated with the NNU. Control posts and points for sample collecting for radiation monitoring of the environment in the area with a radius of 30 km from the Kozloduy NPP site will serve also the new nuclear unit.

In developing the environmental radiation monitoring programme, the main objective is to reflect the trends in the field of radiation monitoring of the environment in terms of increased safety requirements and increased technical capabilities of modern test laboratories.

The program should describe the frequency of sampling and the type of measurements, the measuring time and the minimum detectable activity, the update of these activities should be reasoned with a view to the NNU.

The system for automated external radiation monitoring of the environment has functional options for continuous remote monitoring of the radiation situation in the protected zone in normal and emergency operating conditions of the power unit.

During normal operation, the system must allow for continuous automatic measurement of gamma background and content of ^{131}I in the air in the area around the Kozloduy NPP and NNU.

It is advisable to continue to perform meteorological observations in region of Kozloduy NPP and NNU by means of a meteorological monitoring system, using a representative for the landscape set locations and monitoring, as follows:

- speed and wind direction a height of 10 m;

- air temperature;

- quantity and intensity of precipitation;

- relative air humidity;

- atmospheric pressure;

- standard deviation of wind direction a height of 10 m;

- identification of stability class by Pasquill.

The data obtained from weather stations are input for the preparation of model forecasts in thirty-kilometer zone around the NPP.

The Radiation and meteorological measurements programme in case of radiation accident in NNU and Kozloduy NPP should define the organization and procedures for effective radiation and meteorological monitoring within the designated emergency planning zones.

The programme should contain the volume of measurements, the methods used and technical equipment. It should describe emergency equipment and personal protective equipment with a view to the expansion with the NNU. The routes and sampling network for field measurements should be defined as well as distribution of responsibilities among the various units, established by the National Emergency Plan in order to enable elaboration of analysis and expert opinion.

The programme should define the sites and scope of monitoring on the premises, at the plant site and beyond, as well as the necessary resources – technical equipment, support staff, emergency staff, documentation, information exchange, etc.

The system for automated external radiation environmental monitoring of Kozloduy NPP and NNU should include also the necessary measurements for non-radiation environmental monitoring, given the experience of Kozloduy NPP and the regulatory framework.

9.3.2 NON-RADIATION MONITORING

9.3.2.1 MONITORING OF SURFACE WATER

Surface water monitoring should be obligatory in order to obtain sufficient information on the qualitative and quantitative status of water in accordance with the requirements of Regulation № 1/2011 on water monitoring (SG, No. 34/29.04.2011, amended and supplemented SG, No. 22/ 05.03.2013). The objective of the non-radiation monitoring of surface water is to maintain compliance with regulatory requirements and with the terms and conditions in the permits, which will be issued to NNU.

These recommendations to the surface water monitoring programme with regard of this IP for NNU are only indicative and should be developed in details in the next phase of design.

The program should cover all stages (design, construction, operation, decommissioning) and all types of monitoring.

“Kozloduy NPP” EAD has adopted successfully implements regular and mandatory in-house non-radiation monitoring of wastewater in accordance with the terms and conditions of the permit for discharge into individual sewerage collectors, in the points of discharge into the Main drainage channel, as well as in HC-1 and HC-2 at the points of discharge into the Danube River. This could serve as a basis for development of the programme for NNU. According to currently implemented programme for own non-radiation monitoring, 20 indicators of the quality of wastewater discharged from the plant are controlled for compliance with the individual emission limits, specified in the permits issued by River Basin Directorate.

The mandatory in-house monitoring of non-radiation contaminated wastewater at NNU will also include measurement of the quantities and concentrations of pollutants for which individual emission limits will be set in Permits for discharge into surface water body at NNU.

The existing permits for water intake and use of water body for discharge, issued under the Water Act, will be amended by decision of the competent authority, if in the implementation and operation of the IP all parameters and conditions set therein can not be observed. The ban on new discharges of wastewater into irrigation and drainage systems will be taken into account – Article 6, para 1, items 3, 4. of Regulation № 2 of 08.06.2011 on issuing permits for discharge of wastewater into water bodies and setting individual emission limits for point source pollution.

Monitoring of NNU will be an integral part of the overall monitoring of the Kozloduy NPP and will be coordinated with the ongoing environmental monitoring of the plant.

The internal monitoring, which is currently being implemented in NPP will continue to be implemented in the future after putting into operation of the new unit but will be supplemented and extended to monitor compliance with the conditions and requirements that the competent authority will set for the NNU with regard to individual emission limits, the measures to improve the condition of water bodies prescribed in the river basin management plans, and the amendments to legislation.

A non-radiation monitoring programe for monitoring in the operation period and during decommissioning must be annually prepared and approved by the management.

Sampling and testing of the analysed water samples should be performed by an accredited laboratory.

Surveillance monitoring of all points of discharge of wastewater in the region of NNU and Kozloduy NPP will be performed by the authorities of the MEW/EEA-RL-Vratsa.

Sampling points

The following points should be subject to monitoring of wastewater as a result of the NNU operation:

- ✓ -at the inlet of domestic wastewater treatment plant from 'clean' zone;
- ✓ - at the inlet of domestic wastewater treatment plant from 'controlled' zone;
- ✓ -at the outlet of domestic wastewater treatment plant from 'clean' zone;
- ✓ - at the outlet of domestic wastewater treatment plant from 'controlled' zone;
- ✓ - dosimetric control of the two streams prior to flowing into the sewerage collector for discharge;
- ✓ -at the outlet of neutralization pit for water from Chemical Water Cleanup Facility;
- ✓ -at the outlet of oil and petroleum products separation facilities, including dosimetric control;
- ✓ -at the outlet of buffer rainwater retaining tank;
- ✓ -at the outlet of HC-1 prior to discharge into Danube River.

Sampling frequency

To control the pollution releases with wastewater from the NNU in the monitoring points, it is recommended to conduct sampling with frequencies given in **Table 9.3-1**.

TABLE 9.3-1: RECOMMENDED SAMPLING FREQUENCY

№	Indicator	Frequency
1.	Active reaction	1 month
2.	Total β-activity	1 month
3.	Insoluble substances	1 month
4.	BOD_5	1 month
5.	COD (bichromatic)	1 month
6.	Total phosphorus (PO4)	1 month
7.	Chlorine ions	1 month
8.	Petroleum products	1 month
9.	Total nitrogen	1 month
10.	Detergents	1 month
11.	Extractable substances	3 months
12.	Sulfate ions	3 months
13.	Zinc	1 month
14.	Boron	1 month
15.	Cobalt	1 month
16.	Manganese (total)	1 month
17.	Nickel	1 month
18.	Iron (total)	1 month
19.	Tritium	3 months
20	Quantities of individual flows	1 month
21.	Water quantity prior to flowing in HC-1	1 month

Indicators that will be tested and the frequency of sampling will be determined by the updated discharge permit under the Water Act.

To control the proper operation of the domestic wastewater treatment facility, it is necessary to have daily monitoring at the outlets of the two wastewater treatment plants – for 'clean' area and 'controlled' zone. Further monitoring of the parameter sludge volume should be performed for domestic wastewater with daily monitoring frequency. The results should be kept in monitoring logs/ journals.

For characterisation of surface water, since 03.05.2013 has been enacted Regulation H-4 14.09.2012 (SG. 22 of 5 March 2013), which provides for the procedure and methods for characterization, classification and presentation of status/potential of surface water bodies, determination of anthropogenic pressure on them, while by the monitoring system the ecological status/ ecological potential is assessed and chemical status is classified based on certain quality standards for physical and chemical elements of specific pollutants, chemical and other substances and in combination with biological and hydro morphological quality elements is determined the ecological status of each water body.

Internal monitoring should start already during construction.

The parameters to be analyzed in future monitoring of the NNU should be in accordance with the requirements of Regulation H-4.

Monitoring before putting into operation provides baseline levels for determination of any subsequent changes in the environment that may be associated with releases from NNU.

Monitoring during operation, decommissioning and after completing the decommissioning processes is intended to show the actual impact of NNU on surface water.

Wastewater monitoring is carried out by the operator in all phases of the NNU implementation and also in case of emergency.

Annual monitoring reports should be drawn for the internal non-radiation monitoring performed in accordance with the approved annual programme.

Summarised reports for the monitoring should be sent periodically and annually in Basin Directorate of Water Management in the Danube Region (BDWMDR), while and control over the observance of individual emission limits will be performed by RIEW Vratsa, as required by the Water Act.

The annual reports are submitted to EEA and RIEW-Vratsa, together with the reports of Kozloduy NPP for currently operating units.

The in-house control should be performed as until now through regular internal patrols and inspections. Institutional control of non-radiation monitoring is carried out during the year by the authorities of the MEW, Danube River Basin Directorate and the RIEW-Vratsa.

In the new Regulation № H-4, which is in force of 05.03.2013, the Danube River is designated as a Type-R6 in the Danube sub-ER/sub-eco-region/. For this type of river in the Annexes to the Regulation are not listed either physico-chemical quality elements or biological elements, which are to be supplemented. If the table of Annex № 6 for physicochemical quality elements for river Type R7- major Danube tributaries and lowland type is applied, it is obvious that indicators of water quality in the river (based on the data provided by BDWMDR) range between "good" and "very good." As noted in section 3.2.1 of the Danube River Basin Management Plan in Bulgaria /DRBMP 2010-2015/, based on the available information and expert assessment, the river is designated as heavily modified water body with moderate ecological status and poor chemical status. According to the measures laid down in this plan, in the next planning period – by 2021 – the river water should have a good ecological potential and good chemical status.

For the correct assessment of pollution from NPP and NNU and more accurate assessment of water quality in the river, it is recommended that monitoring points should be set on the Danube prior to wastewater discharge from Kozloduy NPP and NNU therein, as well as after discharge of HC-1. At these points at least once a month should be measured water quantities and physico-chemical and biological elements that characterize the water status in the river.

9.3.2.2 HYDROGEOLOGICAL MONITORING

In the investment proposal the issue of radiation and non-radiation monitoring of groundwater at the site and in the area of NNU is not developed

In the next phase of design it is necessary to propose specially designed programme for organization of internal monitoring, which should include monitoring points that need to be built around the new facilities and buildings and setting general physical and chemical indicators and related to radiation status of groundwater. This monitoring should build upon the experience of existing non-radiation and radiation monitoring of Kozloduy NPP , expanding the scope of the studied indicators and add the following information:

1. The monitoring reports should have attached adequate topographic maps showing the locations of all monitoring points revealing groundwater in the NNU territory and outside the industrial site and ground plan with mapped locations of the monitoring stations for surface water. The symbols used in the presented map material should indicate the type of monitoring point, its depth, elevation of the mouth and static water level, as well as which groundwater body it refers to.
2. To non-radiation and radiation monitoring in the respective point should be attached hydrodynamic maps (maps with isobar lines of the static water levels at the relevant period), drawn on geological and/or suitable topographic base, interpolated by seasonal measurements of water levels for the respective water body;
3. To non-radiation and radiation monitoring in the respective point should be attached hydrochemical maps, drawn on geological and/or suitable topographic base, interpolated by isobar lines of the tested components for the respective water body. The symbols should indicate the types of measurements made and provide a clear visualization of the measured values exceeding the standard, and which period they refer to;
4. To draw up a summary report containing the details of the structure, lithological variations and depth of all monitoring points revealing groundwater, and the water body they refer to. The same report should contain a summary analysis of the performed field measurements of the water levels and hydrochemical results for each point;
5. The annual reports for non-radiation and radiation monitoring in the respective point should contain processed and graphically visualized summarized data from all previous years on the performed hydrochemical and radiological analyses of surface and groundwater compared to data from the recent tests. The information presented should clearly indicate the trend of variation at the monitored point and which period is concerned.
6. Within the implementation of the institutional radiation monitoring in NNU, as well as in Kozloduy NPP, at least once a year should be performed monitoring of radiological indicators – total alpha activity, natural uranium, total beta activity and total indicative dose according to the following regulatory documents:

- ✓ Groundwater quality standards in accordance with Annex № 1 to Art. 10, para. 2, item 1 and Appendix № 3 to § 6, para. 1, REGULATION № 1 of October 10, 2007 on exploration, use and protection of groundwater, effective from 30.10.2007. (promulgated SG, No. 87 of October 30, 2007, amend. SG, No. 2 of January 8, 2010, amended and supplemented SG, No. 15 of February 21, 2012);
- ✓ REGULATION № 1 of 11.04.2011 on Water Monitoring issued by the Minister of Environment and Water, promulgated, SG, No. 34 of 29.04.2011, effective from 29.04.2011;
- ✓ Annex № 1 to Art. 3, para. 2, item 2 and Table D – Radiological indicators; Regulation № 9 of 16.03.2001 on the quality of water intended for drinking and domestic purposes, issued by the Minister of Health, Minister of Regional Development and Public Works and the Minister of Environment and Water, promulgated, SG, No. 30 of 28.03.2001, amended SG, No. 87 of 30.10.2007, effective from 30.10.2007, amended and supplemented SG, No. 1 of 4.01.2011, amended SG, No. 15 of 21.02.2012, effective from 21.02.2012.

Implementation of these recommendations will provide a clear and objective picture of the groundwater status at the new site of the NNU and at the existing NPP.

9.3.3 MONITORING OF SEISMICITY

In the monitoring program and action plan new monitoring points are not proposed in relation to seismic hazard.

The monitoring of local seismicity around existing nuclear capacities of Kozloduy NPP to the fullest extent meets the requirements of the IAEA and has been repeatedly approved by international inspections and verifications.

9.3.4 ENGINEERING AND GEOLOGICAL MONITORING

From geotechnical aspect, the safe operation of the NNU will be monitored by geodetic survey of yielding of the foundations of buildings and facilities therein.

Based on the experience accumulated in the survey of yielding as a result of the operation of power units 5 and 6, the following conclusions and recommendations are made:

- The experience through the years proves that the geodetic network including benchmarks at key points in the structures and in-depth benchmarks is properly designed and can be used for NNU;

→ The selected survey methodology is appropriate;

→ The surveying equipment used has high accuracy and allows to measure very small yieldings. The size of sinking decreases over time and reaches a few millimeters per year;

→ It is necessary to improve the quality of the measurements in relation to the NNU.

9.3.5 WASTE

In order to provide consistent and systematic information at the site and the proper and safe performance of all activities, for the implementation of strict control and effective management, for the support of the engineering security of the site and its impact on the environment, it is necessary to draw up a "Plan for internal monitoring", which should be updated on a regular basis.

- Management of waste generated at the sites of the NNU should be implemented under strict control in accordance with the Waste Management Act and the related regulations;
- All waste must be controlled and monthly record of the qualitative and quantitative characteristics should be kept in record books according to a provided template.

The objective of the internal monitoring of waste is:

- to collect all data on quantities, type and properties of the generated waste;
- data processing and analysis and maintenance of an information database;
- during the operation of the waste water treatment facility of NNU, the management of sludge deposited at the new LWWTP should be strictly controlled according to individual in-house ***Programme for sludge management in LWWTP*** and strict compliance with the requirements for subsequent treatment; logs/journals should be introduced for reporting of generated waste such as:

Sludge from WWTP. In accordance with schedule drawn up in advance to measure the quantity of sludge from WWTP, volume, moisture and organic content. Sludge should be tested periodically to collect the necessary information for the degree of compaction and dewatering in order to optimise the process and reduce the electrolyte used for its mechanical treatment. In order to control the processes of compaction and stabilization of sludge in WWTP, samples will be taken periodically for identification of:

- active sludge – quantity and humidity in %, organic matter in % – pH, total dry residue, COD, total organic carbon, total nitrogen, organic nitrogen, ammonium, total phosphorus, volatile fatty acids – in a specialized laboratory;
- determining the settled sludge volume and settled sludge index – periodically;
- collecting all data on the quantity, type and properties of the generated waste;
- data processing and analysis and maintenance of an information database.

Subject to in-house monitoring are solid matters retained the grid bars, sand in the sand filters and dewatered sludge.

The monitoring of waste from the grid bars and sand filters covers only measurement of their quantity before being hauled out of the WWTP's site.

For better management of this type of waste, a separate Plan for in-house monitoring of LWWTP and other local treatment facilities is proposed to be developed which will include also the waste generated as a result of their operation:

Oils and petroleum products treated in sludge and oil retainers.

Polluted wastewater is treated in sludge and oil retainers to the specified requirements and then is sent for reuse.

To measure regularly the quantity of the upper layer and its humidity (estimated humidity 80-85%) and to submit it to a licensed disposal company.

To determine the quantity of separated oil and petroleum products on annual basis.

To measure regularly the quantity of the separated sediment, to determine its humidity and content of extractable substances and to submit it to a licensed disposal company.

9.3.6 SOLID AND LIQUID RAW

Operational radioactive waste at Kozloduy NPP is stored at different sites in unprocessed, processed or conditioned form and options for their subsequent processing, release and/ or disposal are not limited.

The adopted since 2005 approach to the management of radioactive waste from the Kozloduy NPP aims to submit all currently generated RAW of 2-I and 2-II category to SE "RAW"for treatment and phased release of historically accumulated RAW. The implemented option for waste flows management is in compliance with the regulations for the safe management of radioactive waste, working with sources of ionizing radiation and radiation protection of staff, as well as with the requirements for environmental protection and with the terms of the licenses and permits issued to Kozloduy NPP and SE "RAW".

RAW management activities to be observed by NNU in accordance with the experience of Kozloduy NPP :

- ✓ In controlled zones to organize collection points for collecting waste according to the approved working documents, as well as points for pre-sorting of waste by radiometric and physical characteristics.
- ✓ Treatment and conditioning of liquid RAW should be performed in RAW treatment Plant where is a separate line – "Liquid RAW".
- ✓ To develop a programme for RAW management that describes and justifies the management activities of all generated RAW until their transfer to SE RAW or exemption from regulatory control.
- ✓ To keep records, control and archive of documentation of the RAW management and used equipment.
- ✓ To apply separate collection approach to RAW management, depending on their specific characteristics.
- ✓ to use the mechanisms for clearance of radioactive materials from regulatory control.
- ✓ to perform deactivation after "cost/benefit" analysis.

- ✓ to implement measures to minimize the amount of RAW subject to disposal in terms of volume and activity by the application of appropriate technologies for processing, temporary storage for radioactive decay, reducing the generation of RAW.

Packaging of solid RAW of 2-I and 2-II category to be differentiated depending on the radionuclide characteristics.

Types of transport containers for transportation of RAW:

- Transport containers for RAW – 2 m^3
- Metal containers for RAW – 6 m^3
- Biosecurity containers for RAW – 0.2 m^3
- Biosecurity containers for RAW – 2x0.2 m^3
- Reinforced concrete containers 5m^3 (gross weight ≤ 20 t) with fixed reinforced concrete lid
- Metal barrels 0.2 m^3

The management system (MS) is developed using the guidelines and recommendations given in "The Management System for Facilities and Activities. Safety Requirements" № GS-R-3:2006 of International Atomic Energy Agency (IAEA), Guidelines PP-8:2011 " Management System for Facilities and Activities" of NRA and SSR-2/2: 2011 "Safety of Nuclear Power Plants. Commissioning and Operation". The following standards of the International Organization for Standardization (ISO) are also taken into account: (ISO) BS EN ISO 9001:2008 "Quality Management Systems. Requirements ", BS EN ISO 14001:2004,"Environmental Management Systems", BS OHSAS 18001:2007,"Occupational Health and Safety Management System Standard" and № 13 – "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities" (INFCIRC 225 / Rev.5), etc.

With the deployment of MS was developed a new version of "Management System Handbook" put into effect at the end of 2012 and meeting all the requirements of the safety standard GS-R-3 and other applicable regulatory requirements and recommendations in the field of nuclear energy and industrial practices.

In MS are provided mechanisms for continuous inspection, evaluation and optimization of the MS requirements with options for:

- multilateral analysis of MS at the level of organisational structure, activities, resources, documents, information systems, etc..;
- centralized storage of data in a computer system that ensures uniformity and consistency of information;
- generation of a unified knowledge database on different aspects of the organisation;
- analysis, simulation and optimisation of processes in accordance with a number of parameters and generation of various reports.

For process description and management in Kozloduy NPP is used ARIS software for modeling, analysis and management of business processes.

The accumulated experience in the development of an integrated management system in Kozloduy NPP should be transferred to the new unit.

9.3.7 HAZARDOUS CHEMICAL SUBSTANCES

In subsequent phases of design guidelines should be drawn up for activities related to hazardous substances during construction and operation of NNU required at high risk potential: safety report, emergency plan of the site and/or individual sites, warehouses, etc., instructions for use of hazardous substances, etc.

It is necessary to conduct continuous control over the incoming and used quantities of hazardous substances.

Adherence to the requirements for handling/working with hazardous substances.

To perform an audit of the condition of storage areas and available volumes in accordance with prepared in advance, coordinated and approved schedule.

To keep records of the received and available non-radioactive hazardous substances.

9.3.8 BIODIVERSITY

9.3.8.1 MONITORING THE ECOLOGICAL STATUS OF WATER IN THE 30 KM ZONE OF KOZLODUY NPP

Leading community for the monitoring is macrozoobenthos (aquatic invertebrates). For monitoring purposes is used the general, non-specific trend toward reducing the number of species (or biodiversity) and the total quantity in conditions of anthropogenic impact. The sampling strategy for of aquatic invertebrates is consistent with the Regulation on characterization of surface water (Regulation H-4, promulgated, SG, No. 22, 2013[3]). Multi-habitat approach is applied (Chesmedjiev et al., 2011[4]), by taking relatively quantitative or quantitative samples (according to ISO 7828-1985 or ISO 9391: 1993).

The second major community for determining the ecological status is ichthyofauna (fish). For catches in inland rivers is used electric set (ENISO 14011: 2003). For the littoral of Danube River is used either electrical fishing net or seine, and at places of greater depth – electrical fishing from a boat and multi-mesh gillnets, based on the standards for stillwater basins (ENISO 14757).

Studies are accompanied by field data analysis: determination of qualitative and quantitative parameters of ichthyofauna as well as laboratory taxonomic analysis of aquatic invertebrates and applying basic cenotic, saprobic and biotic indices (according to Uzunov and Yaneva, 1999[5]; Varadinova, 2006[6]; Cheshmedzhiev and Varadinova, 2013[7]).

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[3]REGULATION H-4 of 14.09.2012 on Characterisation of surface water. Promulgated, SG, No. 22/ 5.03.2013.

[4]Cheshmedjiev S, R. Soufi, Y. Vidinova, V. Tyufekchieva, I. Yaneva, Y. Uzunov, E. Varadinova. Multi-habitat sampling method for benthic macroinvertebrate communities in different river types in Bulgaria - Water Research and Management, 2011, 3 (1):55-58 (Hard Copy) UDK: 582.26 (497.2), ISSN 2217-5547

[5]Узунов Й., И. Янева. 1999. В: Герасимов С., Д. Пеев, 1999. Национална програма за биомониторинг на България. Изд. Геалибрис, София. 150 – 158 стр. [National Biomonitoring Programme for Bulgaria]

9.3.8.2 MONITORING FREQUENCY

The dynamics of the composition and structure of aquatic invertebrates is largely determined by seasonal changes and biological cycles of some species and therefore is recommended twofold tests: in spring at high water, and in summer and fall – at low water (Roussev and Ianeva, 1987[8]). Currently, the national environmental monitoring, conducted by MEW, is held once a year, usually in the low water period. With regard to the monitoring of ichthyofauna, the period from August to October is considered suitable, when mating migrations are completed and the progeny are enough developed. Therefore, for the purposes of monitoring associated with the construction and operation of the NNU, following frequencies are considered appropriate:

9.3.8.2.1 During the construction of NNU.

For Danube River is recommended: once a year before the start of construction, during construction, and after construction.

9.3.8.2.2 During NNU operation.

For Danube River sampling is recommended to be performed twice a year – during high water (spring) and during the lowest water (summer – autumn). If needed, in the event of incursion of invasive species or new sources of pollution are detected – sampling can be performed more often.

9.3.8.3 MONITORING LOCATIONS

Place of sampling may be determined according to the specific situation (water levels, new invasive species, etc.), however, the following sampling principles should be observed:

9.3.8.3.1 During NNU construction

Sampling from the Danube River should be performed from 2 stations – located above and below the NPP.

9.3.8.3.2 During the NNU operation.

Sampling from the Danube River should be performed from 4 stations – located above and below the NPP in the region of the hot channels.

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[6]Varadinova E. 2006. Study of macrozoobenthos functional feeding groups of the Mesta river, PhD thesis. Bulgaria, CLGE, BAS.

[7]Чешмеджиев С., Е. Варадинова. 2013. Дънни макробезгръбначни. В: Белкинова Д., Гечева Г. (отг. ред.). 2013. [Bottom Macroinvertebrates] Биологичен анализ и екологична оценка на типовете повърхностни води в България. Унив. Издателство на Пловдивски Университет. 147- 163. [Biological analysis and environmental assessment of surface water types in Bulgaria.]

[8]Русев Б., И. Янева. 1987. Некоторые критерии, устанавливающие изменения бентосных зооценозах при фоновых мониторинга. Проблемы фонового экологического мониторинга. Изд. БАН. София. 157-164.

Monitoring of invasive alien species, aquatic invertebrates and fish during the construction of the NNU.

Methodological basis of the monitoring of invasive alien species of invertebrates and fish.

Implementation of standardised methods.

It is necessary to take additionally plankton samples – for planktonic larvae.

Reviewing all suitable substrates for adult sessile polyps (e.g .Dreissena): wharves, harbor walls, hydrotechnical facilities and vessels.

For invasive species inhabiting soft bottoms (e.g. A. woodiana), bottom dredges, including malacological ones should be used.

It is recommended to monitor as follows:

- presence of aquatic invasive alien species – larvae, adult live individuals, shells, druses, sessiles, etc.;
- quantitative parameters – density of invasive populations, size of colonies/druzes, extent of coverage, etc.;
- population dynamics – increase/decrease of the area, density, degree of coverage, etc.;
- protected species of aquatic invertebrates or fish, in order to monitor the state of the populations as a result of the potential impact of invasive species.

9.3.8.4 MONITORING FREQUENCY

Sampling is recommended to be performed immediately prior to construction of the NNU, several times during the construction and after completion.

9.3.8.4.1 Monitoring locations

Samples should be taken in the Danube River in the area of the NPP port or if there are other used ports serving the construction.

Monitoring of invasive species of aquatic invertebrates and fish during the operation of the NNU.

Methodological basis of the monitoring of invasive alien species of invertebrates and fishes

Standardised methods should be used.

It is necessary to take additionally plankton samples – for planktonic larvae, as well as reviewing all suitable substrates for adult sessile polyps (e.g .Dreissena).

Sampling locations: wharves, harbor walls, hydrotechnical facilities and vessels. For invasive species inhabiting soft bottoms (e.g. A. woodiana), bottom dredges, including malacological ones should be used.

It is recommended to monitor as follows:

- presence of aquatic invasive alien species – larvae, adult live individuals, shells, druses, sessiles, etc.;
- quantitative parameters – density of invasive populations, size of colonies/druzes, extent of coverage, etc.;
- population dynamics – increase/decrease of the area, density, degree of coverage, etc.;
- protected species of aquatic invertebrates or fish, in order to monitor the state of the populations as a result of the potential impact of invasive species.

Monitoring frequency

For Danube River sampling is recommended to be performed twice a year – during high water (spring) and during the lowest water (summer – autumn). If needed, in the event of incursion of invasive species – sampling can be performed more often.

Monitoring locations

In the Danube River sampling must be performed at the mouth of the two hot channels and at least 2 additional stations – located above and below the area of the NPP. Another location is allowed or setting more points in case of incursion of new invasive species.

Regular mechanical cleaning of the hot channels, especially in the formation of eutrophication, fouling, clusters of mussels, etc.

Cleaning of fuel transportation ships – cleaning of fouling, use of anti-fouling coatings for bottoms, water for technical needs from the ships to be disposed of in special containers and in no case in the Danube River or in the channels.

9.3.9 ADVERSE PHYSICAL FACTORS

9.3.9.1 NOISE

In stage operation noise monitoring should be performed in accordance with the Methodology for determining the total sound power emitted into the environment from industrial plant and determining the level of noise in the point of impact, MEW, 2012.

It is recommended to draw a noise map for the area of NPP and NNU which will indicate the noise levels from the operation of the facilities and will and identify critical points for monitoring.

During the operation the critical points from the drawn map of noise levels in the area of Kozloduy NPP and NNU can be monitored in accordance with the respective Programme of measures.

9.3.9.2 THERMAL IMPACT

To perform monthly monitoring for recording the change of the temperature characteristics of the river as a result of the discharge of heated water by Kozloduy NPP

and NNU before and after the discharge of exhaust cooling water by measuring water quantity and temperature of the raw and treated water at the point of discharge of HC-1.

9.3.9.3 HEALTH AND HYGIENIC ASPECTS OF THE ENVIRONMENT AND HUMAN HEALTH

Annual preventive medical checks of staff.

9.3.9.4 CULTURAL AND HISTORICAL HERITAGE

During the construction to monitor for archaeological artifacts and a variety of remains of different nature of ancient human activity usually contained in the surface soil deposits. Archaeological structures created as a result of ancient habitation and activities are often of 'negative' nature (dug in deeply from the level of the ancient terrain), i.e. they may not be visible and identifiable in superficial inspection, especially if the terrains are overgrown or with recent artificial embankments.