CONSORTIUM

DICON – ACCIONA ING

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

for Investment Proposal:

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

CHAPTER 3: DESCRIPTION AND ANALYSIS OF COMPONENTS AND FACTORS OF THE ENVIRONMENT AND CULTURAL HERITAGE THAT SHALL BE LARGELY AFFECTED BY THE INVESTMENT PROPOSAL AND THE INTERACTION BETWEEN THEM

3.1. CLIMATE AND ATMOSPHERIC AIR

3.2. WATERS

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

3 DESCRIPTION AND ANALYSIS OF COMPONENTS AND FACTORS OF THE ENVIRONMENT AND CULTURAL HERITAGE THAT SHALL BE LARGELY AFFECTED BY THE INVESTMENT PROPOSAL AND THE INTERACTION BETWEEN THEM

3.1 CLIMATE AND ATMOSPHERIC AIR

3.1.1 CLIMATE

The considered region surrounding Kozloduy NPP is located in the western parts of two climatic regions according to the climatic zoning of Bulgaria – North and Middle climatic region of the Danube hilly plain from the Moderate-Continental climate subzone.

The climate in this region is characterized as pronouncedly continental due to the sharp contrast between winter and summer thermal conditions. The mean annual air temperature amplitude is between 24.5°C and 26°C – the highest for the whole country. The continental nature of the climate is also confirmed by the precipitation regime in the region. Their annual precipitation is between 540 mm and 580 mm, whereas the maximum is in June and the minimum – in February. The difference between the precipitation for the three summer and the three winter months is between 70 mm and 120 mm, i.e. 15% – 20% of their annual total. The absolute maximum 24-hour precipitation is in summer, reaching about 100 mm – 130 mm. The summer precipitation however, is concentrated around certain dates and especially during the second half of the summer droughts are quite often to occur. In both summer and autumn there are on the average 4 – 5 rainless periods longer than 10 days and average duration of 16 – 20 days. In some years not infrequently even longer drought periods are observed.

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

The dynamic of air mass transport in the surface layer is characterized by the wind rose. The indented relief and proximity of the Danube River, which is considered a big aeration channel, have significant effect on the local climate. It results in the appearance of material non-homogeneities in the fields of the meteorological elements, particularly such as the minimum temperatures and ground wind, which are pronouncedly sensitive towards the shape and the location of the terrain. The establishment of these non-homogeneities is of great significance for many meteorological tasks and, in particular for the spread of pollutants in the atmospheric air.

Until 1997 the climatic characteristics of the region was based on data, determined using statistics of the regular climate observations of the Kozloduy station, performed during the period 1970 – 1982 as well as observations from the Lom station. After 1997 real meteorological data were used, obtained from three meteorological stations, corresponding to III class, which were united in Automated Meteorological Monitoring

System (AMMS). The first of them was installed on n external radiation control site, representative of the observed region Automatic Measurement Station – External Radiation Control (AMS-ERC), and the other two were located in the Blatoto neighborhood and in the village of Harlets.

To assess the microclimate in the region, mainly reports on tasks, assigned by the Power Plant to "Meteorological Systems and Equipment" consortium will be used, as well as official publications published in the Internet.

3.1.1.1 CLIMATE PARAMETERS

3.1.1.1.1 Air temperature

The mean annual air temperature in the studied region for 2009, 2010 and 2011 is from 13.0°C to 13.1°C.[1]

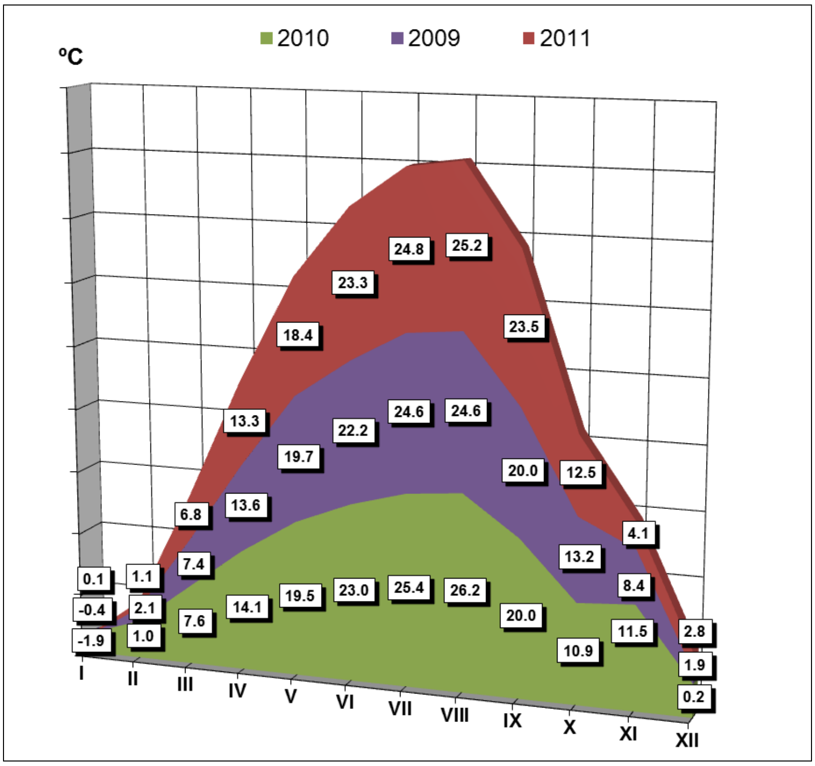

FIGURE 3.1-1: MEAN MONTHLY TEMPERATURE FOR THE PERIOD 2009÷2011

Figure 3.1-2 presents the comparison of the mean monthly temperatures for 2009, 2010 and 2011 with the average values for the period 1998-2011, whose mean annual temperature is 12.4°C[2].

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[1] Reports on Local meteorological conditions in the area of Kozloduy NPP, 2009, 2010 and 2011

[2] Study and determination of the location of preferred site for building new nuclear unit on the site of Kozloduy NPP and adhering territories – REL-1000-ST-005-a-1

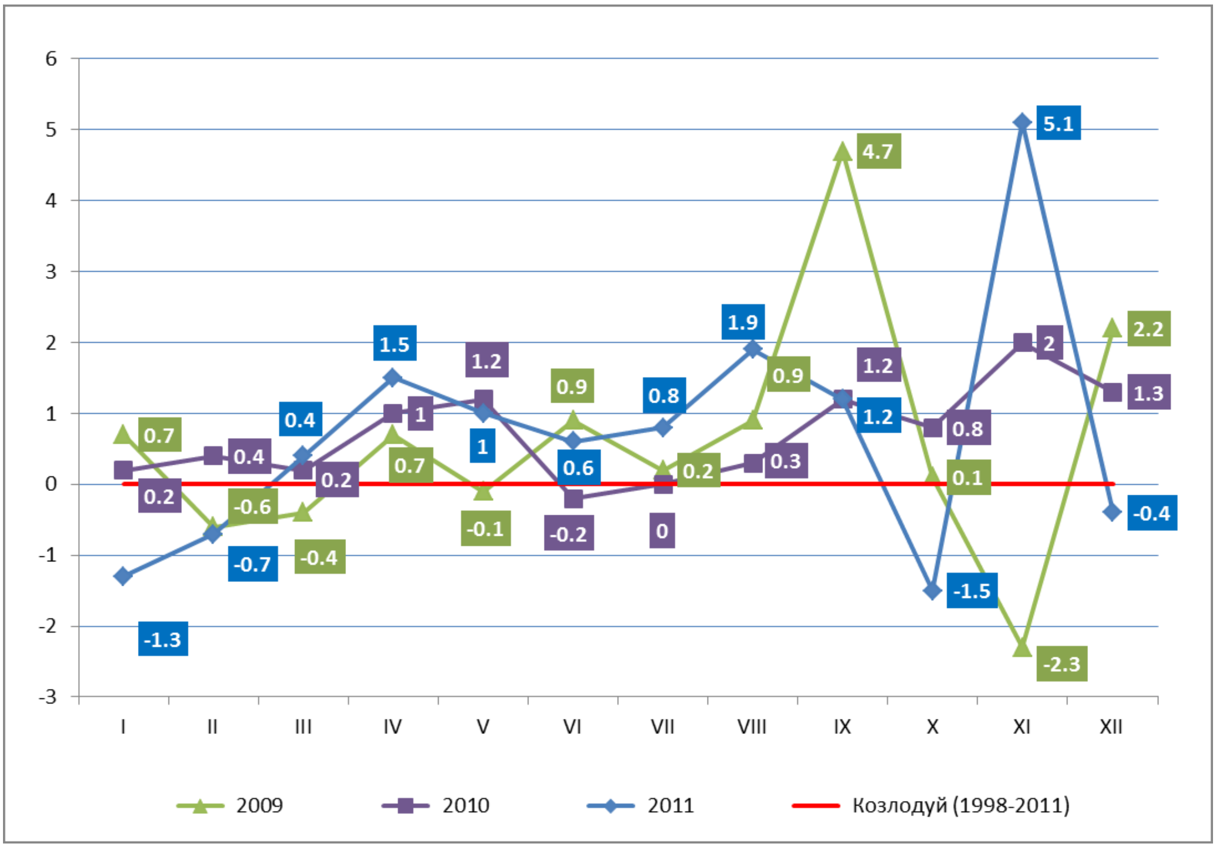


FIGURE 3.1-2: COMPARISON OF MEAN MONTHLY TEMPERATURES (°C) FOR THE PERIOD 1998÷2011 AND FOR THE LAST 3 YEARS.

The differences in the average monthly temperatures for the period and the latest 3 years show that the mean monthly temperatures from April to September are higher than the average values for the period. Differences equal to 0.1°C or 0.2°C (months of May 2009 and June 2010 do not amend the trend).

The annual course of the mean monthly temperatures displays a maximum in August (from 25.2°C to 26.2°C) and a minimum in January (from 0.1°C to minus 1.9°C). For three years, the mean temperatures for the winter season are about 0.8°C, and for the summer season – 24.4°C. The mean temperatures for autumn and spring are 13°C (**Figure 3.1-1**). **Figure 3.1-3**, **Figure 3.1-4,** and **Figure 3.1-5**, present the temperature frequency in gradation spaced at 10 degrees over the 16 sectors of wind direction for the period 2009÷2011, or the so-called "temperature roses in gradation" is presented

The greatest percent falls to temperatures in the interval (+5°C to +15°C) with north-northeast and south winds (above 3% individually). The positive temperatures (above 0°C) exceed 80%, and the mean monthly temperature during the warmest month (August) for 2009 is lowest among the three years – 24.6°C (see **Figure 3.1-1**).

In 2010, the greatest percent falls to temperatures in the interval (+15°C to +25°C) with west-southwest winds (3.7 %). Positive temperatures (above 0°C) exceed 86 %, which shows that 2010 has been much warmer than 2009. The average monthly temperature during the warmest month (August) is highest – 26.2°C (**Figure 3.1-1**).

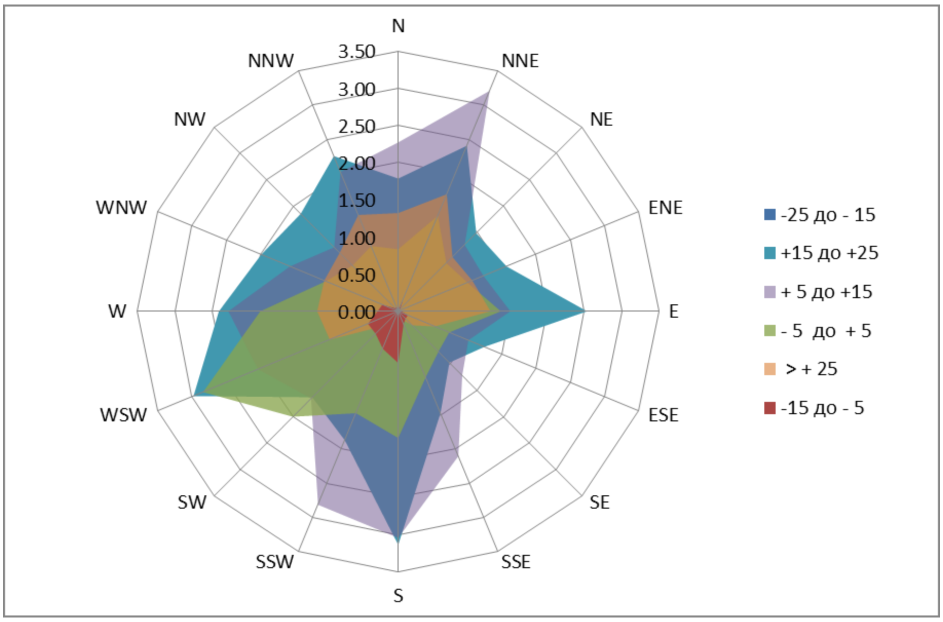


Figure 3.1-3: Temperature roses in gradation for 2009

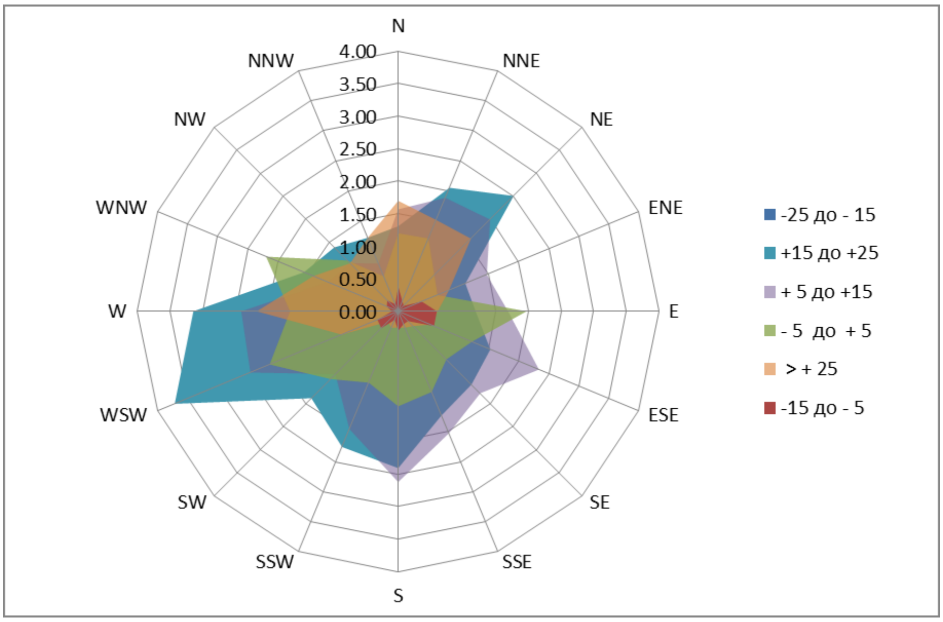


Figure 3.1-4: Temperature roses in gradation for 2010

In 2011 many cases of temperatures in the interval (+15°C to +25°C) upon purely south winds (4.7 %) are observed, but nevertheless, the positive temperatures (above 0°C) are only 75 %.

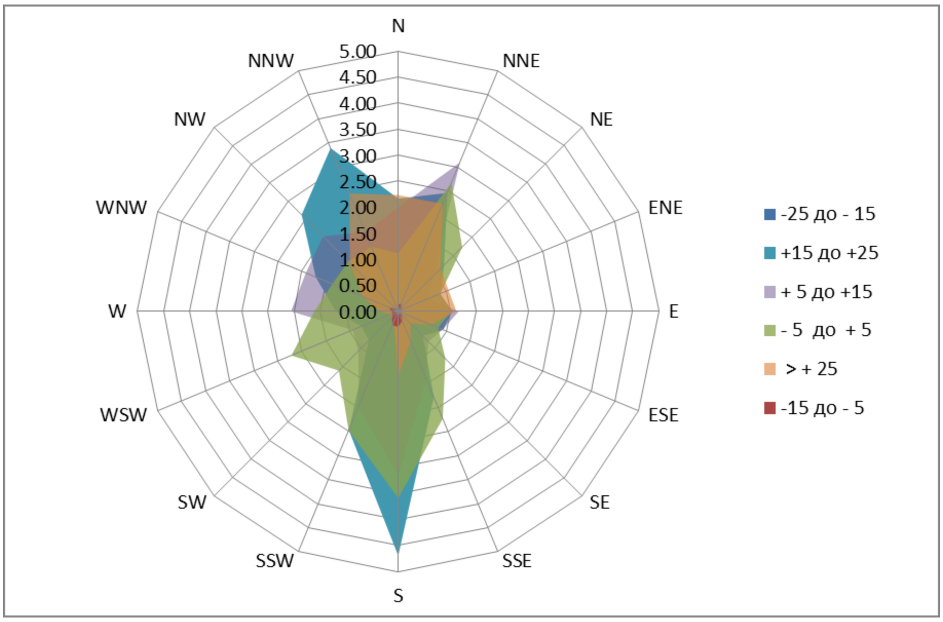


FIGURE 3.1-5: TEMPERATURE ROSES IN GRADATIONS FOR 2011

Table 3.1-1 contains the extreme temperature values in Kozloduy NPP region for 2009, 2010 and 2011. In the column "Date [hour:min]", the date and the exact time of their recording are shown.

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

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

3.1.1.1.2 Precipitation

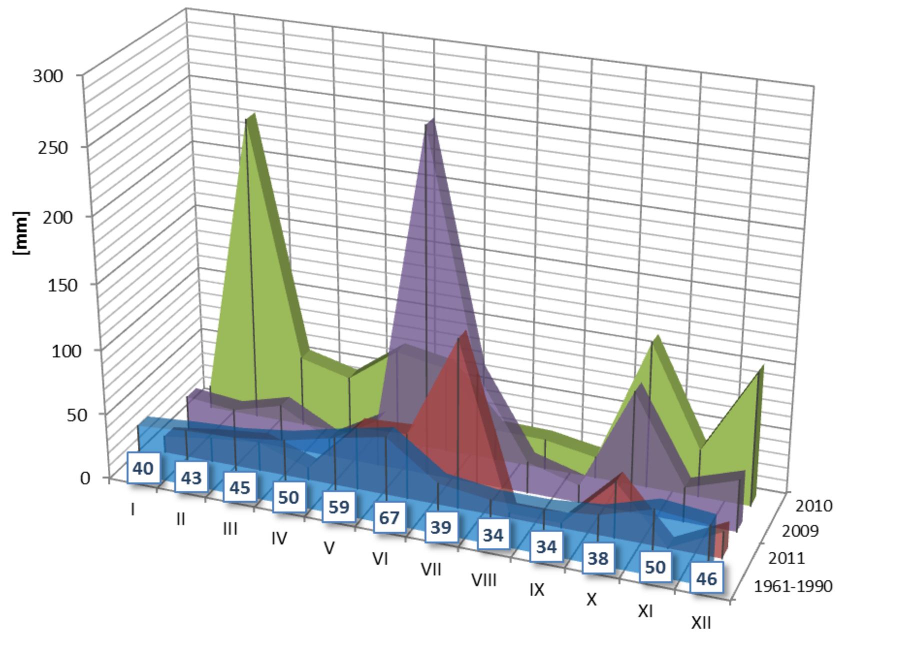
Table 3.1-2 contains the annual precipitation over a period of 8-years – 2004÷2011 based on the reports **"Local Meteorological Conditions in Kozloduy NPP region"** for these years

TABLE 3.1-2: ANNUAL PRECIPITATION (MM) FOR 8-YEAR PERIOD

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

The average annual precipitation total for the period of 8-years is 481.9 mm, which is below the climatic norm (1961 – 1990)[3] for the precipitation in the region amounting to 545 mm.

The deviation of the monthly precipitation totals from the climatic norm is shown on **Figure 3.1-7**.



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

FIGURE 3.1-6: PRECIPITATION FOR THE PERIOD 2009÷2011 AND CLIMATIC NORM FOR 1961-1990

[3]The World Meteorological Organization (WMO) has defined the climatic norm as the average value of a given climatic element for a fixed base period of 30 years. The base periods adopted so far are 1901-1930, 1931-1960, and 1961-1990.

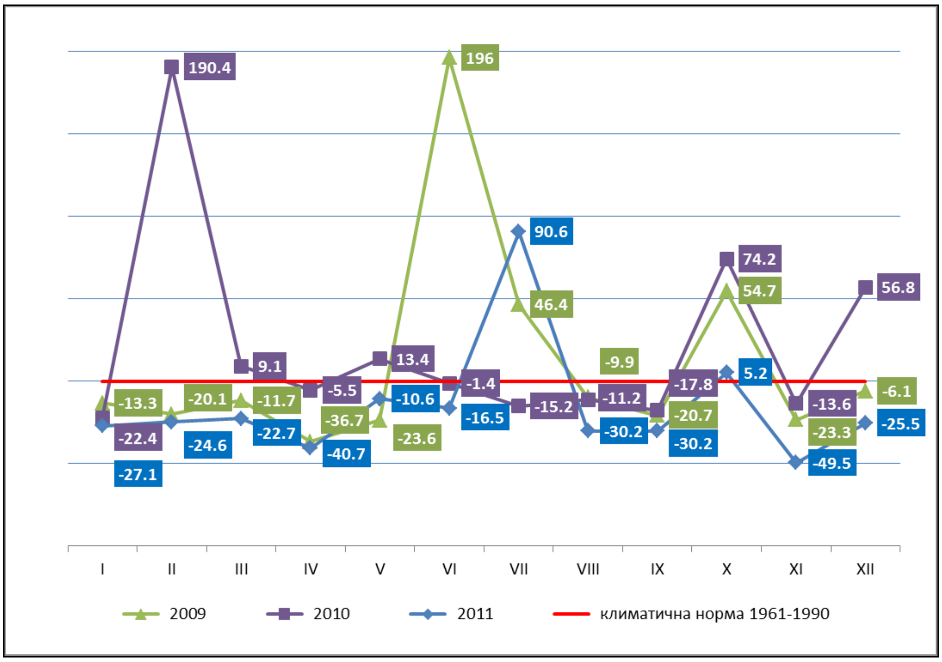
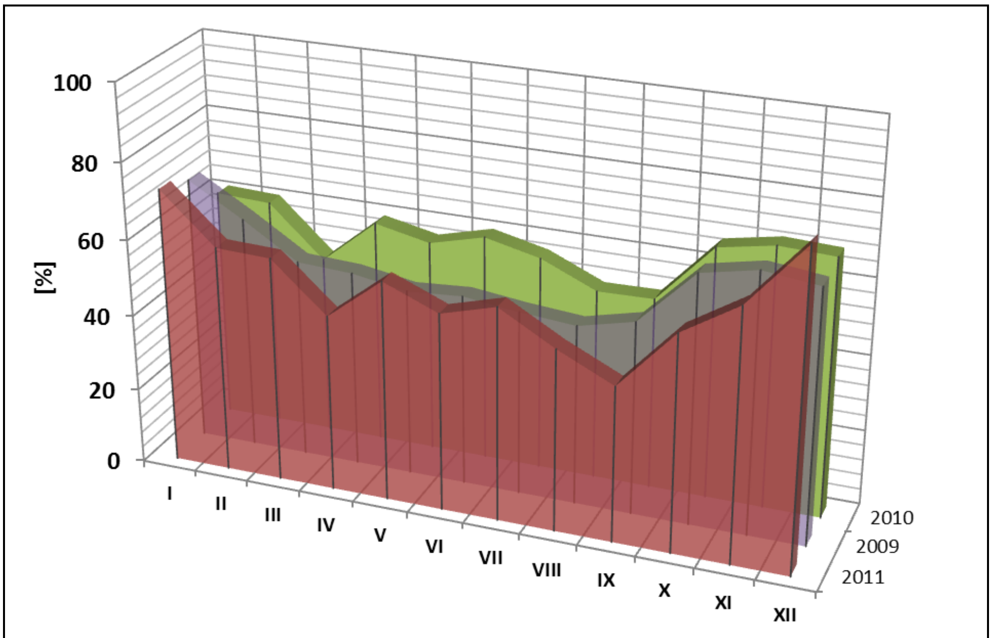


FIGURE 3.1-7: DEVIATIONS OF THE MONTHLY PRECIPITATION TOTALS (MM) FOR THE PERIOD 2009÷2011 FROM THE CLIMATIC NORM SHOW THE CLIMATIC ANOMALIES



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

FIGURE 3.1-8: RELATIVE HUMIDITY FOR THE PERIOD 2009÷2011

3.1.1.1.3 Relative humidity

Relative humidity above 60 % is observed in the winter months and in the last 2 autumn months. Maximum of relative humidity was observed in December 2011, (above 82 %), notwithstanding that the average relative humidity for this year was lower than the average relative humidity for 2009 (**Figure 3.1-8**)

In August the frequency of the rush-ins of fresh and moist Atlantic air is relatively low, therefore, namely at this time, the lowest values of relative humidity are observed.

3.1.1.1.4 Wind

The dynamic of air transport in the surface layer is characterized by the wind rose – the wind speed and wind direction, measured in 16 directions: The wind at a given place is one of the meteorological elements, which depends strongly on the local conditions and, especially, on relief forms. The hilly relief results in redistribution and deformation of air flow, leading to a change of both wind speed and frequency of the prevailing directions. For a region as the considered one, the proximity of a large water basin, such as the Danube River (aeration channel), also exerts some impact.

Figure 3.1-9, **Figure 3.1-10** and **Figure 3.1-11** show the wind roses for wind speed gradations for 2009, 2010 and 2011. The colored area for each wind speed range indicates in percents the speed share for this interval in all wind cases throughout the year.

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

In 2009, the biggest component was the southern one at low wind speeds between 2 and 2.9 m/s (their share in all speeds being 29.6%) and in he interval between 3 and 4.9 m/s, the greatest frequency was the frequency of the northeast winds (**Figure 3.1-9**). The share of the winds in the interval 1÷7 m/s is 97.8% of the cases.

In 2010, the biggest component was the western one at wind speeds between 3 m/s to 4.9m/s (their share in all speeds being30.4%) and between 5 m/s and 6.9 m/s (**Figure 3.1-10**). The share of the winds within the range 1 m/s ÷7 m/s is 96.9 % of the cases.

In 2011, the biggest component was is the southern one at wind speeds between 1 m/s and 1.9 m/s (their share in all speeds being 31%), (**Figure 3.1-11**). The share of the winds within the range 1 m/s ÷7 m/s is 97.9% of the cases.

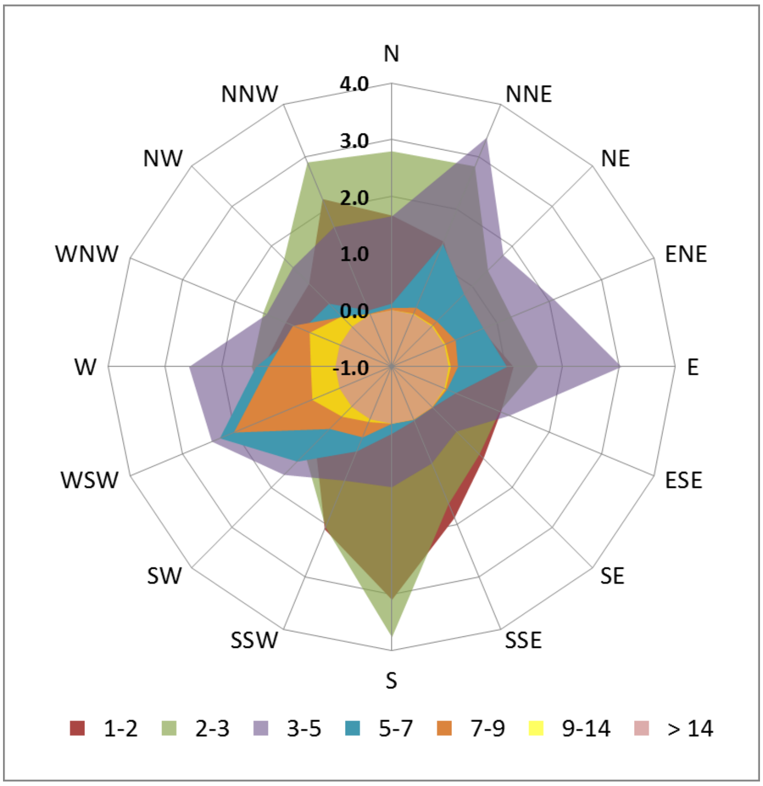


FIGURE 3.1-9: WIND ROSE FOR 2009

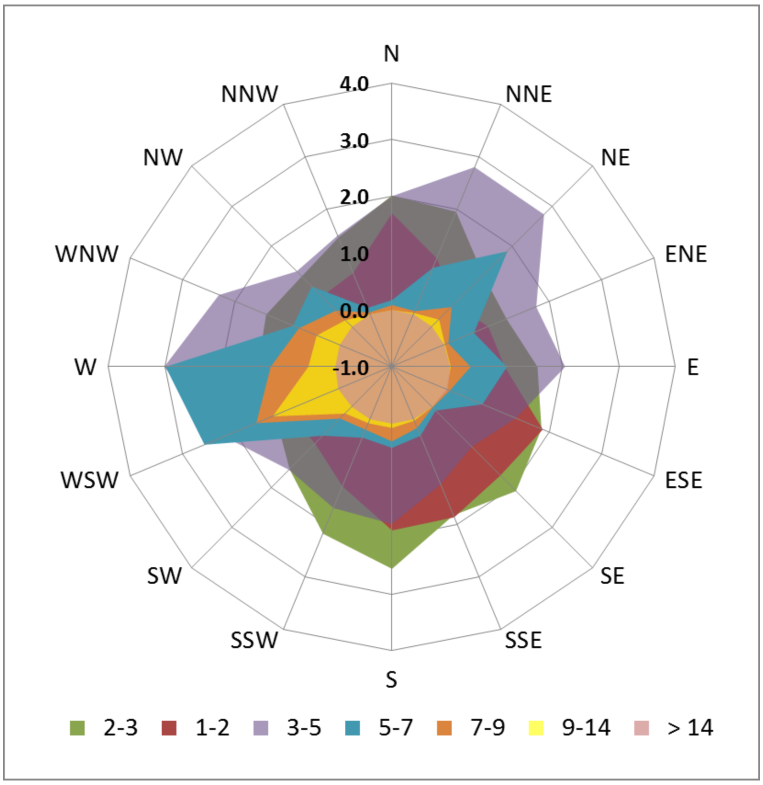


FIGURE 3.1-10: WIND ROSE FOR 2010

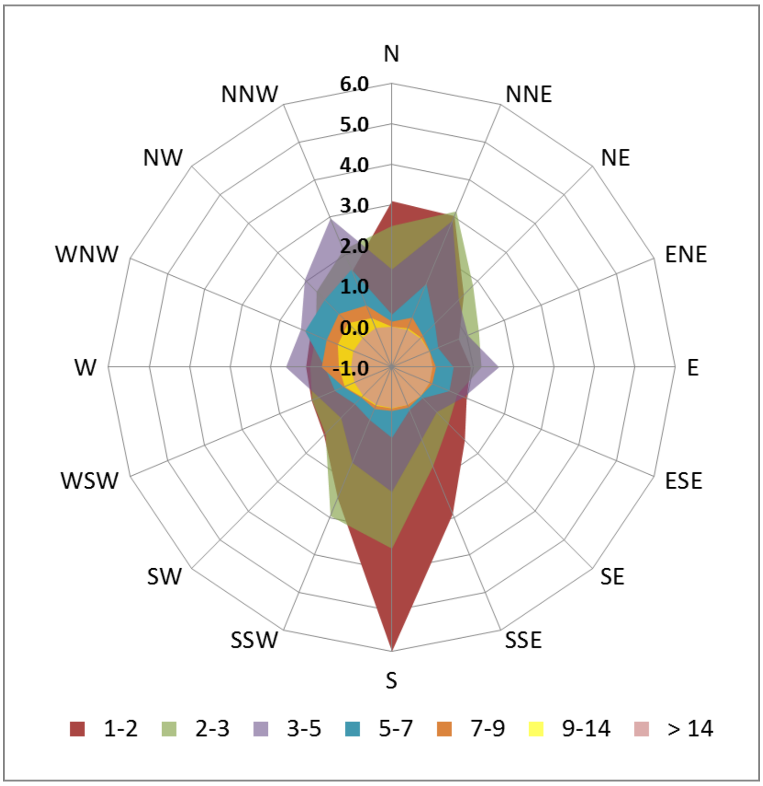


FIGURE 3.1-11: WIND ROSE FOR 2011

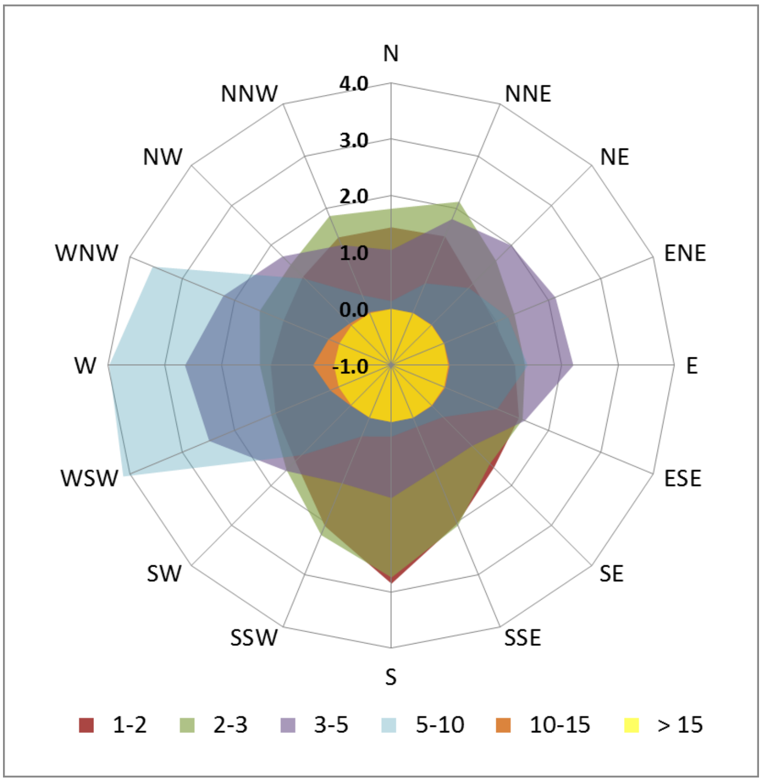


FIGURE 3.1-12: WIND ROSE FOR THE PERIOD 1998-2011

Figure 3.1-12 shows the average annual wind rose for the period 1998-2011. [4] For this period the biggest share (in 27.34% of the cases) have the western, southwestern and north-northwestern ones, followed by winds from southern 45° degree horizon (in 18.41% of the cases), and in 17.43% the winds are from the eastern 45° degree horizon. This confirms the strengthening of the southern winds, which are most strongly demonstrated in the wind rose for 2009 and the one for 2011.

The extreme values for wind speed values are presented in **Table 3.1-3**. It is worth noting that apart from these three years, they have always come only from the north[5].

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

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

3.1.1.1.5 Annual characteristics of Pasquill atmospheric stability classes for Kozloduy NPP region

For the purpose of calculating the dose exposures in the Kozloduy NPP region, one should have information about the state of atmospheric turbulence, which determines the possibility for spread of impurities in the atmospheric air. The major part of the diffusion models most frequently uses the Pasquill atmospheric stability classes. There are 6 atmospheric stability (or sustainability) classes: ***A – very unstable***, ***B – unstable***, ***C – slightly unstable***, ***D – neutral***, ***E – slightly stable*** *and* ***F – stable***.

Under unstable atmospheric conditions (classes **A**, **B** or **C**) the pollutants diffusion takes place much faster due to the strong turbulence in vertical direction, which leads to quick mixing of the pollutants with the ambient air masses. Although these conditions are favorable for the pollutants diffusion, single occurrences of large ground concentrations may be observed near the source at small wind speeds in the early hours of the day in sunny weather.

Under stable atmosphere conditions (classes **E** and **F**) the lack of or too weak turbulence prevents the spread of impurities in the vertical direction and transports them in the horizontal one but, on account of the too weak or lacking winds, the pollution may stay for

[4] Study and determination of the location of preferred site for building new nuclear capacity on the site of Kozloduy NPP and adhering territories – REL-1000-ST-005-a-1

[5] Reports “Local Meteorological Conditions in kozloduy NPP area”, 2004, 2005, 2006, 2007 and 2008

a long time in the area around the source. Such conditions occur upon the existence of inversions, during the late evening hours or at the night.

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

Figure 3.1-13, **Figure 3.1-14** and **Figure 3.1-15** show the roses of the atmospheric stability classes for 2009, 2010 and 2011, accordingly. The colored area for each stability class indicates in percents the share of the relevant class in all classes observed during the year.

In 2009, the greatest share was that of slight atmospheric stability (class **E**) – 54.15%, while the frequency of southern winds being highest – 6.8% – **Figure 3.1-13***.* The share of the neutral conditions – class **D** is 32.5%, the frequency of the west-southwest winds being highest – 4.8 %. The unstable atmospheric conditions (class **A**, **B** and **C**) feature a share of only 8.7% in the cases.

In 2010 the greatest share was that of slight atmospheric instability (class **C**) – 28.6%, the frequency of western winds being highest – 3.4% – **Figure 3.1-14.** Then follows class **E** with share of 27.8%. The share of the neutral conditions – class **D** is 22.1%, the frequency of west-southwest winds being highest – 3.4 %. The unstable atmospheric conditions (classes and **B**) feature a share of 11.3% in the cases.

In 2011 the greatest share was that of slight atmospheric stability (class E) – 28.8%, the frequency of southern wind being the highest – 4.2% – **Figure 3.1-15** Next comes class **C** with share of 23.7%. The share of the class of the neutral conditions (class **D)** amounts to 14%, the frequency of the winds from the north-western quarter of the horizon being highest. The unstable atmospheric conditions (class **A** и **B**) have a share of 15.9% in the cases.

Table 3.1-4 shows the repeatability of the atmospheric stability classes in Kozloduy for the period 1998 ÷ 2011

Table 3.1-4*:* Averaged for the period 1998÷2011 stability classes

Classes	A	B	C	D	E	F
%	0.8	2.9	9.1	33.9	42	11.3

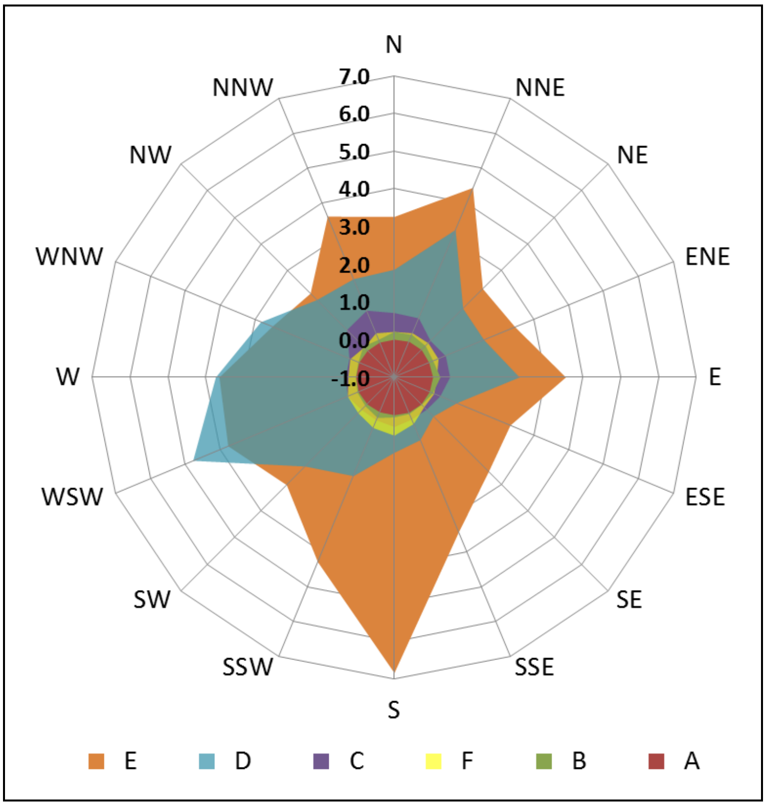


Figure 3.1-13: Rose of pasquill atmospheric stability classes for 2009

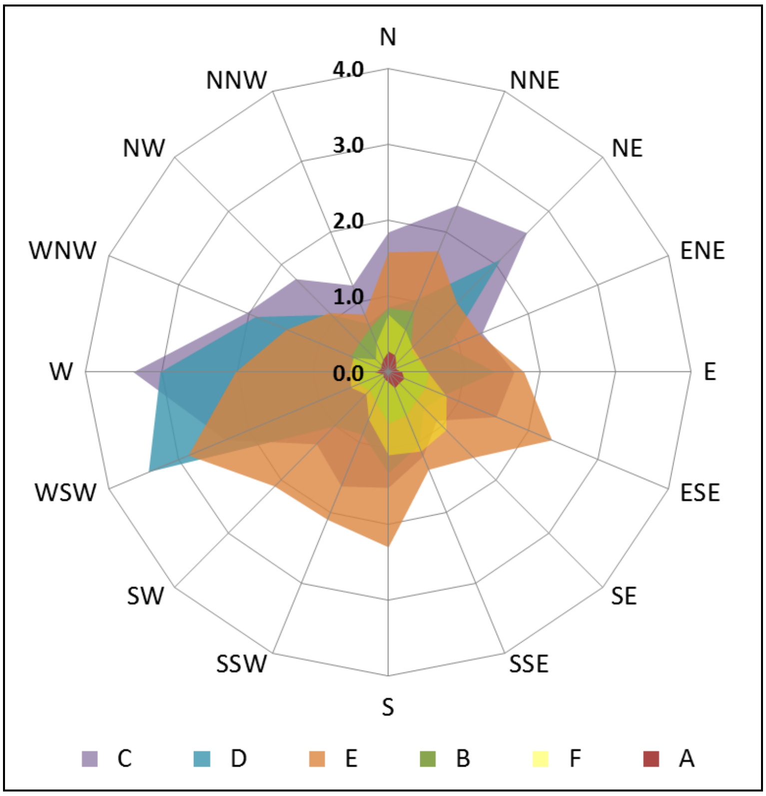


Figure 3.1-14: Rose of pasquill atmospheric stability classes for 2010

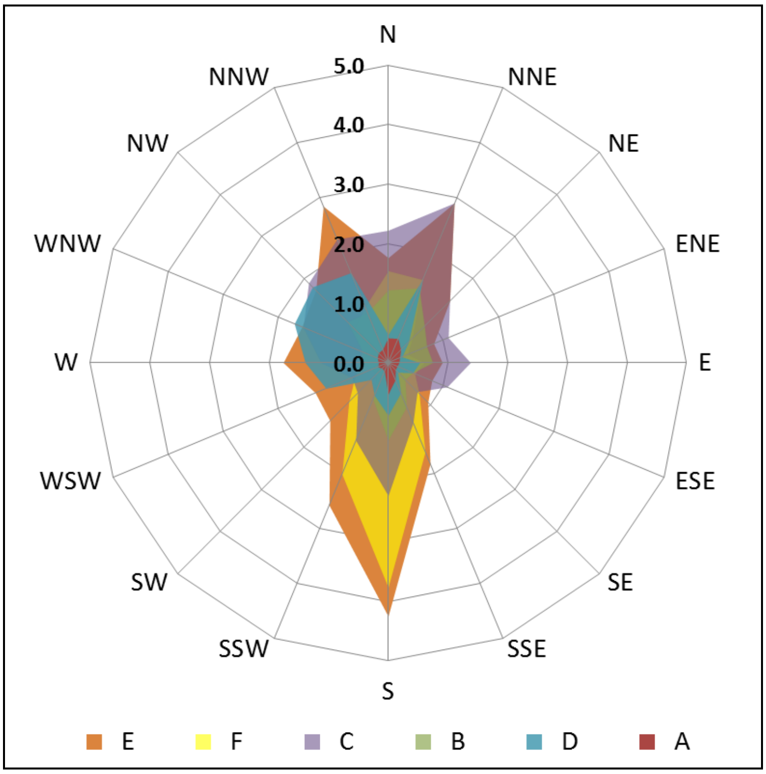


FIGURE 3.1-15: ROSE OF PASQUILL ATMOSPHERIC STABILITY CLASSES FOR 2011

3.1.1.1.6 Cloudiness

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

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

3.1.1.1.7 Fogs

The data for Lom and Oryahovo stations regarding the number of foggy days (**Table 3.1-5**) are quite close, which may provide grounds to assume that they are close to the values typical for the region and for Kozloduy NPP in particular.

TABLE 3.1-5: NUMBER OF FOGGY DAYS BY MONTHS AND ANNUALLY

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

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

The mentioned noticeable differences of the fog duration lead to the conclusion that there are no grounds to assume that fog data from the adjacent stations are characteristic of regions, such as Kozloduy NPP. Therefore, observations of the fog regime on the NPP site should be carried out. This holds for horizontal visibility, too.

3.1.1.1.8 Snow cover

Regarding the climatic characteristics of the *snow* cover in Kozloduy NPP region, conclusions may be drawn from the data from the climatic stations of the NIMH – BAS, located in the region. The results from the climatic processing of these data are presented most completely in "Climatic Directory for the People's Republic of Bulgaria, Volume 2 (1979) – **Table 3.1-6.**

TABLE 3.1-6: CLIMATE CHARACTERISTICS OF THE SNOW COVER

Snow cover (SC) parameter	Lom	Oryahovo
Average SC height (cm)	XII – 5÷9; I – 9÷12; II – 8÷12; III – 3÷6;	XII – 2÷6; I – 6÷7; II – 10
Number of days with SC	XII–5; I–20; II–16; III–3	XII–7; I–16; II–14; III–4
Average SC monthly height (cm)	XII–13; I–25; II–25; III–11	No data available
Maximal SC monthly height (cm)	XI-27; XII–70; I–111; II–104; III–81; IV-8	No data available
Monthly number of days with SC height in cm: a) 10÷20 b) 20÷50 c) ≥ 50 cm	 XII–4; I–11; II–9 I–6; II–6 Not available	No data available

3.1.1.2 METEOROLOGICAL PHENOMENA

3.1.1.2.1 Hail phenomena

The greatest hail frequency with damages of the studied region is observed in July (approx. 36%), followed by June (32%), and May (17%) – "Climate of Bulgaria", 1991. The hail frequency is negligible in April, September and October. The 24-hour course of the beginning of hail precipitation displays maximum in the interval 14:00-18:00 o'clock local time. Night hails between 22:00-24:00 and between 00:00 and 04:00 o'clock are also possible, which fall along cold atmospheric fronts. On the overall, it may be said that, from statistical point of view, hails are strongly expressed random phenomenon due to their big spatial and time variations. This accounts for the small annual materialization probability of the mentioned climatic characteristics.

3.1.1.2.2 Icing of ground-level objects and facilities

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

3.1.1.2.3 Dust storms

No data about observed dust and sand storms of Kozloduy NPP site are available. **Table 3.1-7** (Ivanov and Latinov, 1993) shows the number of the recorded dust storms by years for the entire country and at the two meteorological stations closest to the region of Kozloduy NPP – Lom and Oryahovo.

TABLE 3.1-7: NUMBER OF CASES WITH DUST STORMS BY YEARS

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

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

3.1.1.2.4 Snow storms

This phenomenon occurs as a result of moderate or strong wind (with speed above 5 m/s) in the presence of strong snowfall (it is called general snow storm and comprises the entire sub-cloud layer) or in cases of blowing away and transfer of freshly fallen "dry" snow (comprises surface boundary air layer with height up to several meters – "ground snow storm" or up to several dozen centimeters – "low snow storm"). The phenomenon creates difficulties for the land transport and other activities due to snow-drifts, formed by the blowing away of the snow. Snow storms in our country are observed mostly during the period December-February. They are manifested most intensively and most frequently in North-East Bulgaria, whereas snow transfer usually takes place from North and North-East (depending on the wind direction) of the order of about 10m^3 per linear meter of the front. Snow storms are observed most often in cases of synoptic circumstances, related to Mediterranean cyclone from south and Siberian winter anticyclone crest from north-northeast.

3.1.1.2.5 Tornado

Although rarely, under situations with meso-scale convective storms, tornadoes (or local tornadoes) may be formed in Bulgaria, most frequently above rugged mountainous terrains or above the sea aquatory[6]. Tornado is often mistaken for the so-called "falling" or squally wind (Q).

The typical synoptic circumstances, favoring the development of tornados above our country are a deep valley or a separate cyclonic fortex, located westward of Bulgaria, where the flow in the middle troposphere in the frontal part of the cyclone or the valley is directed from south-west to north-east. Strong convective systems are formed, whereas Coriolis force facilitates the development of tornados in them.

Under such synoptic situation, the tornadoes described in positions 1, 3, 5A and 5B from **Table 3.1-8** were formed. Near to NPP, 2 cases were recorded during this period – at about 20 km southward of NPP, near the village of Hayredin (case 5A), and at the village of in Tarnava, about 35 km south-southeastward, which occurred on the same day. These two are the only cases, observed over a period longer than 100 years.

[6] Analysis of strong convective storms, related to the development of tornadoes in Bulgaria, during the period 2006 – 2009, Petyo Simeonov, Iliyan Gospodinov, Liliya Bocheva, Rangel Petrov.

TABLE 3.1-8: NUMBER OF TORNADO CASES DURING THE PERIOD 2006-2009

No.	Affected region	Date	Start	Duration (min)	Direction of f tornado movement	Precipitation area (km²)	Precipitation intensity (mm)	Diurnal precipitation total (mm)	Maximal size off hail grains (cm)	Damages caused by the tornado (USD)
1	**Bobeshino**	02.04.2006	05:20	31	W-E	200	64	3-11	1.5	80 000
2	**Kalekovets**	21.05.2007	13:20	10	NE-SW	232	45	6-40	6.0	110 000
3	**Kostandenets**	22.05.2008	13:55	80	SW-NE	320	237	2-14	6.0	640 000
4	**Kyustendil**	08.07.2008	16:02	12	NW-SE	500	100	2-24	3.0	68 000
5A	**Hayredin**	02.06.2009	15:58	75	SW-NE	600	225	14-32	9.0	134 000
5B	**Tarnava**	02.06.2009	13:35	75	SW-NE	600	225	14-32	7.5	225 000

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

3.1.1.3 UNFAVORABLE METEOROLOGICAL CONDITIONS FOR THE IMPURITIES DIFFUSION INTO THE ATMOSPHERE

3.1.1.3.1 Temperature inversion

Temperature inversion in a specific region is observed, when the low atmospheric layer is in a very stable equilibrium. Characteristic property of such layers is the suppression of air movements originated in them, which leads to attenuation of the dynamic turbulence and thermal convection, determining the dispersion of the air pollutant. In the cases with ground-level inversions (starting from the earth surface), the low situated pollutant sources are of essential importance. Conclusions regarding the presence of a phenomenon of this type may be drawn, based on the aerological sounding from the period September 1967 – August 1968, performed in the region of Kozloduy NPP[7].

Table 3.1-9 shows the number, thickness $\boldsymbol{d}$, and mean vertical temperature gradient γ obtained from the one-year period of single-time (at 8 a.m.) aerological sounding of the layer to a height of 2 km. The inversions have been also observed in 30 % of the cases, this being about 37% during the cold half of the year and about 22 % – during the warm half-year. There have been ground-level inversions in 15 % of the cases, their frequency being much lower during the warm half-year – about 7%, whereas in the cold season it is about 23 %.

[7] Nikolova N., Assessment of the weather conditions in the region of NPP "Kozloduy" in connection with the project to build a nuclear power plant, Institute of Hydrology and Meteorology, volume XIX, 1972

Table 3.1-9: Characteristics of the temperaturete inversions in the region of Kozloduy NPP based on aerologic sample collection during the period September 1967-August 1968

Observation period	Surface boundary inversions							High inversions									
	Number of the cases with depth, m				Total number of the cases	Average temperature gradien °C/100m	Average layer thickness	Number of the cases with depth, m					Total number of the cases	Average height H1, m	Average temp. gradient γ	Number of the performe sample collection	Number of the days wit inversion
	$200 \leq d_1 \leq 300$	$301 \leq d_1 \leq 500$	$501 \leq d_1 \leq 1000$	$d_1 > 1000$				$100 \leq H_1 \leq 150$	$151 \leq H_1 \leq 250$	$251 \leq H_1 \leq 500$	$501 \leq H_1 \leq 1000$	$H_1 > 1000$					
Warm half-year	-	2	5	1	8	-0.29	757	-	5	8	4	2	19	462	-0.29	121	27
Cold half-year	3	5	14	10	32	-0.62	801	1	3	6	9	6	25	720	-0.51	140	52
Total for the year	3	7	19	11	40	-0.46	779	1	8	14	13	8	44	591	-0.40	261	79

Although for one-year period and single time sounding, there is some notion given also for the atmospheric stability categories of the boundary layer above the station of Kozloduy according to Pasquill classification. The stability classes are determined based on ground-level data (radiation balance (non-traditional) and wind speed) and in accordance with the values of the vertical temperature gradient in the lower 200-meter air layer -**γ** [deg/100m]. In the cited study it is shown, that for the year as a whole highest frequency is observed for the following classes for atmospheric conditions:

- → **D** (neutral) – 0.5 deg / 100 m ≤ γ ≤ 1 deg / 100 m – in about 40 % of the cases;
- → **E** (slightly stable) – 0.5 deg / 100 m < γ < 0.5 deg / 100 m – in about 30 % of the cases;
- → **C** (slightly unstable) – 1 deg / 100 m < γ ≤ 1,5 deg / 100m – in about 25 % of the cases;
- → **B** (unstable) – γ > 1.5 deg / 100 m) and **F** (stable) – γ ≤ – 0.5 deg /100 m feature small frequency in the order of 5 % – 8 % of the cases.

Based on the data and the performed analyses, the following conclusions could be drawn about the processes and phenomena of interest for Kozloduy NPP site, in relation with its specifics:

- → Due to the prevailing low wind speeds (between 2 m/s and 5 m/s), the wind field potential for pollutants transportation to long distances is low, i.e. there is no immediate danger of cross-border pollution of the Romanian territories;

- The precipitations are below the climatic norms, due to which their potential for pollutants purification (wetting and raining down) in the atmosphere is small;
- Icing of ground facilities in this part of the Danube River lowland may occur under combinations of the following meteorological parameters: air temperature between 0°C and minus 2°C to minus 4°C, wind speed between 0 m/s and 3 to 5 m/s, and relative humidity between 95 % and 100 %;
- Damage-causing hailstorms in North-West Bulgaria were observed during the period 5 May – 31 July, but especially with respect to Kozloduy NPP, from statistical point of view, they constitute a marked occasional phenomenon, on account of their great spatial and time variations;
- The probability of occurrence of snow storms is much lower than in the North-East part of the Danube plain;
- On average for the country, the probability for occurrence of tornado is in the order of 10^{-6} cases per year;
- The fogs are annually observed on average on approximately 45 days with a maximum of 120-140 days. They last up to 1 day in about 80 % of the cases in January.

3.1.2 ATMOSPHERIC AIR QUALITY (AAQ)

3.1.2.1 EMISSIONS IN THE REGION OF THE INVESTMENT PROPOSAL

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

As a rule, the quality of the surface boundary air in the region is determined by the operation of Kozloduy NPP, industrial activity, road transport and domestic sources.

The more significant sources of atmospheric air emissions on the territory of Kozloduy Municipality are: concrete batching plant with sieving equipment in Butan village, adhering to Patstroy Engineering AD, city of Vratsa, "Atomenergo-Stroyprogress", "Zavodski Stroezhi" and "Mechanizatsia and Transport".[8] These are locally active dust sources. Transport is the greatest source of carbon monoxide, hydrocarbons, nitrogen oxides, etc. The roads in the municipality are characterized by relatively high traffic intensity. In the peak hours, though for a short while, conditions for increase of road transport emissions are created.

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[8] *Annex 8 – INPUT DATA* – Delivery-Acceptance Protocol 15 of 26.02.2013

Valchedram municipality falls within the Montana District, whereas the major emission sources are concentrated in the district central city and are outside the 30 km Urgent Protective Action Planning Zone (UPAPZ).

3.1.2.2 EMISSIONS FORM INDUSTRIAL COMBUSTION AND PRODUCTION PROCESSES BY MUNICIPALITIES.

According to data from the National Statistical Institute (NSI), **Regions, Districts and Municipalities in the Republic of Bulgaria 2006, 2007, 2008[9],** analysis of the emissions from the industrial and combustion and production processes for the municipalities of Valchedram, Kozloduy, Mizia and Hayredin has been performed – **Table 3.1-10**.

TABLE 3.1-10: EMISSIONS FROM COMBUSTION AND PRODUCTION PROCESSES (THOUSAND TONS) FOR THE MUNICIPALITIES IN THE REGION OF KOZLODUY NPP DURING THE PERIOD 2006÷2008

EKATTE	Statistical regions, districts and municipalities	Sulphur oxides	Nitrogen oxides	NMVOC	CH_4	CO_2	CO	N_2O
		Thousand tons						
	2006							
MON11	Valchedram	0.19	0.0203	3.0583	0.043	0.0087	7.12	0.0007
VRC20	Kozloduy	4.894	2.971	62.066	59.719	0.537	2120.974	0.277
VRC28	Mizia	7.072	0.988	5.637	13.358	0.319	448.349	0.071
VRC35	Hayredin	9.979	1.277	0.753	0.253	0.547	406.426	0.046
	2007							
MON11	Valchedram	-	-	2.056	-	-	-	-
VRC20	Kozloduy	6.873	2.793	21.176	12.184	0.811	1619.163	0.029
VRC28	Mizia	0.238	0.075	4.386	6.594	0.004	112.149	-
VRC35	Hayredin	3.620	0.368	0.386	0.012	0.007	206.876	0.036
	2008							
MON11	Valchedram	-	-	1.733	-	-	-	-
VRC20	Kozloduy	4.434	32.336	21.325	8.194	2.985	12026.426	0.309
VRC28	Mizia	0.146	0.046	0.539	6.363	0.002	68.858	-
VRC35	Hayredin	0.736	0.045	0.256	0.002	0.001	37.038	0.007

Figure 3.1-16 presents the data from **Table 3.1-10**, whereas it can be clearly seen that Kozloduy Municipality features the best developed production activity, which accounts for the biggest share in the combustion emissions. They are not caused by the power plant itself, since nuclear production does not involve emissions of conventional pollutants. The above mentioned emissions are related to both auxiliary production activities at the NPP, as well as with the favourable business environment in the municipality, which helps the

[9] The data up to 2008 are used because since 2009, the emission data for combustion and production processes for each municipality are confidential and are not accessible according to the Statistics Act, art.22.

development of small productions, related to combustion processes, whose production is designated mainly for the power plant – asphalt facility, concrete batching plants, etc. In calculating the above emission amounts, the statistics has not taken into account municipal fuel burning.

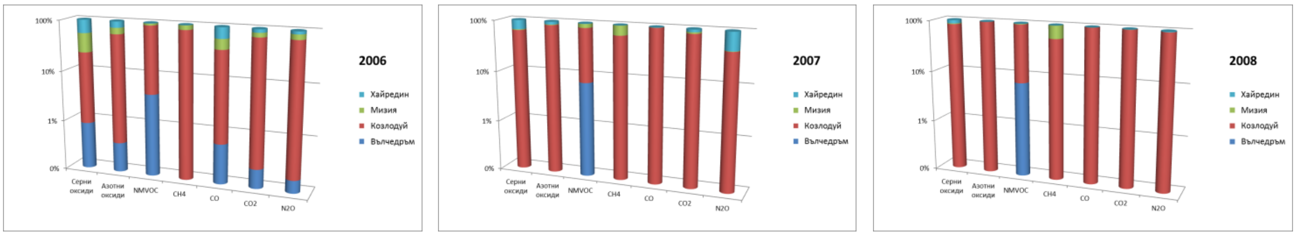


FIGURE 3.1-16: EMISSIONS FROM COMBUSTION AND PRODUCTION PROCESSES

3.1.2.3 EMISSIONS FROM NAVIGATION ALONG DANUBE RIVER

River traffic along the Danube River bordering the region around the NPP (national and international) is a source of emissions from ship engines. Diesel (compression ignition) engine emissions to atmospheric air along inland water ways (IWW[10]) are regulated by MARPOL 73/78, Appendix VI, where the emission restrictions for certain pollutants depend on the engine class (cylinder working volume).

The assessment of emissions into the air is based on river traffic (number and type of passed ships) in the lower stream of the Danube river (the Bulgarian section of the river) published in EUROSTAT[11], where the total amount of goods (in tons), transported on an annual basis along inland water ways, as well as the national, international, and transit transportations are given in the form of "ton-km" (Tkm) –**Table 3.1-11**. This provides to apply emission factors in the dimension grams of harmful substance emitted per ton-kilometer (g/Tkm) in emission calculations[12].

TABLE 3.1-11: FREIGHTS TRANSPORTED ALONG INLAND WATER WAYS IN LOWER DANUBE

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

[10] IWW – Inland Water Ways

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

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

Year	Ton	Ton-km	km
average	9 776 705	2 508 699 955	213

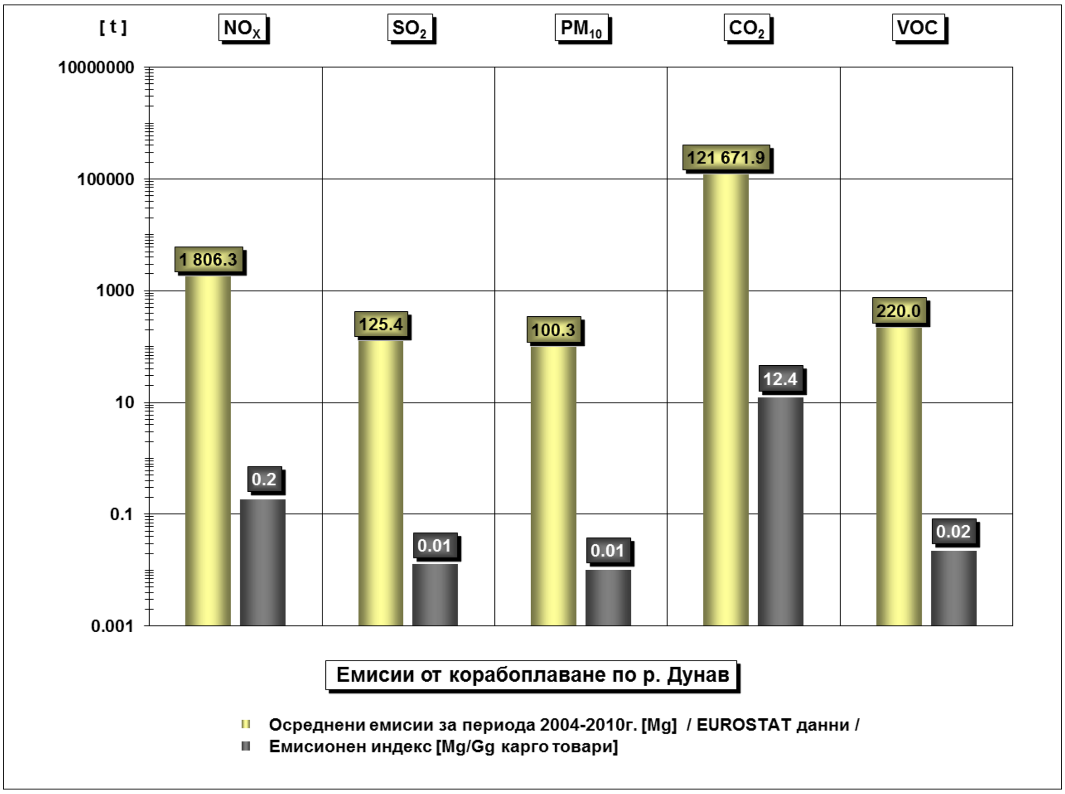


FIGURE 3.1-17: EMISSION LEVELS, AVERAGE VALUES FOR THE PERIOD 2004-2010 AND EMISSION INDEX OF A GIVEN POLLUTANT FROM THE NAVIGATION ALONG LOWER DANUBE

Emissions from navigation along Danube River
Average emissions for 2004-2009 period [Mg] /EUROSTAT data/
Emission Index [Mg/Kg Cargo]

Figure 3.1-17 shows the annual levels of navigation emissions, as well as the emission index of a given pollutant averaged over the period, calculated pursuant to the requirements of MARPOL 73/78, Annex VI.

The obtained emission indexes for a given pollutant are below the usual values of the same indexes – e.g. for Varna port they are many times higher. It will be taken into consideration that the indexes for the Varna port are for a small area (the port area), while for the Danube River the indexes cover the whole river stretch, therefore for a certain river section (e.g. along the length of the power plant) they will be even lower.

3.1.2.4 EMISSION SOURCES TO THE AIR WITHIN 30 KM ZONE AROUND KOZLODUY NPP AD[13]

TABLE 3.1-12: ENTERPRISES, EMISSION SOURCES OF WASTE GASES WITHIN THE 30 KM ZONE

Name of the operator	Activity	Location	Sources of emissions to the air	Waste water treatment plants	Hazardous substances, released to the air	Emissions kg/y
"Eggs and Poultry" AD, city of Mizia – city of Kozloduy site	Intensive poultry breeding with more than 40 000 places	city of Kozloduy, Kozloduy Municipality, Vratsa District	Ventilation system			
			9 axial ventilators	-	CH_4[14]	4 064
					N_2O	632
					NH_3	16 708
					FPM_{10}	1 369.1
			Fodder kitchen			
			Dozing and micro-elements	1 pc. Sleeve filter and 1 pc. cyclone	dust	7 14 (Nm³/h)
			Grain miller	1pc. cyclone		559 (Nm³/h)
			Elevator at 12 meters elevation	1pc. cyclone		1 180 (Nm³/h)
			Elevator at 16 meters elevation	1pc. cyclone		1 211 (Nm³/h)
"Eggs and Poultry" AD, city of Mizia – city of Mizia site	Intensive poultry breeding with more than 40 000 places	city of Mizia, Mizia Municipality, Vratsa District	130 pcs. axial wall ventilators	-	CH_4[15]	5 977
					N_2O	930
					NH_3	24 572
					FPM_{10}	1 992
Oryahovo Municipality	Regional landfill for non-hazardous waste for Oryahovo, Valchedram, Kozloduy, Hayredin, Mizia, Byala Slatina, Borovan and Knezha municipa-	city of Oryahovo Oryahovo Municipality, Vratsa District	The building of gas wells and gas ventilation system for biogas combustion	-	CH_4,[16]	1 295.1
					CO2	2 604.2
					NH_3	45.05

[13] Regional Inspectorate of Environment and Water – Vratsa, letter No198/25.02.2013, Delivery-Acceptance Protocol No15/26.02.2013

[14] Annual Report on the Implementation of the Activities under KP No259-HO/2008, March 2012

[15] Annual Report on the Implementation of the Activities under KP No258-HO/2008, March 2012

[16] Annual Report on the Implementation of the Activities under KP No249-HO/2008, 2012

Name of the operator	Activity	Location	Sources of emissions to the air	Waste water treatment plants	Hazardous substances, released to the air	Emissions kg/y
	lities Cells No 1, 2 and 3					
"Hidcom"AD city of Oryahovo	Production of construction metal structures and other metal products	city of Oryahovo, Oryahovo Municipa-lity, Vratsa District	Metal surface coating installations	-	Common hydrocarbons (total organic carbon)	5 000 (Nm3/h)

Upon observation of the emission norms, included in the complex permits, the quantities of hazardous substances, released into the air by the above mentioned emission, do not impact the ambient air quality within the 30 km zone.

3.1.2.5 EMISSIONS FROM AUTOMOBILE TRAFFIC ON SECOND CLASS ROAD II-11

Kozloduy NPP site is connected to the Republican road network through a second class road with two-way traffic, asphalted and well-marked. This is road II-11, "Oryahovo-Mizia-Kozloduy-Lom" section, which runs southward of Kozloduy NPP and the site of the National Radioactive Waste Storage Facility (NRWSF), through the non-flooding terrace of the Danube River. It provides to take away the inter-settlement passenger, inclusive of the transit freight traffic.

The emissions from the regular traffic around the region of the NPP have been evaluated by data about the mean-24-hour annual intensity of the car traffic for 2010, as measured at the counting sites of the Road Infrastructure Agency for road II-11 of the Republican road network: at additional counting posts (ACP)-205 in the Kozloduy-Lom section and at ACP-496 in the Mizia-Kozloduy section[17].

Table 3.1-13 contains the data for the Mean-24-hour annual intensity of car traffic – diagnosis for 2010 and forecast for 2015 and 2020, presents the data about the mean-24-hour intensity of automobile traffic for the 6 major car classes are shown: Automobiles, Light-Duty Automobiles, Medium-Duty Automobiles, Heavy-Duty Automobiles, Buses (out-of-town) and Heavy-Duty Automobiles with Trailers. The forecast intensity for 2015 and 2020 has been made based on traffic increase between 10% and 18% for the different types of automobile classes.

[17] *Annex 8 – INPUT DATA* – Letter No ЦИ-0167-0158 of 04.02.2013

TABLE 3.1-13: MEAN ANNUAL24-HOUR INTENSITY OF THE AUTOMOBILE TRAFFIC – DIAGNOSIS 2010 AND PROJECTION FOR 2015 AND 2020

Year	Counting point	Light automobiles	Buses	Light -duty trucks	Medium- duty trucks	Heavy- duty trucks	Heavy- duty trucks with trailers & tow trucks with semi-trailers	Total of freight automobiles	Total number of vehicles
2010	ACP-205	798	17	267	24	13	38	342	1 157
	ACP-496	6 185	252	964	166	48	150	1 328	7 765
2015	ACP-205	938	20	314	28	14	45	401	1 359
	ACP-496	7 266	295	1 134	195	53	177	1 559	9 120
2020	ACP-205	1 102	24	369	33	16	53	470	1 597
	ACP-496	8 535	346	1 333	229	59	208	1 830	10 711

The assessment of emission levels of various pollutants from the road is made using **Tier 2**[18] from the European *Air Pollutant Emission Inventory Guidebook of* ***EMEP/EEA CORINAIR'2009*** for the man pollutants from: (a) passenger cars (**NFR** code **1.A.3.b.i**), **(b)** light-duty vehicles below 3.5 tons (**1.A.3.b.ii**), (c) heavy-duty vehicles above 3.5 tons and (d) buses (**1.A.3.b.iii**) under item **Transport.** Based on that, the results from the calculation of the following emissions have been presented:

- Precursors to ozone – CO, NO_X, NMVOC (non-methane volatile compounds),
- Greenhouse gases (CO_2, CH_4, N_2O),
- Acidifying substances (NH_3, SO_2),
- Fine particulate matter (PM) – only $PM_{2.5}$ fraction, since the higher fraction $PM_{2.5÷10}$ is negligible in the soot of the exhaust gases;
- Carcinogenic compounds:
  - ✓ PAH – polycyclic aromatic hydrocarbons (Benzo (α) pyrene, Benzo (b) fluoranthene + Benzo (k) fluoranthene, indeno (1,2,3-cd) pyrene – for lead-free petrol),
  - ✓ POP – persistent organic pollutants,
  - ✓ Toxic substances (DIOX – Dioxins and furans (for lead-free petrol),
- Heavy metals.

[18] In determining the emission levels of greenhouse gases (GHGs) in IPCC methodology, methods with different complexity are used. The level of complexity of the method is designated as Tier X, i.e. when X is higher digit, the method is more complex and more accurate.

The estimation does not include emissions from fuel evaporation (**NFR** code **1.A.3.b.v**), tire and brake wear (**NFR** code **1.A.3.b.vi**), as well as from road pavement wear (**NFR** code **1.A.3.b.vii**).

Table 3.1-14, shows the emission loading in kilograms per 1 kilometer of the relevant road from the Republican Road Network.

TABLE 3.1-14: EXISTING EMISSION LOADING IN KILOGRAMS PER 1 KILOMETER OF THE RELEVANT ROAD SECTION (KG/KM)

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

3.1.2.6 EMISSIONS FROM ACTIVITIES AT KOZLODUY NPP SITE

3.1.2.6.1 Emissions from LNRMIW of Kozloduy NPP

The Landfill for Non-Radioactive Municipal and Industrial Wastes (LNRMIW) receives no radioactive waste from the protected zone of Kozloduy NPP. The landfill is a source of greenhouse gases – methane (**CH_4**) and carbon dioxide (**CO_2**) and small quantities of other volatile organic compounds.

Landfill[19] gas is formed in the body of a given landfill at temperature of approximately 10-20°C higher than the temperature of the surrounding air, and its speed and quantities depend on:

- → Morphological composition of the waste – the bigger the organic component of the waste, the greater the amount of the released landfill gas
- → Age of the waste
- → Presence of oxygen – methane generation starts only after the oxygen amounts in the waste body are depleted,
- → Moisture content – the moisture content accelerates the biological decomposition process. The optimal moisture content is 40% – 50%,
- → Temperature – in summer the released gas amounts increase and in winter they decrease.

After the landfill gas is generated in the cell body, it is emitted to air through:

- → **Diffusion –** gases shift from places with high concentration to places with low concentration;
- → **Convection** – places with higher pressure push out the gas to the surface;
- → **Solubility** – methane is soluble in water and it is also released in small amounts through the produced infiltrate.

The waste quantities, accepted at the landfill until 2011, are shown in **Table 3.1-15**.

[19] When the landfill gas is cleaned from the condensate and some admixtures (e.g. sulphur), it turns into biogas, which can be used as fuel.

TABLE 3.1-15: RECEIVED WASTE AMOUNTS AT LNRMIW.[20]

Years	Amount of received waste [m³]	Amount of received waste with accumulation [m³]	Tim of filling [years]
As of 31.XII 2001.	7 298	-	1
As of 31.XII 2002	5 397	12 695	2
As of 31.XII 2003	4 690	17 385	3
As of 31.XII 2004	4 267	21 652	4
As of 31.XII 2005	4 690	26 342	5
As of 31.XII 2006	5 153	31 495	6
As of 31.XII 2007	4 421	35 916	7
As of 31.XII 2008	4 836	40 752	8
As of 31.XII 2009	5 519	46 271	9
As of 31.XII 2010	4 747	51 018	10
As of 31.XII 2011	4 949	55 967	11

The emissions (total: from diffusion, convection and dissolved in the infiltrate) from the landfill body are calculated using the **LandGEM**[21] model of the US Environmental Protection Agency (EPA).

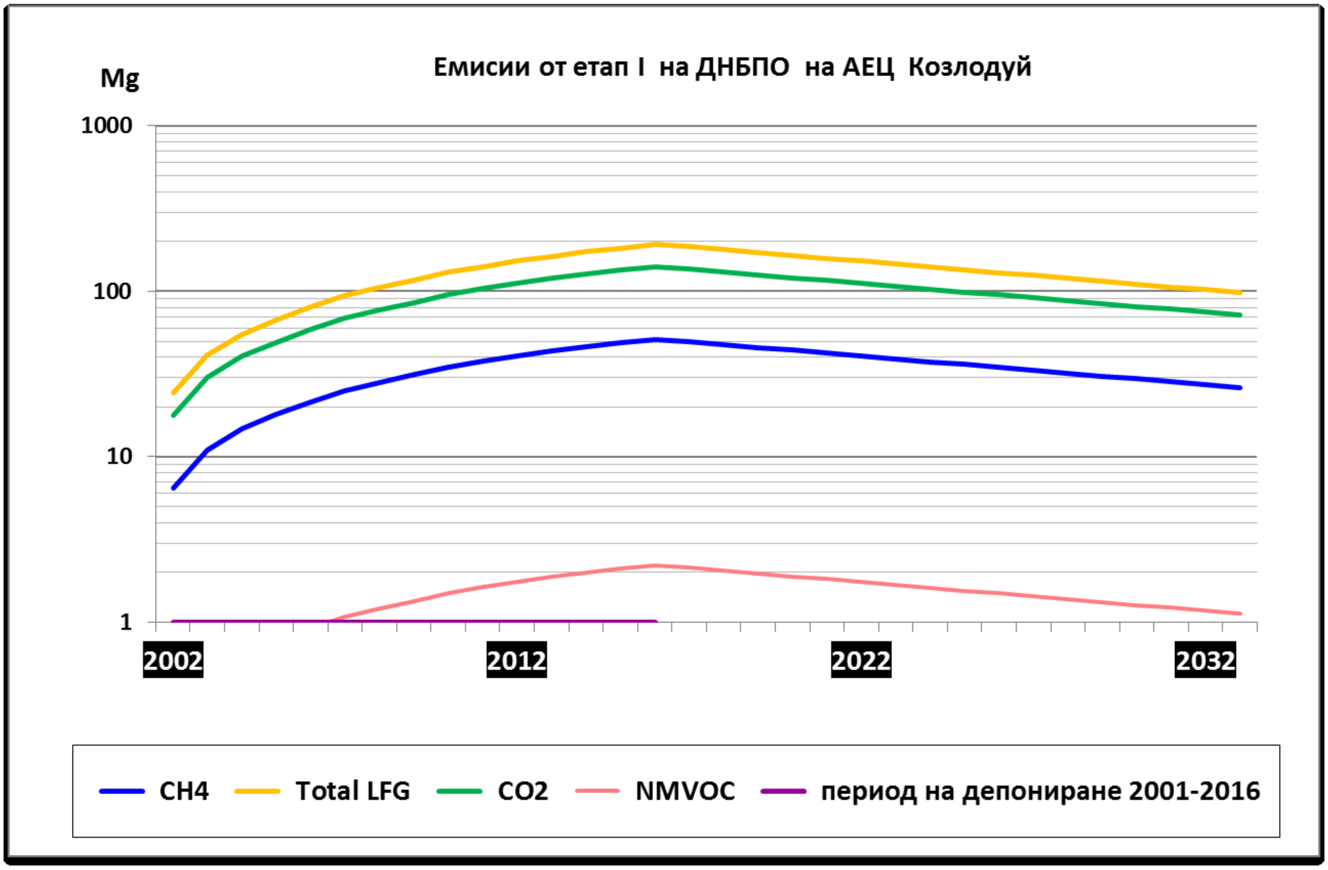
The model is based on the (bacteriological) decomposition of the organic component of the municipal waste linear equation. The input parameters are the starting year of deposition, the landfill capacity and the amounts of deposited waste by years (Mg). Based on the capacity of a given landfill, the model may also calculate the year until which it will be available for deposition. Since in the document for in-house monitoring of LNRMIW it is stated that 85% of the capacity is filled at Stage I, the model has calculated that with 9% increase of the deposited amounts, Stage I may be used until 2016.

The emission evolution of some gases from the landfill with 50% (voluminous %) methane content in the landfill gas is shown on **Emissions from** *Stage I of LNRMIW of Kozloduy NPP, Deposition period 2001 – 2016*

Figure 3.1-18*.*

[20] Plant non-radiation monitoring of the Landfill for Non-Radioactive Municipal and Industrial Wastes, 2011.

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



Emissions from Stage I of LNRMIW of Kozloduy NPP, Deposition period 2001 – 2016

FIGURE 3.1-18: EMISSION LEVELS FROM LNRMIW WITH DEPOSITION UNTIL 2016

The inventory of the emission amounts during 2012 from the Landfill body is given in **Table 3.1-16**

TABLE 3.1-16*:* AMOUNTS OF GASES (TONS), EMITTED FROM DRHIW FOR 2012.

CH_4	CO_2	NMVOC	Landfill gas
40.76	111.83	1.75	152.6

3.1.2.6.2 Emissions from the diesel generators for emergency power supply of the safety systems

There is practically no greenhouse gas release during the electricity production by the nuclear power plant. As a part of the safety systems of the nuclear power units in Kozloduy NPP though, diesel generators and diesel pumps are used, whose designation is to join the operation in case of emergency power cut-off.

The diesel generators for emergency power supply to the safety systems on the site of Kozloduy NPP represent combustion installations with a rated thermal input exceeding 50 MW, which fall within the scope of art.131c, par.1 of the Environmental Protection Act (EPA).

According to art.10, par. 6 of the Regulation on the procedure and the way for issuing and revision of permits for greenhouse gas emissions and for performing of monitoring by the operators of installations and by the operators of aircrafts, participating in the scheme for trading with greenhouse gas emission quotas (promulgated SG, No 99 of 17.12.2010), Kozloduy NPP EAD has issued Permit for greenhouse gas emissions – No143-H1/2012 with rated thermal input of the installation of 71.398 MW, including the following equipment **Table 3.1-17**.

TABLE 3.1-17: EQUIPMENT OF THE DIESEL GENERATORS FOR EMERGENCY POWER SUPPLY TO THE SAFETY SYSTEMS

	Combustion installation	Engine type	Rated power (kW)
BPS	DG-1	15D100	1700
	DG -2	15D100	1700
EP-1	31 DG (Unit 3)	15D100	1700
	32 DG (Unit 3)	15D100	1700
	33 DG (Unit 3)	15D100	1700
	41 DG (Unit 4)	15D100	1700
	42 DG (Unit 4)	15D100	1700
	43 DG (Unit 4)	15D100	1700
	1 EDG of ASESSP for Unit 3	8V 396 TC 34	735
	2 EDG of ASESSP for Unit 4	8V 396 TC 34	735
	3 EDG of ASESSP for Unit 3	8V 396 TC 34	735
	4 EDG of ASESSP for Unit 4	8V 396 TC 34	735
	1 Mobile DG (MDG) for Units 1÷6	KTA 50-G3	1500
	1 DFPP for Units 1÷4	IVECOAIFO82 10Sril2	316
	2 DFPP for Units 1÷4	IVECOAIFOS2 10Sril2	316
EP-2	5 GX (Unit 5)	12ZV 40/48	6600
	5 GV (Unit 5)	I2ZV 40/48	6600
	5 GW (Unit 5)	12ZV 40/48	6600
	5 GZ (1pc. Additional DG for Unit 5)	Caterpillar 3616	5429
	6 GX (Unit 6)	12ZV 40/48	6600
	6 GV (Unit 6)	12ZV 40/48	6600
	6 GW (Unit 6)	12ZV 40/48	6600
	6 GZ (1 pc. Additional DG for Unit 6)	Caterpillar 3616	5429
У"Б"	Diesel pumps in CPS-3, 4 (2 x 4 pcs.)	Д12АС	220
	Diesel generator No 1 of ERA (1 pc.)	АД-30	35
	Diesel generator No 2 of ERA (1 pc.)	XP-1000FG Wilson	100

	Combustion installation	Engine type	Rated power (kW)
У"С' WSFSF	Diesel generator No 3 of ERC-ELB (1 pc.)	АД-60-3-С-4	60
	DG of ENC (1 pc.)	P2IM	18
	Diesel generator of WSFSF (1 pc.)	МГВ2-200	295
		TOTAL	71 398

Legend:

EDG Emergency Diesel Generator
BPS Bank Pumping Station
DG Diesel generator
DFPP Diesel Fire-Protection Pump
ASESSP Additional System for Emergency Supply of Steam Plants
MDG Mobile Diesel Generator
ELB Engineering Laboratory Building
FFPS Fire-Fighting Pumping Station
ENC Emergency Notification Center
CPS Circulation Pumping Station
ERC Emergency Response Center
WSFSF Wet Spent Fuel Storage Facility
GZ, GV, GW, GX Denotations of the diesel generators in EG-2

The diesel generators (DG) are designated for emergency power supply to the safety systems (SS) of NPP, and the diesel powered pumping units ensure water for the fire-fighting systems upon power supply failure. They are maintained as "hot reserve" and periodically tested according to approved schedules and procedures. The periodicity and duration are different for the different testing regimes.

The diesel generators (DG 31÷33 и DG 41÷43) are tested pursuant to schedule once per 3 months in the course of 1 hour. The duration is the same for the testing after current repair.

Under normal operation, DG of units 5 and 6 (denoted as GZ, GV, GW, GX) are started and operate according to schedule once per month – two months for 30 minutes and in the third month – for one hour. After repair, testing is carried out compliant with a separate program, and its duration is longer than the normally scheduled. After planned annual repair of any of the power units, the testing of the relevant DG continues (normally) for about 5 hours. During NPP blackout, DGs are started and may operate under full load up to 10 days after blackout.

The diesel generators DG-1 и DG-2 of BPS are tested according to schedule once per month in for 1 hour. After overhaul all diesel units undergo 72-hour tests.

The tanks on the site of Kozloduy NPP are shown in **Table 3.1-18**.

TABLE 3.1-18: DIESEL TANKS

Diesel tanks	Pieces	Volume (m^3)	Tank design
DGS-1 (surface, SE"RAW")			
DG-12, 22	2	40	Welded, cylindrical
Ground-level EP-1			
DG-31÷43 DGS-2 consumption	6	2.7	Welded, cylindrical

Diesel tanks	Pieces	Volume (m^3)	Tank design
MDG	1	3	Welded, cylindrical
Main fuel tank	1	100	Welded, cylindrical
ППС-2 main	2	10	Welded, cylindrical
ППС-2 consumption	2	0.8	Welded, cylindrical
PS of ASESSP backup	2	8	Welded, cylindrical
PS of ASESSP daily	2	3.5	Welded, cylindrical
DG-1, ERC	1	0.08	Welded, cylindrical
DG-2, ERC	1	0.2	Welded, cylindrical
Underground, EP-1			
DG-31÷43 DGC-2 intermediate	6	23	
Ground-level, EP-2 (DGS-5, 6)			
5 GV, 5 GW,5 GX, 6 GV, 6 GW, 6 GX – intermediate	6	100	
5 GV, 5 GW, 5 GX, 6 GV, 6 GW, 6 GX – consumption	6	12	
5 GZ, 6 GZ- intermediate	2	100	
5 GZ, 6 GZ- consumption	2	3	
Fuel facility	2	2000	
WSFSF			
DG-1	1	0.4	
BPS			
DG-1, 2: common	1	40	
DG-1, 2	2	2.7	
Others			
CPS-3,4: Common fuel tank	2	6	
CPS-3,4: Consumption fuel tank	8	0.2	
DG Emergency preparedness – ELB-2:	1	0.2	

The emissions (**Table 3.1-19**) of FPM_{10}, SO_X, NO_X, CO and NMVOC (non-methane volatile organic substances) are calculated according to the emission factors of the US Environmental Protection Agency (EPA) AP-42 – **Big stationary diesel generators**, **section 3.4**[22]**,** based on the used fuel. To determine CO_2 the emissions during the burning of a given fuel quantity with lower heating value (LHV) of 74.0667 t/TG the *Methodology for GHG emission monitoring by the operators of the installations*[23] is used.

[22] http://www.epa.gov/ttn/chief/ap42/ch03/index.html

[23] Methodology for GHG monitoring by the operators of installations, participating in the scheme for trading with greenhouse gas emission quotas, endorsed with Order No РД-442/17.07.2008 of the Minister of Environment and Water.

TABLE 3.1-19: ANNUAL EMISSIONS FROM THE DIESEL GENERATORS AT KOZLODUY NPP SITE

Year	Quantity tons	FPM_{10}	SO_X	NO_X	CO	NMVOC	CO_2
		тона за година					
2009	108.14	14.42	13.49	205.07	44.18	16.28	**338.80**
2010	100.47	13.39	12.53	190.52	41.04	15.12	**314.77**
2011	117.82	15.71	14.69	223.42	48.13	17.73	**369.13**
2012	92.60	12.34	11.55	175.60	37.83	13.94	**290.12**

3.1.2.6.3 Emissions from bus traffic from and to Kozloduy NPP

The emissions (**Table 3.1-21**) in the Transport scheme for workers' transportation[24] are evaluated pursuant to EMEP/EEA CORINAIR'2009 (SNAP **0808**, and for carbon dioxide – according to IPCC (**NFR** code **1.A.5.b.iii**), based on the data from **Table 3.1-20**. The average bus speed is 50 km/h.

TABLE 3.1-20: PARAMETERS OF THE BUS TRANSPORT SCHEME FOR KOZLODUY NPP

	Number	Trip/day	Distance	km/year	Working hours/year
bus Mercedes (Турз.)	1	1	175	45 500	910
bus Iveco	5	5	110	715 000	14 300
bus Mercedes	25	25	60	9 750 000	195 000
bus Setra 215 НД	5	5	120	780 000	15 600
bus Setra 315 НД	3	4	175	546 000	10 920

TABLE 3.1-21: EMISSIONS FROM THE BUSES IN THE TRANSPORT SCHEME

Emissions [Mg] / MV	Greenhouse gases			Main and specific pollutants					
	CO_2	CH_4	N_2O	NO_X	SO_X	CO	NMVOC	PM_{10}	NH_3
Buses	48 811.9	3.0	21.1	211.0	1.5	211.0	30.1	12.1	0.12

Emissions are directly released to air by the exhaust pipes of the buses. The total amount of greenhouse gases, expressed in tons of CO_2 equivalent, is 55 415.6 tons per 1 year. The burned quantity of diesel fuel by emission factors is 15 311.1 tons per year.

[24] The data are for 2011, letter РиМ No 96/14.02.2013

3.1.2.6.4 Emissions from the personal automobiles of Kozloduy NPP staff

Kozloduy NPP site is connected with the Republican road network through a second class road with two-way traffic, asphalted and with well-marked, deviation from road II-11, "Oryahovo-Mizia-Kozloduy-Lom" section, which passes south from Kozloduy NPP and NRWSF site.

The annual assessment of the emission levels from the staff automobiles (**Table 3.1-22**) is made pursuant to Tier 2 of the European *Air Pollutant Emission Inventory Guidebook* EMEP/EEA CORINAIR'2009 on the main pollutants from light-duty vehicles (**1.A.3.b.ii**) for 1500 parking places[25] under average conservative value of automobile movement distance to/from the parking place equal to 1 000 meters.

TABLE 3.1-22: ANNUAL EMISSIONS IN KG/Y

CO	NMVOC	NOx	N2O	NH3	Pb	PM2.5	Ideno Pyrene
kg/y							
1.665	0.159	0.978	0.009	0.016	2.36E-06	0.036	6.38E-07

TABLE 3.1-21(CONTINUED)

B(k)F	B(b)F	B(a)P	CO_2	SO2	benzene	tCO_2eq
kg/y						t/y
7.78E-07	9.50E-07	5.25E-07	301.87	0.00384	0.0048	**0.31**

The emissions are released directly to air by the exhaust pipes of the automobiles. The total GHG amount, expressed in tons of CO_2 equivalent is 0.31 tons per year

3.1.2.7 MEASURED CONCENTRATIONS

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

In 2011, after the approved operation schedule for the Mobile Automatic Stations (MAS), which perform additional measurements in regions, where stationary points are lacking or restricted in number, the Mobile Automatic Stations (MASs) performed measurements for atmospheric air control in the North/Danubean Region for Assessment and Control of the Atmospheric Air Quality (RACAAQ) in the Municipality of Kozloduy for 52 24-hour periods,

[25] Based Client's data – РиМ No 96/14.02.2013

performed by the Regional Laboratory – Pleven at the site of the Regional Fire and Emergency Safety Service (RFESS), city of Kozloduy[26].

The atmospheric conditions for the measurement periods are shown on the figures below (**Atmospheric status** *within the period 07-14 March 2011, Sun shining, Wind speed, Stability class, Temperature*

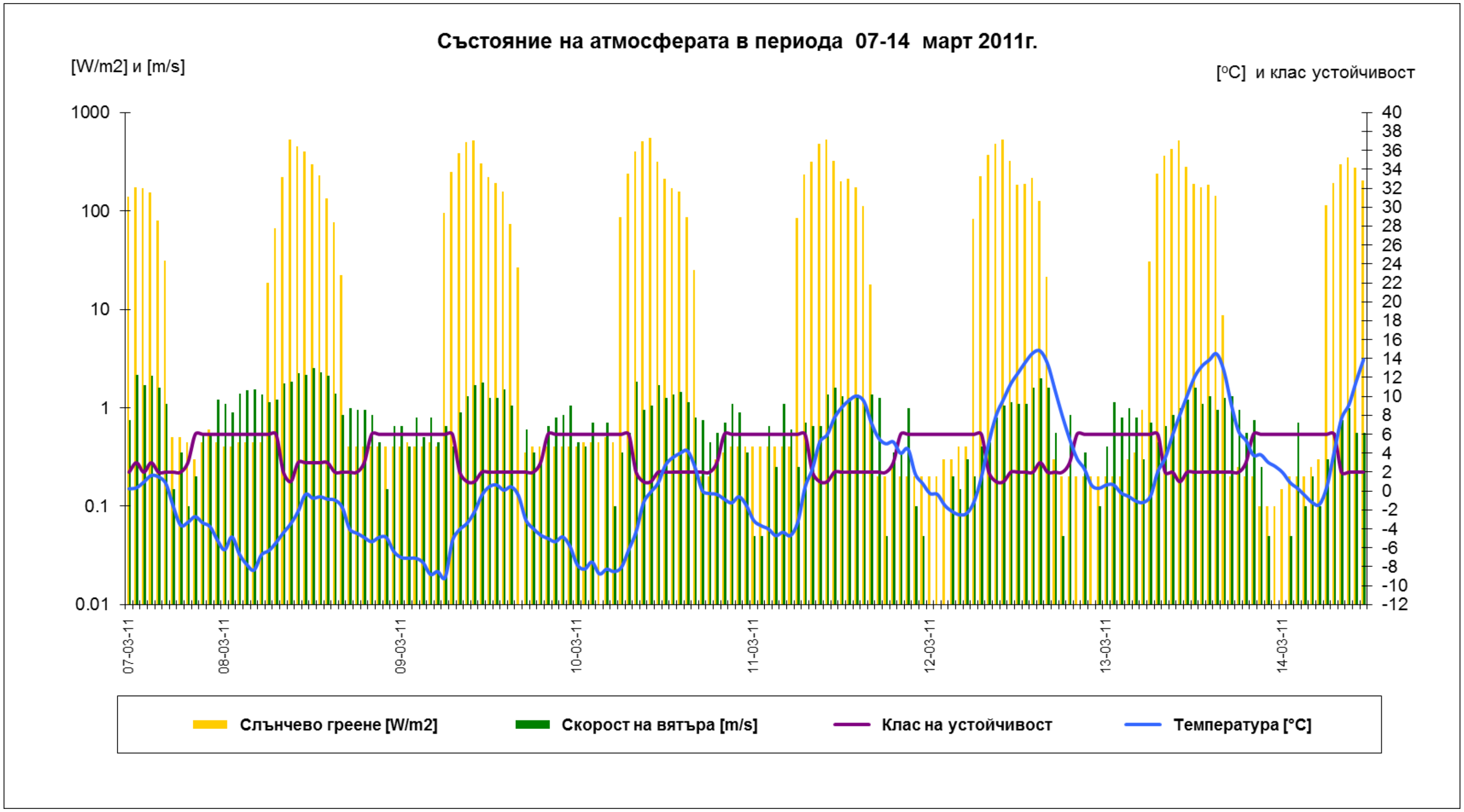
Figure 3.1-19 to **Atmospheric status** *within the period 22 November-02 December 2011, Sun shining, Wind speed, Stability class, Temperature*

Figure 3.1-25). Depending on the sun radiation, wind speed and the hour within the 24-period, the Pasquill stability classes (A = 1, B = 2, C = 3, D = 4, E = 5 and F = 6) have been determined. From these figures it is seen that the stable atmospheric conditions occur in the evening and during the night – between 19:00 and 08:00[27].

The sun shining has been stronger in June. In September it is higher than in March, which may be due to bigger cloudiness in the spring (this parameter is not recorded) and more precipitations, which is confirmed by the measured higher humidity in March, compared with September, where the average humidity for the measurement period is slightly exceeding 41%.

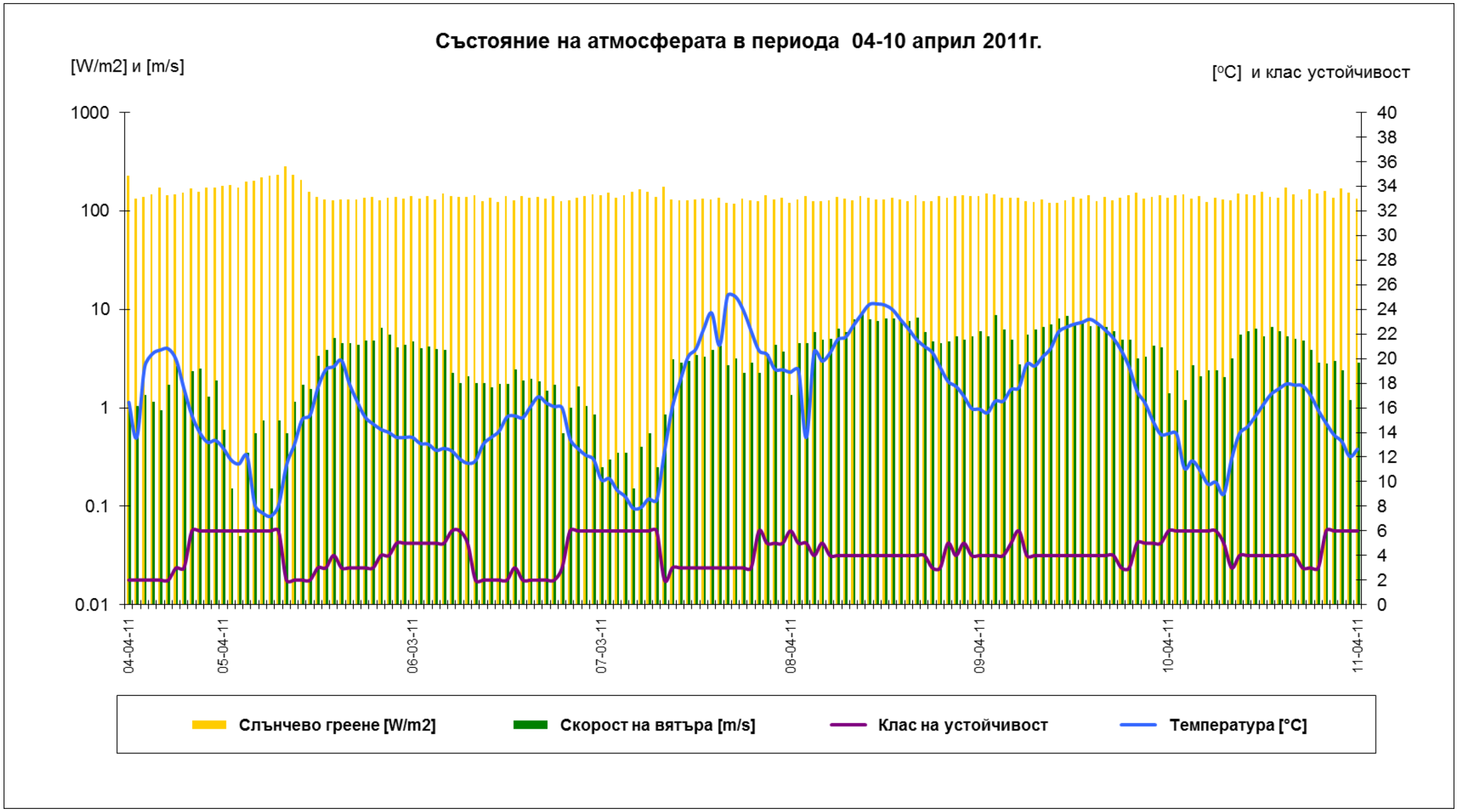
[26] *Annex 8 – INPUT DATA* – Protocols from the Regional Laboratory – Pleven, 2011

[27] The measurements for the period 04 – 10 April are not reliable, due to the non-inherent values of the sun radiation – high radiation quantities during the night hours.



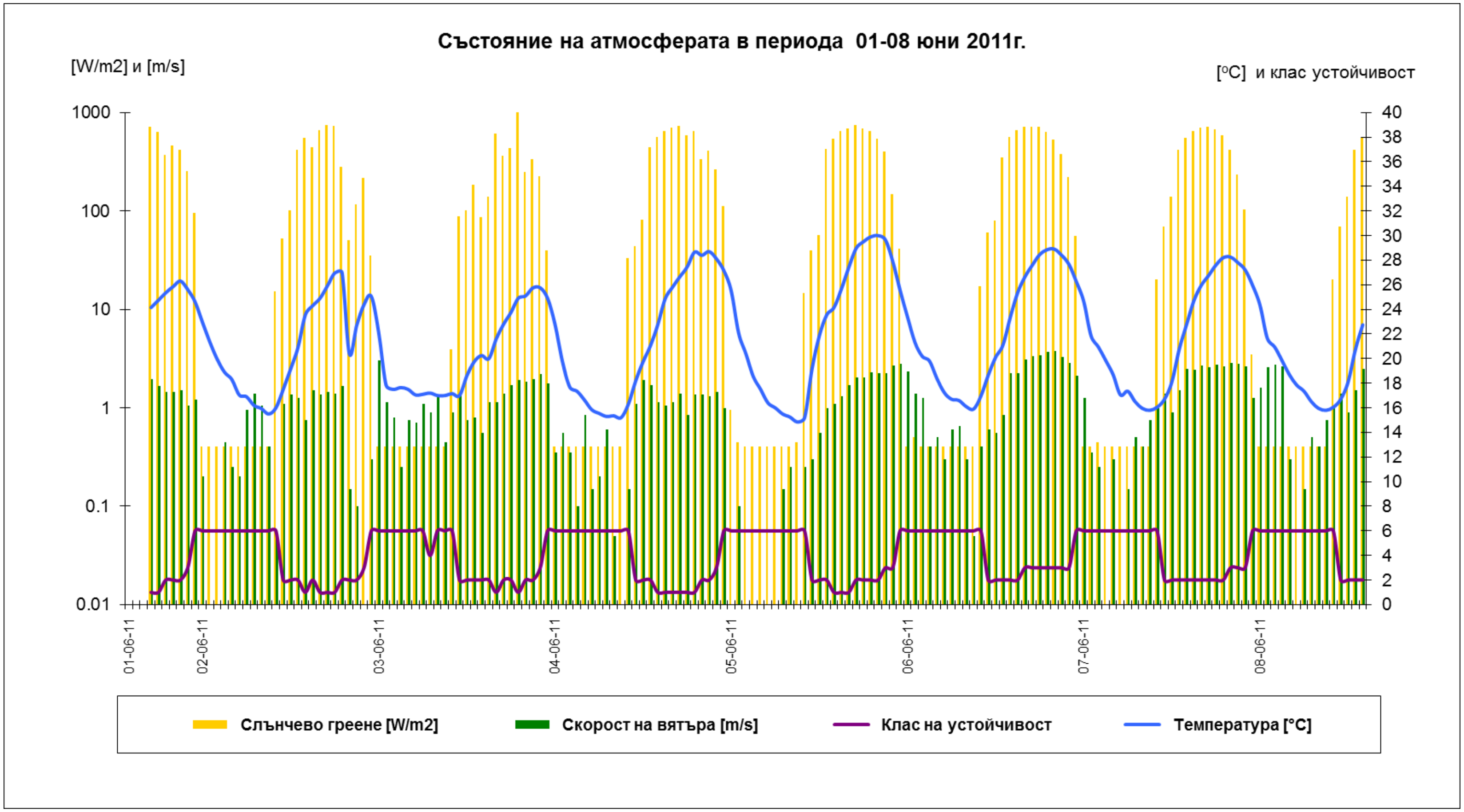
Atmospheric status within the period 07-14 March 2011, Sun shining, Wind speed, Stability class, Temperature

FIGURE 3.1-19: MARCH 2011



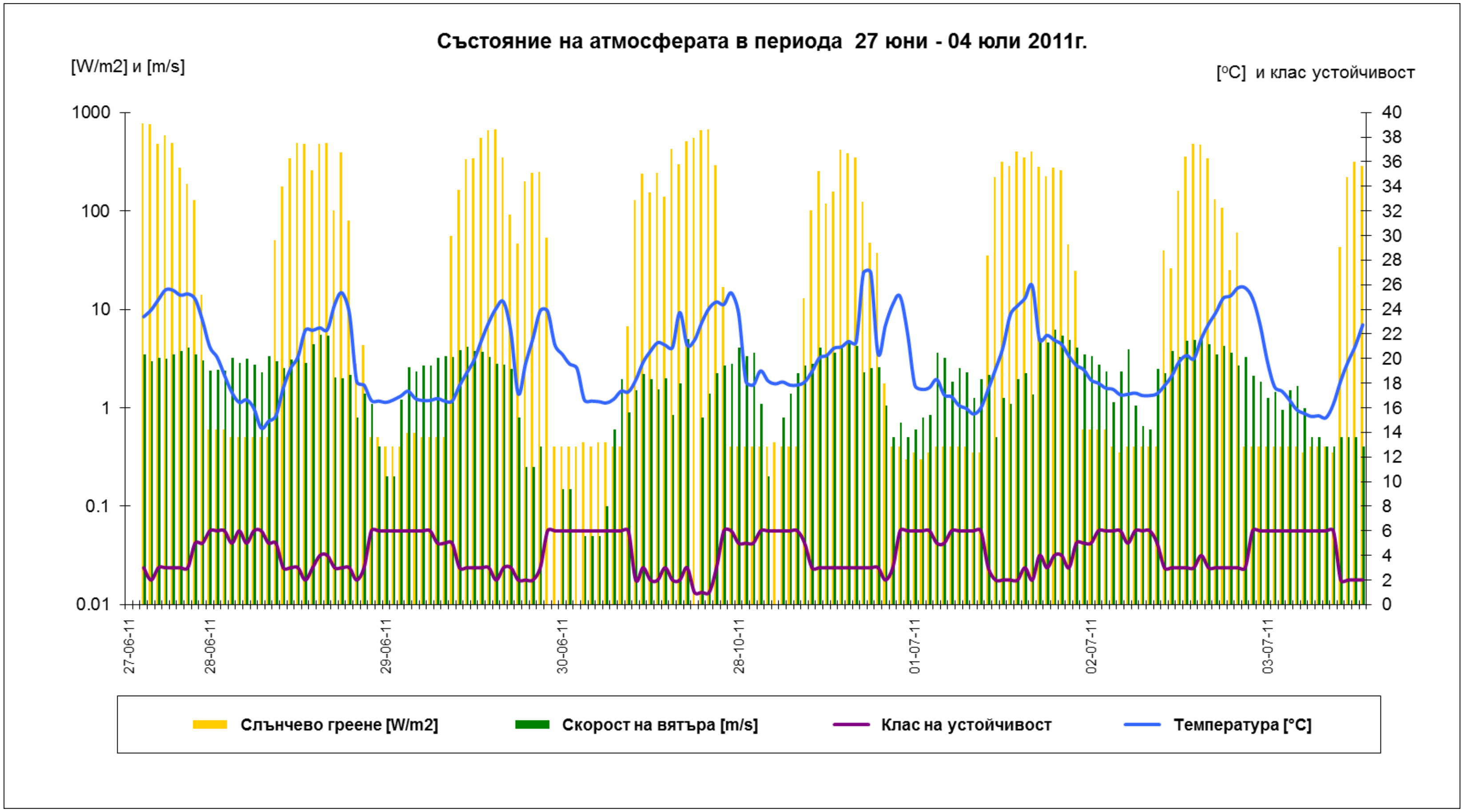
Atmospheric status within the period 04-10 March 2011, Sun shining, Wind speed, Stability class, Temperature

FIGURE 3.1-20: APRIL 2011



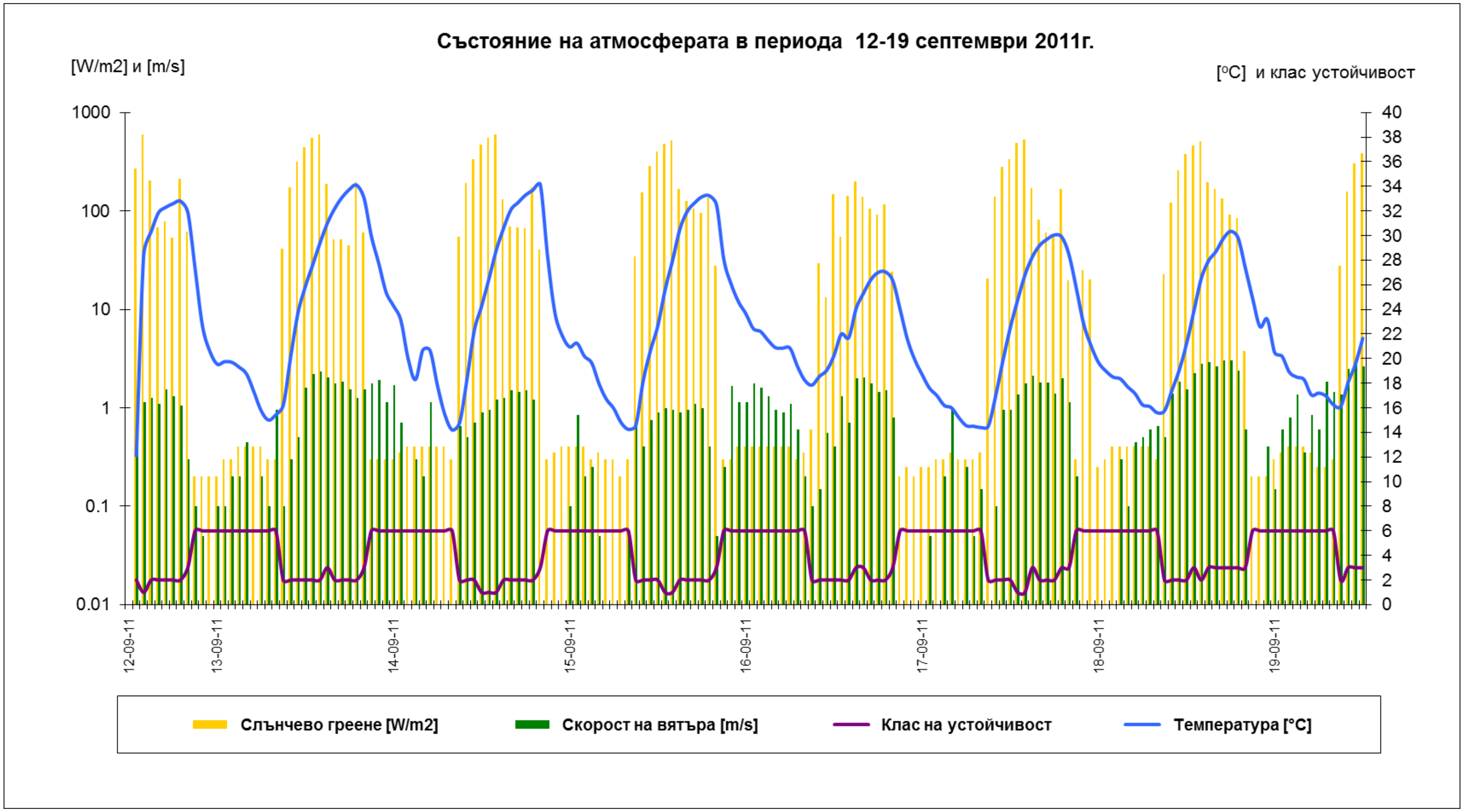
Atmospheric status within the period 01-08 June 2011, Sun shining, Wind speed, Stability class, Temperature

FIGURE 3.1-21: JUNE 2011



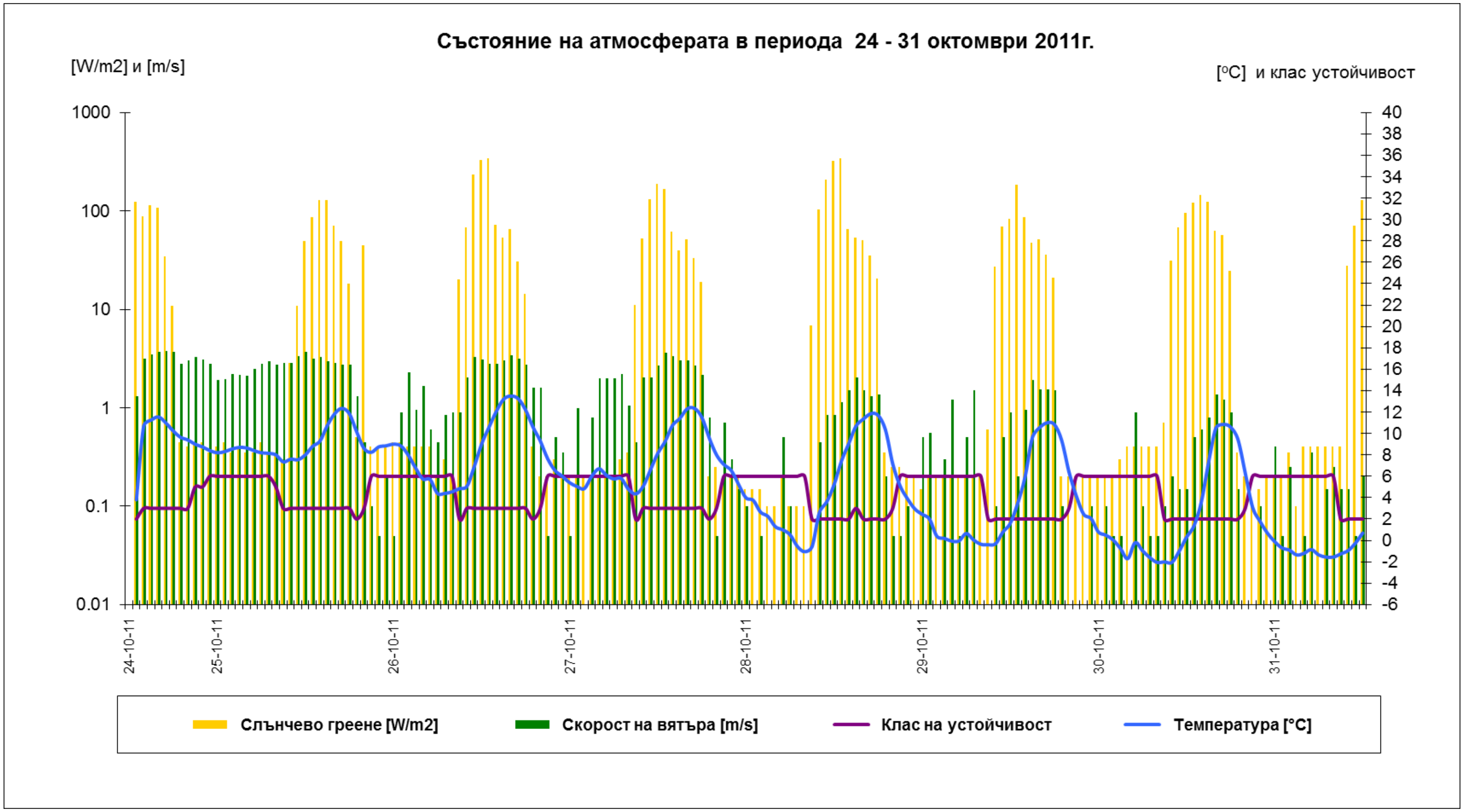
Atmospheric status within the period 27 June-04 July 2011, Sun shining, Wind speed, Stability class, Temperature

FIGURE 3.1-22: JUNE/JULY 2011



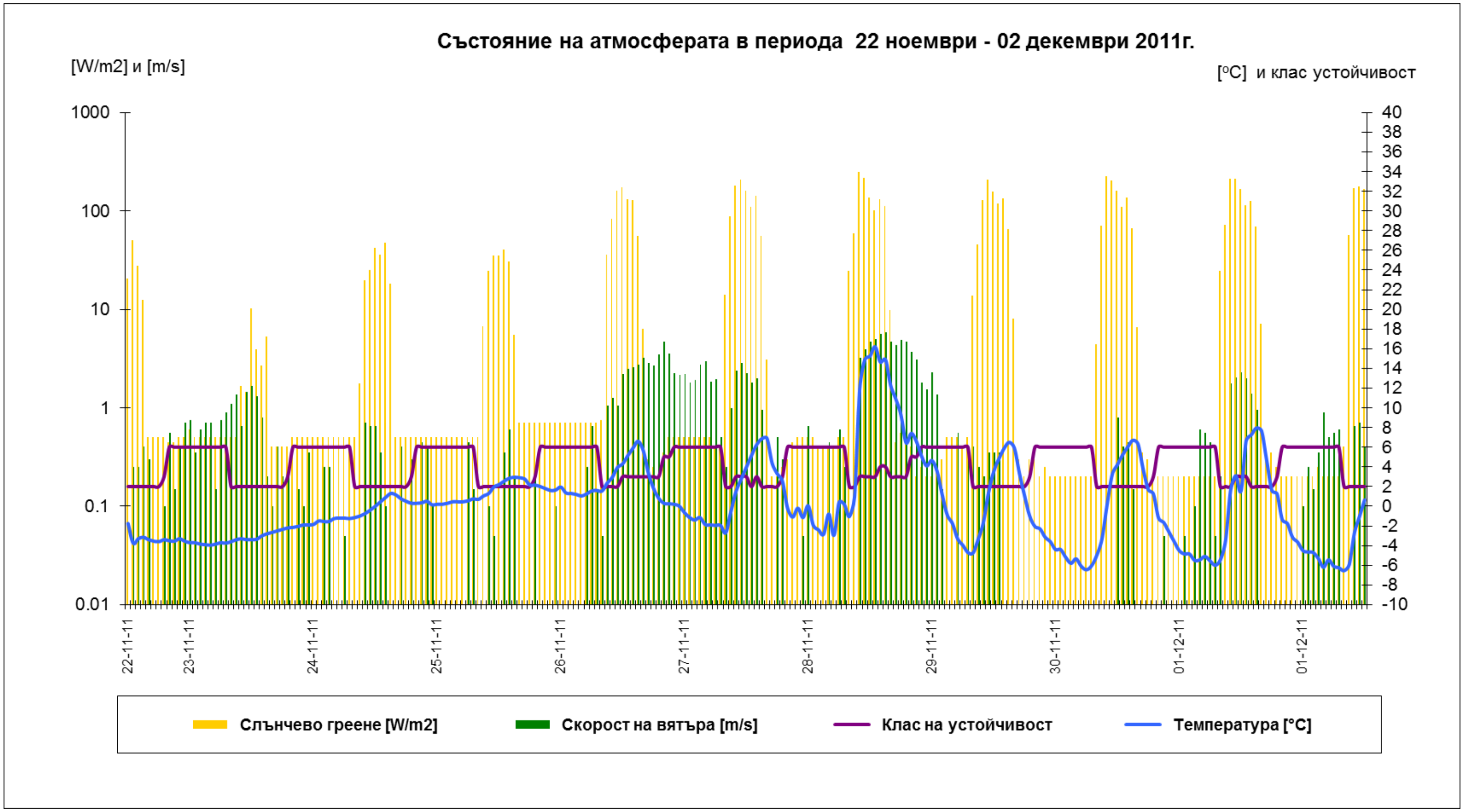
Atmospheric status within the period 12-19 September 2011, Sun shining, Wind speed, Stability class, Temperature

FIGURE 3.1-23: SEPTEMBER 2011



Atmospheric status within the period 24-30 October 2011, Sun shining, Wind speed, Stability class, Temperature

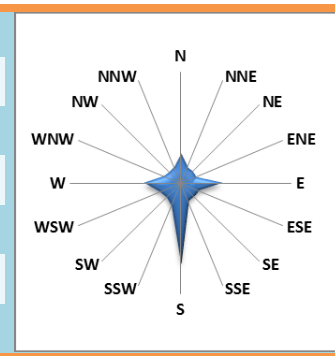
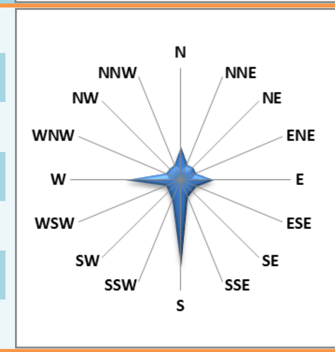
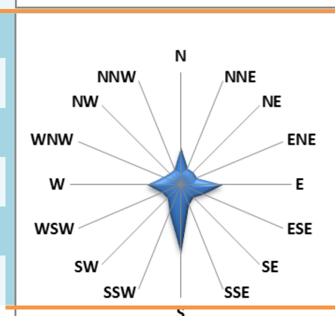
FIGURE 3.1-24: OCTOBER 2011



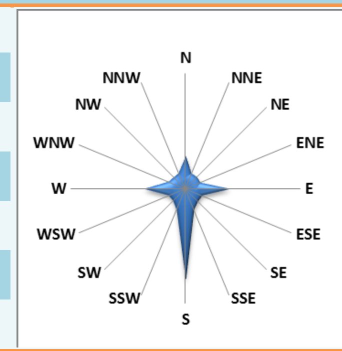
Atmospheric status within the period 22 November-02 December 2011, Sun shining, Wind speed, Stability class, Temperature

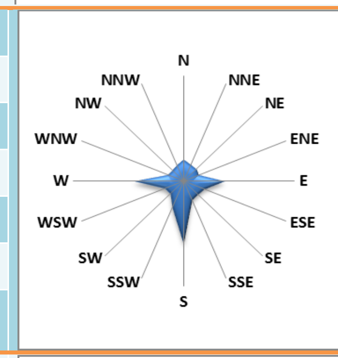
FIGURE 3.1-25: NOVEMBER/DECEMBER 2011

TABLE 3.1-23: ANALYSIS OF THE PROTOCOLS FOR MEASURED CONCENTRATIONS ON THE SITE OF THE REGIONAL FIRE AND EMERGENCY SAFETY SERVICE (RFESS), CITY OF KOZLODUY

Protocols \ Parameters		FPM_{10}	SO_2	NO_2	NO	O_3	CO	Temperature	Atm. pressure	Wind speed	Relative humidity	Wind rose for the period
Limit Values ($\mu g/m^3$)		50	125	-	-	120	10	°C	hPa	m/s	%	
No 123/124 March	07-03-11	31..7	16.2	6.7	1.3	25.9	2.1	-1.38	1010.2	1.0	59.5	
	08-03-11	28.8	13.9	5.9	2.5	37.8	2.1	-4.26	1012.5	1.3	63.9	
	09-03-11	17.8	17.6	6.7	1.5	43.6	1.6	-4.25	1006.8	0.8	52.7	
	10-03-11	25.8	17.1	1.9	0.5	43.8	1.2	-2.32	1002.0	0.8	44.2	
	11-03-11	29.8	16.8	8.6	3.4	42.0	2.4	2.75	1001.3	0.7	47.6	
	12-03-11	30.2	15.1	14.3	8.3	35.1	0.8	5.22	1003.7	0.6	58.1	
	13-03-11	21.3	14.5	13.5	4.7	35.1	0.9	5.32	1002.5	0.8	68.5	
No 180/181 April	04-04-11	67.5	24.7	9.8	4.6	32.5	2.3	17.1	986.2	1.6	41.3	
	05-04-11	41.4	12.1	7.8	4.2	19.2	1.2	13.7	996.1	2.7	70.2	
	06-03-11	39.5	13.7	6.5	4.3	21.8	1.5	13.8	1002.1	2.2	70.8	
	07-03-11	29.8	13.6	10.7	8.5	25.5	1.2	16.7	996.9	2.2	54.2	
	08-04-11	59.9	11.0	9.1	9.2	26.9	1.3	20.7	986.9	6.1	30.3	
	09-04-11	26.6	12.1	8.8	5.9	31.3	1.4	19.3	988.2	5.9	23.2	
	10-04-11	20.4	14.6	9.2	6.9	32.1	1.3	14.0	991.3	3.6	25.4	
No 396/397 June	01-06-11	27.9	8.3	6.4	5.3	34.3	2.9	24.1	1081.3	1.0	51.4	
	02-06-11	24.9	11.9	7.3	5.9	27.8	1.9	20.6	1089.9	0.9	70.0	
	03-06-11	11.3	15.5	7.8	6.0	28.9	1.8	20.3	1090.9	1.1	75.4	
	04-06-11	8.4	15.3	7.3	8.2	32.4	1.7	21.8	1090.8	0.8	60.4	
	05-06-11	15.7	17.5	8.9	8.1	35.3	1.0	22.4	1090.1	1.2	59.1	
	06-06-11	32.1	16.3	10.3	4.9	39.3	1.5	22.4	1088.3	1.5	56.7	

Protocols \ Parameters		FPM_{10}	SO_2	NO_2	NO	O_3	CO	Temperature	Atm. pressure	Wind speed	Relative humidity	Wind rose for the period
Limit Values (μg/m³)		50	125	-	-	120	10	°C	hPa	m/s	%	
	07-06-11	23.9	17.4	7.0	11.4	23.6	1.2	21.9	1085.0	1.6	53.4	
No 490/491 June/July	27-06-11	28.3	51.6	12.5	4.3	40.5	3.1	23.9	1087.0	3.2	12.3	
	28-06-11	29.1	15.2	17.8	4.3	34.8	1.5	18.8	1079.3	2.5	45.1	
	29-06-11	36.5	16.0	16.8	4.5	30.3	1.3	19.7	1074.9	2.1	59.3	
	30-06-11	15.4	15.0	10.8	6.5	22.6	0.9	20.3	1077.2	1.6	66.2	
	01-07-11	12.5	13.0	12.3	6.4	26.0	1.0	20.5	1077.8	2.1	71.9	
	02-07-11	16.3	10.3	14.8	8.1	29.7	1.0	19.6	1080.1	2.8	56.7	
	03-07-11	14.2	9.4	12.5	9.2	25.8	1.1	20.4	1092.4	2.8	71.0	
No 09-0716/ 09-717 September	12-09-11	76.1	27.9	19.9	5.1	30.3	1.6	26.9	1039.7	0.7	21.4	
	13-09-11	64.2	12.0	20.1	6.2	30.6	0.6	24.5	1087.5	1.1	32.7	
	14-09-11	47.1	16.8	18.6	6.3	31.1	0.6	24.0	1086.8	0.6	30.9	
	15-09-11	44.7	16.5	18.3	7.7	32.3	0.6	23.6	1087.5	0.6	33.8	
	16-09-11	52.4	15.9	16.6	6.0	27.7	0.7	21.9	1093.0	0.9	51.8	
	17-09-11	49.5	15.1	15.0	2.8	28.0	0.7	21.5	1092.4	0.7	53.6	
	18-09-11	44.5	15.7	15.4	2.0	30.2	0.8	22.0	1086.9	1.2	49.2	
No 09-0878/ 09-879 October	24-10-11	37.8	12.4	9.2	3.8	18.9	2.1	9.3	1032.4	3.0	64.6	
	25-10-11	43.7	12.0	9.6	4.3	22.0	1.2	9.0	1080.5	2.2	59.9	
	26-10-11	59.7	15.3	8.9	4.4	18.8	1.3	8.1	1080.1	1.7	67.2	
	27-10-11	42.8	14.9	10.0	5.0	19.1	1.0	7.4	1085.6	1.6	65.1	
	28-10-11	51.4	13.6	11.8	5.1	15.6	0.4	4.8	1092.6	0.5	68.0	
	29-10-11	35.1	11.0	10.3	4.9	14.6	0.4	3.4	1091.7	0.6	81.4	
	30-10-11	41.4	13.4	8.8	4.5	14.8	0.4	2.2	1086.8	0.3	80.1	





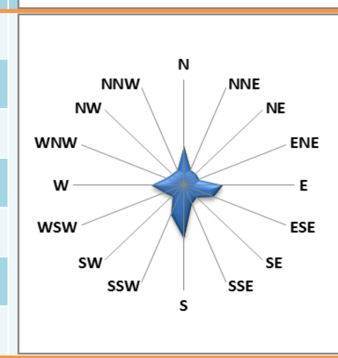
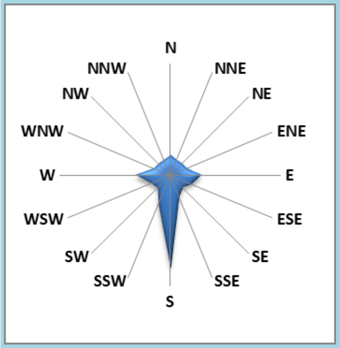


TABLE 3.1-22: (CONTINUED)

Protocols \ Parameters		ФПЧ$_{10}$	SO_2	NO_2	NO	O_3	CO	Temperature	Atm. pressure	Wind velocity	Relative humidity	Wind rose for the period
Limit values (μg/m^3)		50	125	-	-	120	10	°C	hPa	m/s	%	
No 09-1017/ 09-1053 November/ December	22-11-11	66.2	15.5	11.2	4.6	17.2	1.7	-2.7	1037.1	0.3	75.6	
	23-11-11	64.8	26.9	9.1	4.6	16.8	1.0	-3.1	1090.1	0.6	88.9	
	24-11-11	71.7	26.6	9.2	4.7	15.3	1.2	-0.3	1100.6	0.2	83.5	
	25-11-11	54.7	29.1	8.9	5.2	15.8	1.3	1.5	1094.1	0.1	78.5	
	26-11-11	43.8	30.7	7.2	4.9	21.4	1.1	2.3	1084.1	1.6	63.2	
	27-11-11	38.8	29.7	5.5	4.3	19.0	0.9	1.1	1084.5	1.3	63.4	
	28-11-11	49.3	30.9	7.8	5.4	19.9	0.9	5.8	1074.7	2.5	43.5	
	29-11-11	-	27.5	8.0	5.6	17.6	1.1	-0.8	1091.7	0.3	71.5	
	30-11-11	89.5	27.1	16.4	5.3	14.4	1.3	-3.4	1086.7	0.1	71.2	
	01-12-11	99.8	27.1	21.3	2.6	14.7	1.3	-3.4	1084.5	0.5	64.1	

The average 24-hour limit values of the measured meteorological elements and the respective concentrations of the pollutants for the measurements 2011 are given in

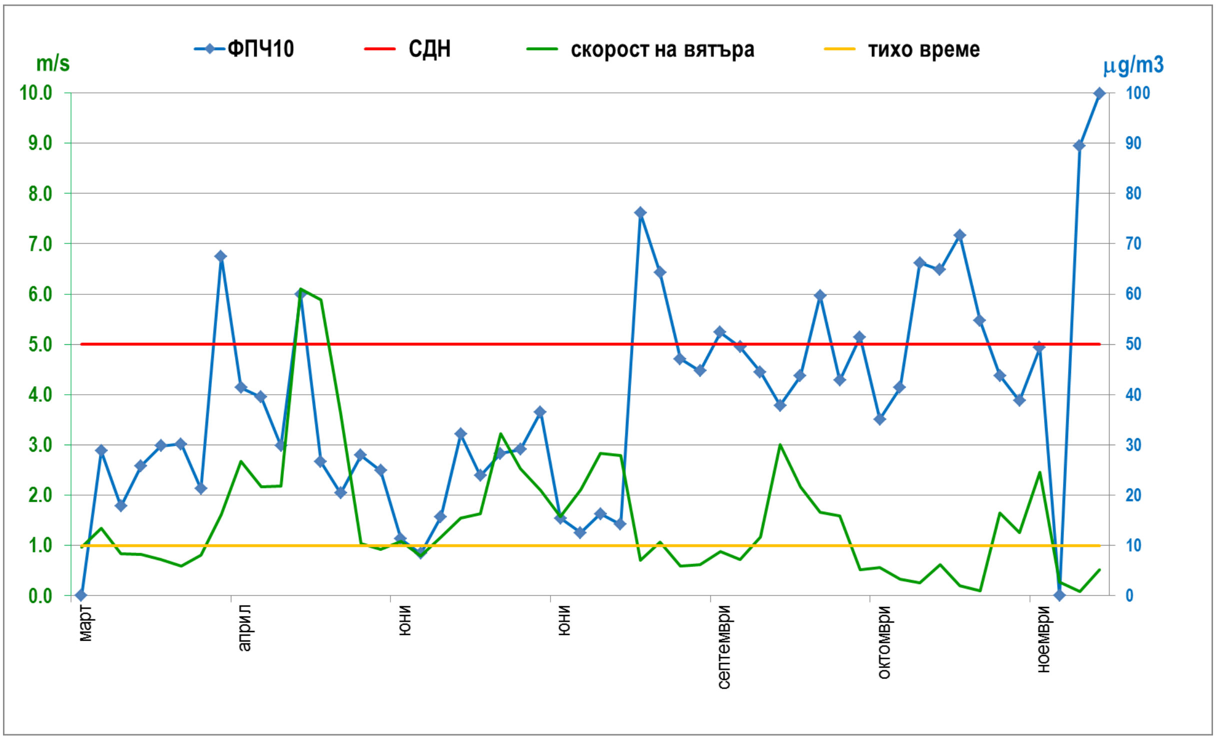
Table 3.1-23. The wind roses for the separate periods are shown in the last column. The south winds are prevalent, which is a reflection of the local characteristic of the point of measurement, and not of the prevailing transmission for the region of Kozloduy city.

The wind roses during the measurement periods show that the prevalent winds are from the south, which is a strongly local effect, since for the region of Kozloduy Municipality the zonal transmission – west-east winds.

It is seen from the Table that in some of the days of measurement the average daily concentrations of fine particulate matter (PM_{10}) exceed the daily limit value of 50 µg/m³.

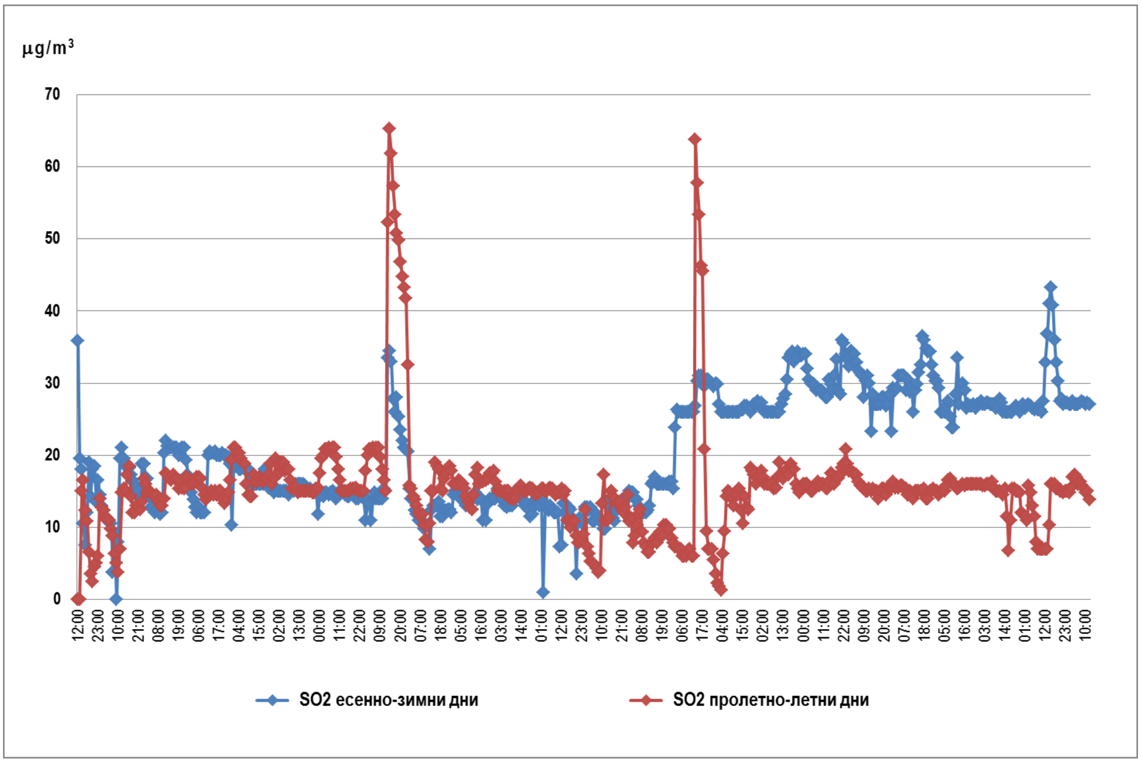
The high average daily concentrations are obtained with wind speed below 1 m/s. – **PM10,** *Daily limit value, Wind speed, Calm conditions*

Figure 3.1-26 . The explanation is that in the absence of wind the region, where the mobile station has been located, is quite dusted. In the presence of wind the dusted air is diluted and the sensor for fine particulate matter records lower concentrations. This is a local effect and should be described in the protocols of the laboratory for emission control of the atmospheric air as a state of the ambient conditions during the measurements.



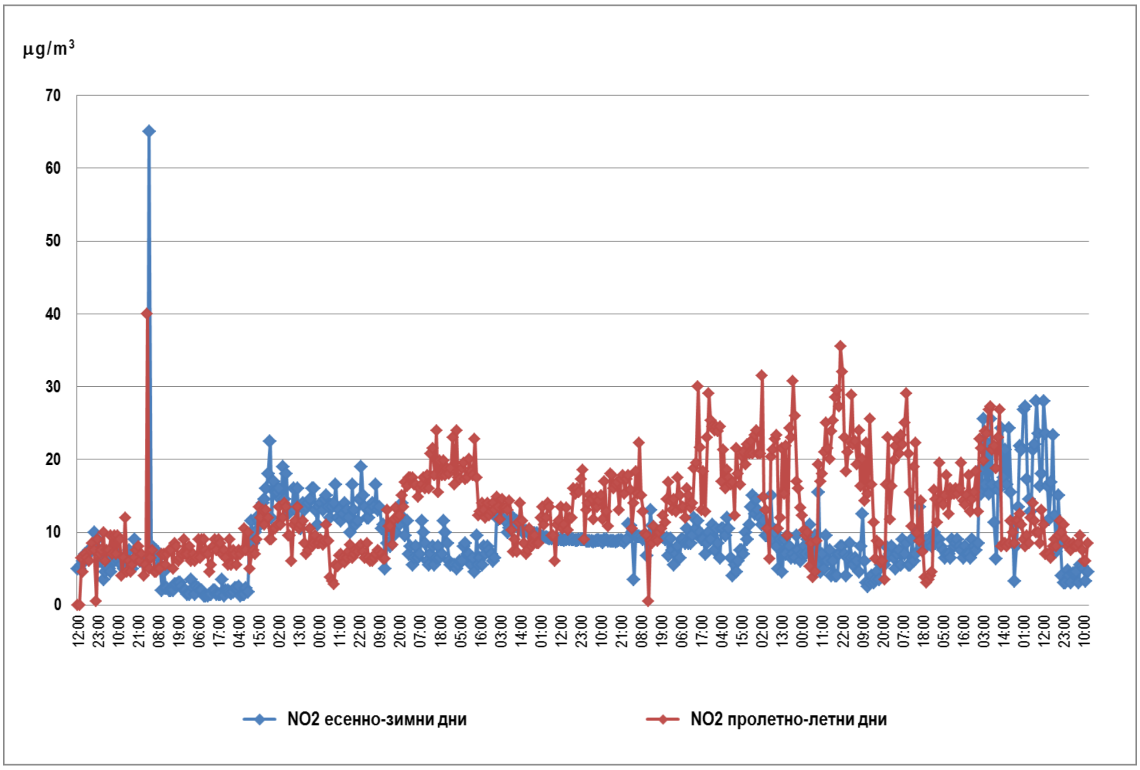
PM_{10}, Daily limit value, Wind speed, Calm conditions

FIGURE 3.1-26: FPM_{10} CONCENTRATION AND WIND SPEEDS



SO_2 – autumn-winter days, SO_2- spring-summer days

FIGURE 3.1-27: COMPARISON OF THE SULPHUR DIOXIDE CONCENTRATIONS



NO_2 – autumn-winter days, NO_2- spring-summer days

FIGURE 3.1-28: COMPARISON OF THE NITROGEN DIOXIDE CONCENTRATIONS

The comparison between the measured concentrations of sulfur and nitrogen dioxides (**SO2 –** *autumn-winter days, SO2- spring-summer days*

Figure 3.1-27 and **NO2 –** *autumn-winter days, NO2- spring-summer days*

Figure 3.1-28) shows, that the emissions from burning of solid fuel for domestic heating purposes during the winter increase the pollution with sulfur dioxide, and the exhaust gases from the automobile transport in summer increase the pollution with nitrogen dioxide. The measured concentrations of the sulfur and nitrogen dioxides have values much lower than the limit values, which are respectively 350 μg/m^3 and 200 μg/m^3.

The remaining pollutants show concentrations below the average daily norm (AND) or the average hourly norm (AHN).

Therefore, the atmospheric air quality within the 30 km zone is undamaged.

3.1.3 ATMOSPHERIC RADIOACTIVITY

3.1.3.1 RADIOECOLOGICAL MONITORING OF KOZLODUY NPP EAD

Aerosols – atmospheric air radioactivity is examined on a weekly basis at 11 control posts within 100 km Surveillance Zone (SZ) around the NPP. The summarized data from the performed aerosol monitoring during the period 2009 – 2012 (Results from Radio-Ecological Monitoring of Kozloduy NPP, Annual Report 2012), show that the results are within the normal limits and the operation of Kozloduy NPP, as a potential source of surface boundary layer pollution with radioactive substances, **has not led to a change in the gamma background radiation** and the atmospheric radioactivity.

The data for the total beta activity in the surface boundary layer (**Figure 3.1-29***)* feature normal values, typical for the surface boundary layer in this geographic region. The results are commensurate in narrow limits throughout the years. The contents of ^{137}Cs equal to 0.8 μBq/m^3 up to 11 μBq/m^3, or average value of 2.3 μBq/m^3, falls within the minimal detectable activity limits of the analysis method, 10^6 times lower than the norms for the country according to *Regulation on the basic norms of radiation protection, 2012*, which is 3.2 Bq/m^3.

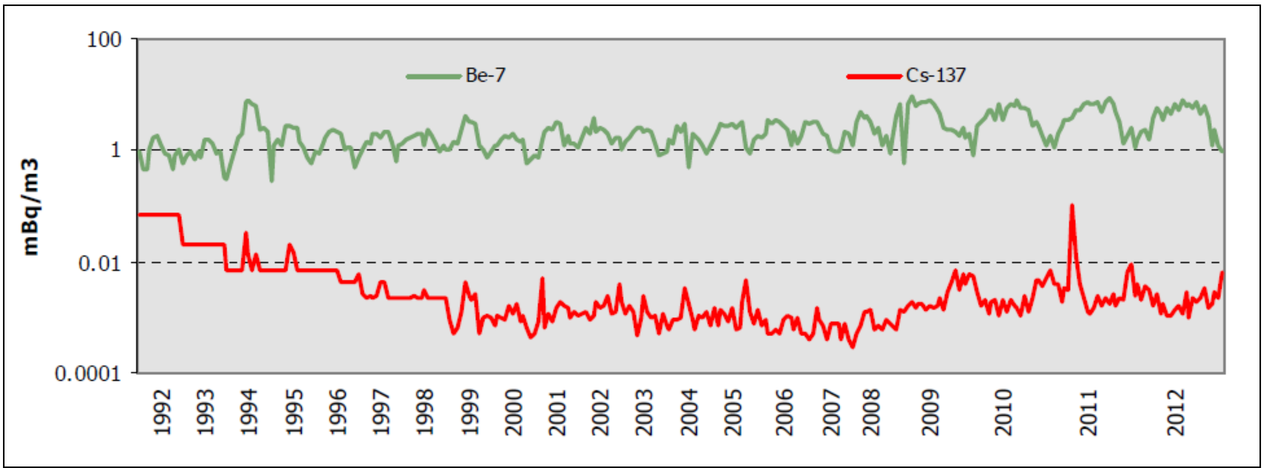


FIGURE 3.1-29: GAMMA SPECTROMETRIC ANALYSIS OF ^{137}CS AND ^{7}BE IN SURFA BOUNDARY LAYER (MBQ/M^{3}) FROM THE REGION OF KOZLODUY NPP, POST-9 (HARLETS VILLAGE), 1992 – 2012

The measured concentrations of ^{137}Cs in aerosols from all control posts within the 100 km SZ of Kozloduy NPP during 2012 and past years are negligible, with background concentrations. Minimal activities are measured only episodically at individual posts. No impact has been registered, as well as trends in the aerosol activity from the operation of Kozloduy NPP.

During 2012, no technogenic activity, different from ^{137}Cs, was registered in the environment of Kozloduy NPP at any of the control posts.

The results from the conducted aerosol monitoring during 2012 and previous years provide actual assessment of the negligible impact of Kozloduy NPP on the air aerosol activity. In practice, this indicator is unaffected by the power plant operation. The technogenic radionuclides concentrations feature background levels.

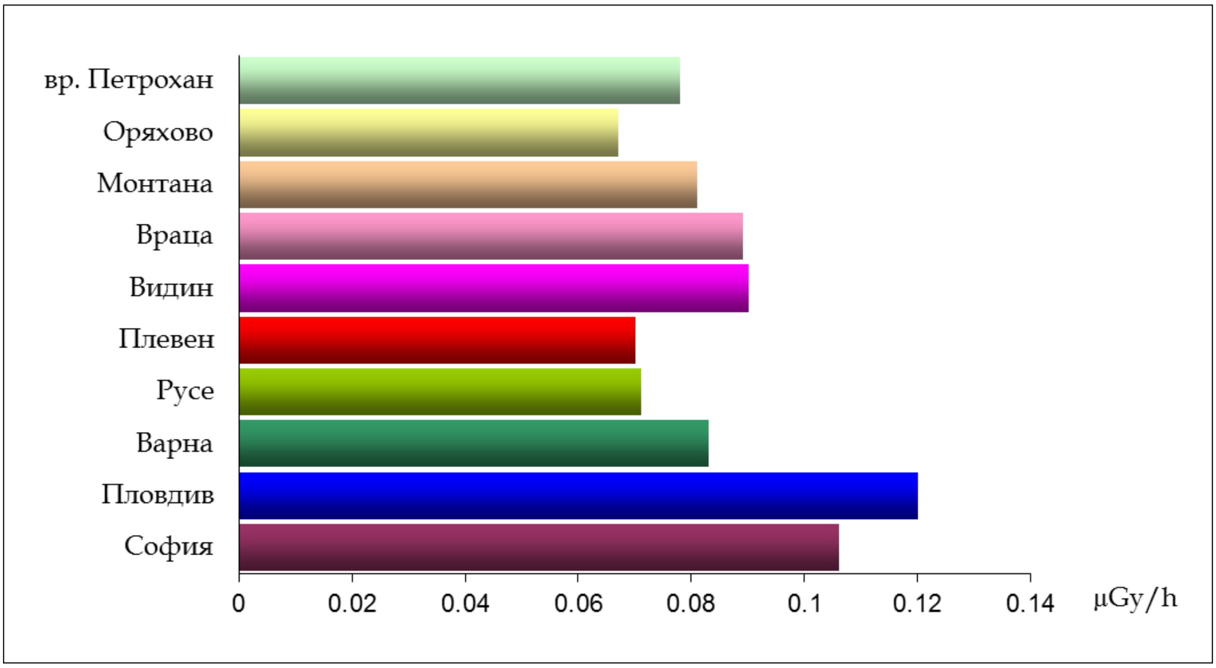
The radiation cleanliness of the air fully meets the normative requirements.

Atmospheric fallouts – atmospheric fallouts are controlled on a monthly basis at 33 from the 36 control posts within the 100 km surveillance zone around the NPP. Slightly expressed seasonal dependence has been established with maximal values during the spring-summer period, which is due to the intensive precipitations and the self-cleaning of the atmosphere, resulting in reduction of aerosol activity, accordingly, increase of fallout activity.
In 2012, the controlled total beta activity varies within the interval 0.058 Bq/(m^{2}.d) ÷ 1.96 Bq/(m^{2}.d), with average value of 0.43 Bq/(m$_{2}$.d). The results are commensurate with the preceding multiannual measurements and constitute typical for the region natural values. The results for ^{90}Sr in atmospheric depositions display a stable reduction tendency due to the atmosphere's self-cleaning from the Chernobyl ^{90}Sr.

The results from the analysis of atmospheric fallouts in 2012 fully comparable with these from previous years and with the data for the region prior to the commissioning of the NPP.

Gamma background radiation – in 2012 a total of 1315 measurements at the control posts and the routes were made, using portable dosimetric devices and statically positioned thermo-luminescent dosimeters. Of them 1039 measurements were made, using portable dosimetric devices at a total of 77 checkpoints within the 100 km zone. For independent passive control of the gamma background radiation, a total of 70 thermo-luminescent dosimeters UD-802AS have been used, with which a total of 276 measurements have been made.

A comparison with the National Automatic System for Continuous Monitoring of Gamma Background in Bulgaria (BulRAMO) at the Ministry of Environment and Water /MEW/ is shown on **Figure 3.1-30**. The results are for bigger cities of the country.



Petrohan peak, Oryahovo, Montana, Vratsa. Vidin, Pleven, Rouse, Varna, Plovdiv, Sofia,

FIGURE 3.1-30: GAMMA BACKGROUND RADIATION IN BIGGER CITIES OF THE COUNTRY, 2012 /BUL RAMO-MEW/, MGY/H

The summarized data and results for 2012 and their comparison with those for the period 2007–2011 show, as follows:

- The gamma background radiation at points of the NPP fence and at the control points and settlements within 100 km zone is completely commensurate with the natural background radiation, falling between 0.05 µSv/h ÷ 0.15 µSv/h;
- The radiation situation in the region is stable and unchanged by Kozloduy NPP.

3.1.3.2 RADIATION CONTROL ON RIEW-VRATSA[28] TERRITORY

The observations on the radiation parameters of the main environmental components are continuous and periodical. They are performed with the aim to provide up-to-date information to the state and local authorities, as well as to the public. Radiation control on RIEW – Vratsa territory is carried out by Regional Laboratory – city of Vratsa, adhering to the Executive Environment Agency (EIA) – Sofia.

In 2012, for the purpose of monitoring the presence of radionuclides in the atmospheric air (mBq/m^3), 25 pcs. of aerosol filters have been sampled by the stationary station in the city of Vratsa. The results from the protocols[29] are shown on **Figure 3.1-31**.

[28] RIEW-VRATSA, Regional Environmental Status Report – 2012 -http://riosv.vracakarst.com/bg/godishnik1/

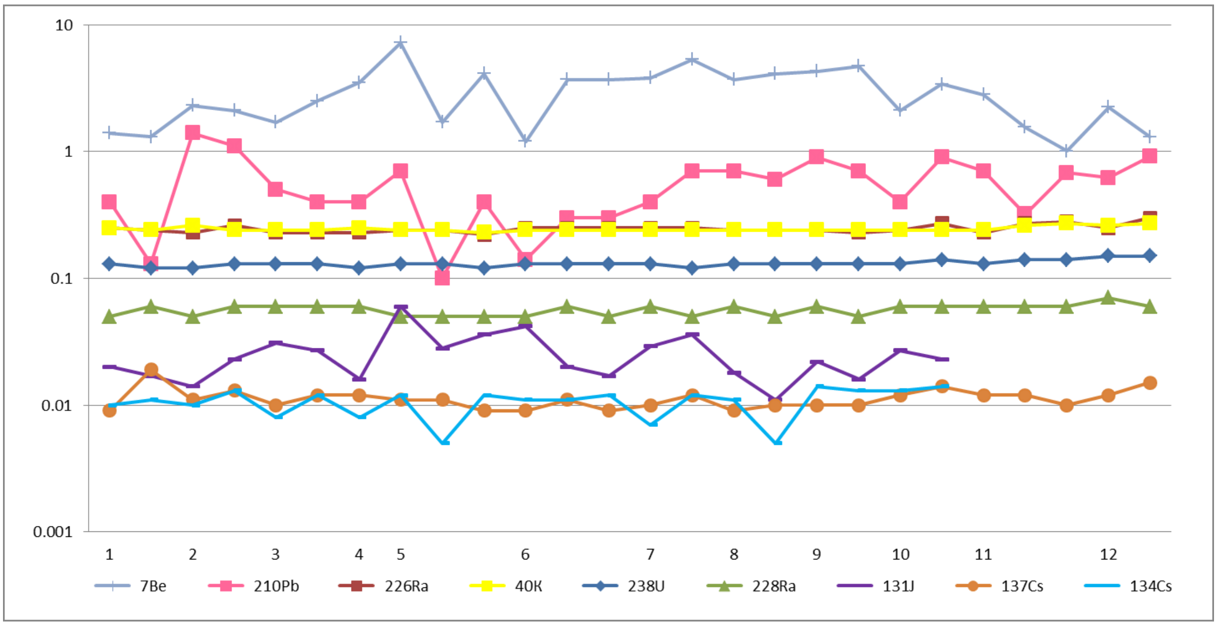


FIGURE 3.1-31: ATMOSPHERIC ACTIVITY IN MBQ/M³, CITY OF VRATSA POST, 2012

No increases of the specific activity of natural and technogenic radionuclides in the atmospheric air have been established and the measured values do not differ from those from previous years.

In 2012, the condition of the gamma background radiation was still monitored at the permanent sampling stations on the Vratsa District territory. The results from the monitoring of the stations within the 30 km zone – Hayredin and Oryahovo, and from the 100 km zone – Vratsa, show that the equivalent dose power is within the range of the typical background values for the respective posts and varies within limits from 0.10 µSv/h to 0.20 µSv/h.

[29] *Annex 8 – INPUT DATA* – Testing protocols – aerosol filters in 2012

3.2 WATERS

3.2.1 SURFACE WATERS

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

- 10 km to 30 km southward and southeastward – Ogosta River with water body code BG1OG100R014 and water body Ogosta River – Skat River, with code BG1OG307R013. Ogosta River together with Skat River (after the correction they have common river-bed in the mouth part) is discharged in the Danube river at km 684,700. The water body of BGTR7 type with code BG1OG100R014 – the Ogosta River is 3.175 km long (part of the Ogosta River water body), is heavily modified and has been assessed in the River Basin Management Plan (RBMP) as being in good chemical status and moderate ecological status, and as a water body "at risk" with regard to the achievement of the ecological objectives. During the Kozloduy NPP construction, the mouth of the Ogosta River mouth was modified to provide service water supply from the Danube to the power plant. It has been shifted eastward under the Bank Pumping Station (BPSs).
- 10 km to 30 km eastward and southward – the Skat River with water body code BG1OG200R008;
- 20 km to 30 km westward – the Tsibritsa River – two water bodies with codes BG1WO800R016 and BG1WO800R017;
- From the left tributaries more significant is Jiu River, which discharges in the Danube River at km 691.400, but it also does not produce special impact on the NPP site, since its discharge is separated from the right bank by the Kozloduy Island;
- In the immediate vicinity and of greatest significance for the NPP, northward of the site, flows Danube River, with the name „Danube River RWB01" and code BG1DU000R001, according to RBMP of the Basin Directorate for Water Management – Danube Region (BDWMDR), in Bulgaria. The width of Danube River-bed fluctuates within 800 – 1300 m. The depth of the fairway reaches up to 14 m, and the smallest low level depth reaches 1.8 m. The maximum speed of the river flow is about 2.5 m/s (9 km/h)[30]. Kozloduy Island is located within the boundaries of the discussed river section (701.5 km – 690.5 km, having width up to 1 km and length of about 11 km), which splits the river into two sleeves. The service water supply of the power plant is accomplished from the main river sleeve opposite at 687 km.

With respect to these rivers, all requirements of the River Basin Management Plan (RBMP) are in effect, as well as the measures to it, as addressed in Program 7.1.5, Program 7.1.6,

[30] REL-1000-ST-001-2 Survey of the conducted studies by "Risk Engineering" AD.

Program 7.1.7, Program 7.1.8, according to Letter No. 3804/January 08,2013 of the Basin Directorate for Water Management – Danube Region (BDWMDR), aimed at: emission regulation through prohibition of the introduction of pollutants from point sources, prohibition of the introduction of pollutants from diffuse sources, prevention of water pollution with priority substances, and prevention or reduction of the impact of emergency pollutions. These requirements will have to be observed during the implementation of the Investment Proposal (IP) for the New Nuclear Unit (NNU).

Small dams have been constructed in the region, which are run by the relevant municipalities, as well as dams, which are run by "Irrigation Systems" EAD. Near the city of Montana on the Ogosta River, the Ogosta Dam has been constructed, which is on the List of Large and Complex Dams in the Country from Annex 1 to the Water Act (WA). It impacts greatly the river flow regime. Apart from the Ogosta Dam, another such dam near Kozloduy NPP is the Shishmanov Val/Asparuhov Val/ located 10 km away from the power plant. The water basin was constructed for the needs of the eponymous irrigation system. The water basin is fed by the Danube River through a floating pumping station and has capacity of 7 000 000 m^3. The dam is defined in RBMP as an artificial water body with code BGW0900L017 and its registered area is 2 km^2.

The right bank of the Danube River is higher than the Romanian bank, which is determined by the geological structure and the lythological composition of the Danube valley, as well as by the Coriolis forces. At some places the high Bulgarian bank steps back and moves away from the river, creating conditions for forming of low riverside valleys, one of which is the Kozloduy valley, where the site of the operation Kozloduy NPP is located. Due to the flat terrain and the relatively small altitude of the Danube lowlands, in the middle of the past century large scale dyke building initiatives were carried out, with the help of which these lowlands were protected against the high waters of the Danube River. For protection against floods with 1% chance of occurring (within 100-year period), the lowland is safeguarded by a protection dyke with 30.5 m average elevation.

There is a hydraulic connection between the river waters and the groundwaters in the terraces. The latter are situated at a small depth and upon high waters they cause boggings in the lowest lowland sections. To reduce these effects, drainage channel systems have been built northward of the site, which take away the waters to pumping stations/PS/, which transfer the waters back to the Danube River. Thus, a relatively low groundwater level in the lowland, located to the north of the existing Kozloduy NPP site, is controlled and maintained.

Due to the constantly high level of the groundwaters on a large area of the lowlands in the region of Kozloduy NPP, and for protection against the slope waters, which run down the north slopes of the plateaus, systems of drainage channels and facilities have been constructed. These systems protect the region in case of abundant precipitations and prevent bogging of the lowlands. The drainage systems protect against flooding the site of the power plant. They include three types of channels: drainage, collector and main. Waters from the main channels are transferred into the Danube River over the dykes with the help of the pumping stations (PSs). Through the built sewerage system the main drainage channel (MDC) is one of the collectors of four NPP waste water flows, originating fully from EP-1 territory and of a part of EP-2 generated waters. These drainage facilities are of significant importance for the protection of the agricultural lands in the region and of the existing infrastructure, therefore their existence is definitive.

The operating site of Kozloduy NPP is located on the right bank (at 694th km) of the Danube River. It is located in the north part of the first non-flooding terrace of Danube River (elevation +35.0 m according to the Baltic Height System) and has area of 4471.712 decares. No natural water bodies pass through it.

The proposed new, conditionally named Sites 1, 2, 3 and 4, adjoin the existing site of the power plant.

Conditionally named site 1 – The site is located northeastward of units 1 and 2 of Kozloduy NPP, between ODF and "Valyata", next to the built cold and hot channels – north of them. The terrain area is about 55 ha. The terrain is flat with a slight slope from southwest to northeast. There are open drainage channels within the site area, which should be reconstructed. The humus loess layer of the arable land should be retrieved in advance.

The terrain is used for growing agricultural crops.

Conditionally named site 2 – The site is located to the east of units 1 and 2 of Kozloduy NPP in direction of Harlets village, southward of the built cold and hot channels. The terrain area is about 55 ha. The terrain is hilly with a significant slope from south to north, more strongly expressed in the southeast part of the site. A former farmyard falls within the site area. The remaining terrain is used for growing agricultural crops.

Conditionally named site 3 – The site is located to the northwest of units 5 and 6 of Kozloduy NPP, near the by-pass road of the existing power plant. The terrain area is about 53 ha. The terrain is flat with a slight slope from south to north. Within the region of the site fall open drainage channels, that should be reconstructed. The humus (loess) layer of the arable land should be retrieved in advance.

From view point of the engineering absorption and connection with the energy system a big number of activities and complicated reconstructions of the fan of overhead transmission line (OHL) 400 kV are needed.

The terrain under expropriation is used for growing agricultural crops.

Conditionally named site 4 – The site is located westward of units 3 and 4 of Kozloduy NPP and the Wet Spent Fuel Storage Facility (WSFSF), south from the cold and hot channels. The available area is about 21 ha, within the boundaries of the expropriated terrains of Kozloduy NPP. The terrain overlaps with the area of the existing service facilities – "Equipment Bureau", "Automobile Repair Unit" и "Assembly Unit". The site use includes reconstruction and displacement of main underground communications of the NPP, as well as emptying and displacement of the aforementioned facilities.

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

The Danube River is used for circulation and service water supply to all consumers at *Kozloduy* NPP site. The total area of the international Danube basin is 817 000 km2, and its total length is 2 857 km. The river is an international water transport corridor. In relation to the threat to the river water's ecological state as a result of the intensified man-induced impact on the banks and the transport traffic, established by the countries along the river, as well as for the purpose of preserving a number of protected areas and habitats, affected by its water, in 1992, the decision was made to establish an International Committee for Preservation of the Danube River (ICPDR). The Republic of Bulgaria has ratified the Convention for Protection of the Danube River. The first Management Plan for the entire Danube basin is in effect in the Republic of Bulgaria, as well as the Basin Management Plan for the Danube region. In this Plan, the river is classified as a river named Danube RWB01, with code BG1DU000R001, and type R6[31]. It has been defined as a strongly modified water body of moderate ecological state and poor chemical state. An Action Program aiming to achieve good chemical condition and good ecological potential during the next planning periods until 2021 and 2027 has been prepared and is being implemented. These requirements will be applicable with respect to the ecological commitments during the implementation of this Investment Proposal (IP). The river is subject to control physico-chemical monitoring and operative monitoring under a special National Monitoring Program for major physico-chemical indicators, priority and specific pollutants, and hydro-morphological quality elements, according to the Program of the International Committee for Preservation of the Danube River (ICPDR) which is included in the National Environmental Monitoring System (NEMS) implemented by the National Environment Agency (NEA) and the Regional Laboratories (RLs). Under the same Program, control and operative hydro-biological monitoring is also performed. To implement the Monitoring Program for the Danube River, as well as for monitoring the condition of Ogosta River, Order No РД-715/02.08.2010 of the Minister of MEW has been enacted and a new Order No РД-182/26.02.2013, which has been into force since 01.03.2013.

3.2.1.1 DRINKING-DOMESTIC WATER SUPPLY

A very good water supply network for drinking domestic and service water needs has been built at Kozloduy NPP site. The drinking water for the NPP is provided from Raney type wells – three drills, located on the terrace of the Danube River before the town of Kozloduy according to a contract with ViK (WS&S) EOOD – Vratsa. They provide drinking-domestic water supply to the city of Kozloduy and the villages Harlets and Glozhene. A Permit for Water Intake was issued for these water intake structures of Kozloduy Municipality according to the WA by the BDWMDR. From the tanks of the city of Kozloduy, the water flows by gravity to reach the pumping station (PS) via pipeline with length 11 km, diameter Ø 500 mm and maximum water quantity 260 l/s. The pumping station pumps the water to the tank of the power plant at elevation 93.0 m, with a volume of 2x2000 m^3, from which it flows by gravity to the individual consumers. The length of the pressure water conduit

[31] Regulation H-4/SG, No. 22 of 05.03.2013 on surface waters characterization

from PS to the reservoir is 0.5 km[32]. The external water supply system of wells, pumping stations, water mains and other facilities up to the first distribution shaft are maintained by ViK EAD – Vratsa. Kozloduy NPP EAD annually executes a contract with the WS&S operator for supply of water with drinking qualities. The consumed water quantities are measured by water meters. The external consumers of drinking water at the site of the power plant are supplied from the internal site water mains of the NPP, and the water they consume is measured.

The made calculations for the mean monthly consumption of drinking water by the NPP consumers indicate that the actual quantity of drinking water amounts to approximately 35÷40 l/s for 2012, compared with about 60l/s in 2006[33] The reduction in the consumption of water with drinking characteristics is a result of the implemented measures for stopping the water supply network leakages, improving the condition of the water pipeline fixtures and of the decreased consumption by the EP-1 consumers.

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

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

CONSUMERS	DEVIATION – Ø mm	CONSUMPTION l/s
EG-1	315	73.00
EG-2	315	73.00
AEP	150	17.50
ZS	60	5.00
INV.	57	3.40
MONTAZHI	100	8.00
FFPS-56л.	125	9.20
	TOTAL:	**189.10**

3. Reserve – **70.90 l/s.**

A shaft well in the “Valyata” neighborhood is used for the showers in EP-1 bathrooms. Pursuant to the Water Act (WA), a water intake permit under No 11590203/30.05.2008 (for hygienic needs – other purposes) has been issued for this facility by BDWMDR.

The necessary maximum hourly water rate of 50 l/s is guaranteed with a normative reserve. The available pressure in the network is 8 atm., ensuring water supply to all consumers.

The available reserve of 70.90 l/s is sufficient to ensure the drinking-domestic water supply of NNU, as well as to cover the needs for water with drinking characteristics during the construction, operation and decommissioning of the new unit. There is a technical possibility to connect the water supply network of the new unit with the existing water

[32] Letter of ViK OOD – Vratsa, No264/04.04.2013

[33] Letter of Kozloduy NPP EAD with No ДП58/19.04.2013

supply network of the NPP at suitable places (points), according to the attached scheme, reflected on **Figure 3.2-1**, depending on the selected site.

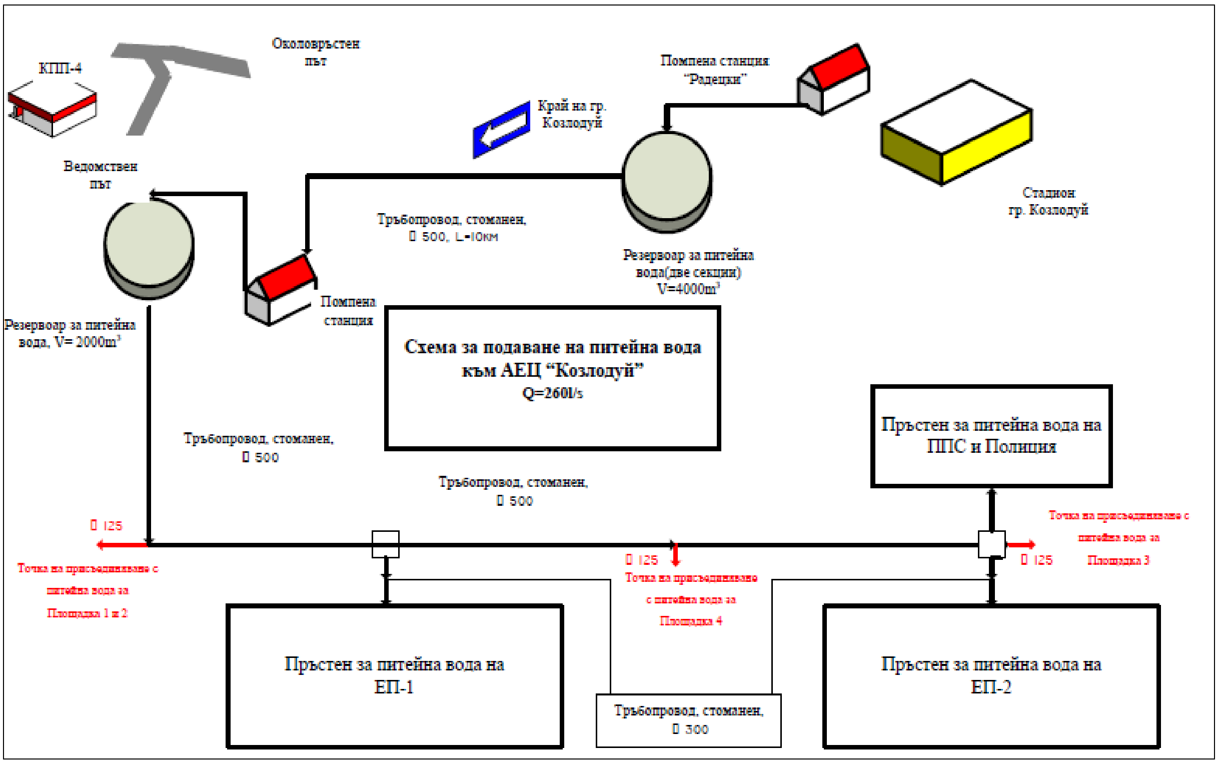


FIGURE 3.2-1: SCHEME FOR DRINKING-DOMESTIC WATER SUPPLY OF KOZLODUY NPP

Scheme for drinking water supply to Kozloduy NPP

CP-4 (Checkpoint 4)

NPP road

Ring road

End of Kozloduy city

Radetski Pumping Station

Kozloduy stadium

Drinking water tank, V = 2000 m³

Pumping station

Steel pipeline ф 500, L = 10 km

Drinking water tank (two sections), V = 4000 m³

Steel pipeline ф 500

Steel pipeline ф 500

Drinking water ring of FFS and Police

Point of drinking water connection for Site 1 and 2

Drinking water ring of EP-1

Point of drinking water connection for Site 4

Steel pipeline ф 300

Drinking water ring of EP-2

Point of drinking water connection for Site 3

3.2.1.1.1 Staff number of Kozloduy NPP EAD and staff number of external organizations in the Precautionary Action Zone (PAZ)

The total staff number of Kozloduy NPP EAD – workers and employees, is 4105[34] people, whereas the total number of the shift staff on the territory of Kozloduy NPP from 16:00 to 08:00, as well as during weekends and holidays, is 600 people.

On the site are also located:

- ✓ Staff of the Regional Police Administration – Kozloduy NPP;
- ✓ Staff of the Regional Service "Fire Safety and Protection of Population" (RS "FSPP");
- ✓ Staff of the external organizations, located on Kozloduy NPP EAD site – approximately 1500 people.

3.2.1.1.2 Interfaces between units 1÷4 and units 5÷6 (steam, WSFSF, fire ring)

Between the process systems of the first 4 units (1÷4), on the one hand, and those of units 5 and 6 on the other hand, there are built interfaces, which provide for the supply of demineralized water, steam, water for fire-extinguishing in case of technological necessity:

- → The fire-extinguishing systems for units 1÷4 and for units 5 and 6 are united in fire-rings: ring for automatic fire-extinguishing and water supply ring for domestic fire-fighting, which are connected with each other and if required there is a possibility to transfer water for fire extinguishing from one to another;
- → The steam systems – own needs of units 5 and 6, are connected with those of units 1÷4 for the purpose of supplying steam for technological needs.

The demineralized water systems of units 5 and 6 are connected to those of units 1÷4, with a possibility to share demineralized water between the units, whenever necessary. The consumption of chemically purified water will remain unchanged regarding the consumption of the decommissioned units, since demineralized water is needed for all desactivation processes.

3.2.1.2 SERVICE WATER SUPPLY

The service water supply provides cooling water (circulation – for the condensers of the turbines, and service – for the other facilities). It is provided by means of 3 bank pumping stations from the Danube River, as well as by means of 6 shaft pumping stations, located on the terrace of the Danube River – for emergency water supply of units 5 and 6. The service water for technological needs (lubrication of the bearings of the bank pumps) and for the fire-fighting system, at BPS 1, 2 and 3 it is ensured from Raney 5 well

The water intake from the Danube River and the bank pumping stations is located at km 687 from the Danube River mouth, after the island at the city of Kozloduy. The water intake is in deep water. The constructed BPS -1, -2 и -3 provide the NPP with service water. The

[34] Letter REG No АИК55/29.01.2013 of Kozloduy NPP.

capacity of the cold channel is 180 m^3/s with proven maximum capacity of 200 m^3/s[35]. Permits for water intake have been issued by BDWMDR for the use of water from the Danube River, as well as from groundwater sources.

Water from the Danube River is supplied to the power plant via the built hydro-technical facilities, which have a decisive importance for the normal operation of the power plant. The cold channel connects the outflow tanks of BPS with RPS-1 (Recirculation Pumping Station) with a length 7023 m. At the end of curve 8 is built a long transverse crosswise shoot up to elevation 29.25, providing for an emergency volume in case of blackout. With the consecutive construction of the nuclear units, it has been extended up to RPS-2 and later up to RPS-3 and RPS-3 and RPS-4, where it has been plugged. RPSs /the recirculation pumping stations/ are located in front of the turbine halls of the relevant power units. The supply cold open channel for the water from the Danube River has a bottom width of 19.00 m, slopes 1:2 and a depth of 5.6 m.

The used water from the power units is returned to the Danube River by means of the discharge hot channel TK-1. The hot channel HC-1 starts at the outlet shaft of the low-pressure channels and ends next to the spillway of the bypass channel for discharging the hot waters into the Danube River. Its length is 6930 m, trapezoidal cross section and the crown of the dykes is at elevation 33.0 m in the backfill section and at 34.0 m – in the excavation section. The capacity of the hot channel is 180 m^3/s, with proven maximum capacity of 200m^3/s and depends on the elevation of the spillway after the low-pressure channels and the elevation of the water in the Danube River. The discharge hot channel passes parallel to the cold channel CC-1 along the larger part of their route. The two channels have a common dike and form a double channel. Another hot channel HC-2, has also been built, designed for 110 m^3/s for the needs of the power units 5 and 6.

A bypass channel has also been built, which is used for connection between HC-1 and the mainstream of the Danube River and for reducing the energy of the water flow. It has a rectangular cross-section with width of 35.00 m and vertical reinforced concrete enclosing walls. Its bottom is at elevation 27.40. A bridge – partition facility was built at its beginning with nine openings, equipped with sluice gates. The channel ends by a spillway and chute with a stilling basin, as well as a battery for hot water, which serves for supplying hot water from the HC-1 to the fore chambers of the BPS-1, -2 and -3 during the winter months. The purpose is to reduce the losses from over-cooling of the condensate of the steam from the turbines. The same consists of 6 pipelines with diameter of 1.20 m and is designed for a water discharge of 12 m_3/s The intake of hot water is provided by means of a channel which outflows before the spillway at the end of HC-1.

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

A benchmark monitoring system has been built to monitor the deformations along the double channel.

[35] SRDI Energoproekt, 1991 – Existing channels for service water supply of Kozloduy NPP

44 drainage wells have been built around the channels (17 in the non-flooded terrace and 27 in the valley) for control of the ground waters. They are used for monitoring of the ground water table and for isotope measurements.

In addition to these HTF, spray ponds for cooling the water from the service water systems of EP-1 and EP-2 were built on the plant territory. For each of the units 5 and 6 3 SP were built (with dimensions 68 x 65 m and a depth of 3 m).

The service water consumers are united in two groups – safety related and not-safety related, according to their relation to the nuclear safety. The safety related ones are the consumers of the safety systems and the consumers of the normal operation systems, which are related directly to safety. In emergency situations, when the CC 1 is not capable of conveying water from the Danube River, service water from the fore-chambers of the RPS is conveyed only to the safety related consumers, its cooling being provided by the spray ponds. In such cases, the water reserve is provided by the partition spillway in the area of curve 8. In the cases, when the water in the fore-chambers of the RPS is insufficient, it is possible to compensate the water losses in the SP (from evaporation and wind blowing) by other sources. For units 1÷6, these are 3 service water emergency pumps (SWTP), installed in BPS 2 and 3, which pump water from the Danube River to the fore-chamber of the CPS, and for units 5 and 6 – additionally from groundwater sources (shaft pumping stations (SPS) 1÷6).

Protection dikes have also been built along the Danube River in the region of the Kozloduy valley, which are also important for the safe operation of the power plant.

From the point of view of the service water supply, taking into consideration that the first four units have been shut down, a free capacity exists of up to 100 m^3/sec, with the required conservative value of 60 m^3/s for the new power unit, according to letter of Kozloduy NPP-New Build EAD. During the operation of the new nuclear unit no increase in the quantity of used water is expected for technological needs in excess to the provided for by the water intake permit.
The water supply system of Kozloduy NPP for service and industrial water, as well as for drinking water is well designed and reliable, being well maintained by the operating personnel. The provision of service water for each of the alternative sites, proposed for the building of NNU, is technically possible to be accomplished from the existing system – CC-1, through appropriate engineering solutions, as well as to secure the discharging of the processed (used) cooling water and the other types of waste waters through the constructed HC-1 and HC-2 into the Danube River.

TABLE 3.2-1: ANNUAL WATER AMOUNTS, USED FOR SERVICE AND DOMESTIC WATER SUPPLY

Water – extraction point	Allowed amount [thousand m^3]	Used amount [thousand m^3]						
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Surface waters from the Danube River	5 000 000	3 331 722	2 323 800	2 629 876	2 593 459.5	2 564 530	2 660 788	2 415 903
Six shaft wells	7 884	-	-	0	0	0	24.779	55.556

Water – extraction point	Allowed amount [thousand m³]	Used amount [thousand m³]						
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
(SPS 1÷6)								
Ranney-5 well	1 600	190	314	75	15.929	24.00(	2.729	1.578
Valyata shaft well	788.400	291	183	204	192.27	193.0(	216.70	289.59
Urban water mains	-	1 877.70'	1 846	1 259	1 460	1 435	1 379	1 142.565

Source: Annual report of Plant non-radiological monitoring of the environment at Kozloduy NPP for the period 2006 – 2012

From the presented information (**Table 3.2-1**) it can be deduced that the water discharge rates applied for considerably exceed the water discharges used and, therefore, there will be no excessive operation from any specific water body, with sufficient water quantities being available for drinking, domestic and industrial water supply upon realization of the Investment proposal

There is a continuous reduction of the water intake for technical purposes from the Danube River, which is indicative for the absence of direct impact on the river water quantities. According to information from Kozloduy NPP, the total raw water quantity, taken for technical purposes from the Danube River was 4 220 994 174 m³ in 2002, when six reactors were operating, 3 331 722 214 m³ in 2006, when four reactors were operating, and 2 415 902 580m³ in 2012, when two reactors were operating[36].

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

- Permit No0562 dated 14.03.2005;
- Permit No11590203 dated 30.05.2008;
- Permit No11530128 dated 30.05.2008;
- Permit No11530127 dated 30.05.2008;
- Permit No13750001 dated 20.04.2007 with subsequent amendments;
- Permit No13120037 dated 22.11.2010

Permit for water intake No. 11530127 dated 30.05.2008 from six shaft wells – SPS 1÷6 regulates the water intake for reserve (emergency) service water supply for the spray ponds of units 5 and 6 at Kozloduy NPP. During normal operation, the losses of water in the spray ponds of units 5-6 are refilled from RPS 3 and RPS 4. A system for emergency service water supply was built to increase the level of safety, which provides water for the spray ponds in the cases, when it cannot be provided by the RPS. The emergency service water

[36] Letter No Д"П" 13/05. 04. 2013. Kozloduy NPP EAD, Production Directorate.

supply system was designed for a water discharge of 280 l/s and consists of 6 shaft well pumping stations (SWPS). The SWPS are located on the terrace of the Danube River at approximately 25 – 30 m to the south of the base of the state dike. They are equipped with 2 submersible pumps.

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

- For process needs – 46 l/s; two pumps are installed, each with a discharge rate 50 l/s (one operational , the second standby);
- Water for fire-fighting – 70l/s; two pumps are installed, each one with a discharge rate of up to 140 l/s.

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

Whenever necessary, the issued permits for discharge, according to the WA for water intake and use of a water body for discharge, can be modified, in case during the realization and operation of the IP they cannot comply with all the parameters and terms, specified therein. The prohibition for new discharges of waste waters into the irrigation drainage systems shall also be taken into consideration as per art. 6, clause 1,items 3 and 4 of Regulation No. 2 dated 08.06.2011 (State Gazette No. 47 dated21.06.2011) concerning the issue of permits for discharge of waste waters into water bodies and determination of the individual emission limits for specific sources of contamination.

3.2.1.3 SEWERAGE NETWORK

Kozloduy NPP has been provided with a built sewerage network to collect domestic waste water, industrial and rain waters – mixed for EP-1 and separated for EP-2. It includes the whole territory of the power plant and takes in all types of waste waters. The individual sewerage branches have been built at various times during the construction EP-1 and EP-2. The waste waters of some sub-sites of EP-2 are included in the sewerage network of EP-1. The sewerage network is designed and built with additional measures for water tightness:

- ✓ The sewerage branches (with circular cross section) are made with pig iron or steel pipes, laid in waterproof protection channels;
- ✓ The sewerage collectors (with egg-shaped cross section) are in reinforced concrete beds, covering almost the whole height of the profile;
- ✓ All inspection shafts are from monolithic water proof reinforced concrete, while the bottoms and the walls up to two meters above the bottom have improved water tightness.

  The sewerage collectors are laid at depth 4 – 5 m, which in some sections (at IS-9) reaches 10 m to ensure the necessary slope and the gravitational discharge of the waste waters from the separate sub-sites. The average depth of the domestic sewerage system of EP-2 is 3 to 4 m, and of the rain system – by approx. 1 – 2 m bigger.

The total condition of the built sewerage network on the territory of Kozloduy NPP is good. Periodical inspections of the separate sewerage branches are carried out. The occurred accidents are infrequent and easily removed.

The waters from the Danube River, used the service water supply for the cooling of the turbines and for other technological needs, as well as a part of the industrial waste waters discharge in the Danube River via HC-1 and HC-2, which have been commented hereinabove in it. 3.2.1.2.

The sewerage system of Kozloduy NPP represents a set of facilities, which includes:

- ✓ Inspection shafts (IS), collectors of domestic and rain waters;
- ✓ Central sewerage collector and a network of connecting pipelines;
- ✓ Waste water treatment plant (WWTP) – north from unit 1÷4, out-of-operation for years;
- ✓ Waste water treatment complex (WWTC) – on the industrial site of EP-2;
- ✓ Drainage collectors, along which the waters from NPP are discharged into the drainage channels (into the lowland, northward of NPP).

The waste waters from the site (domestic, industrial and rain) are organized in four streams:

- → **stream 1** – trapezoidal channel (TC) – Q_{max} = 30 l/s и Q_{min} = 10 l/s;
- → **stream 2** – Ø 300 mm – Q_{max} = 30 l/s и Q_{min} = 0 l/s;
- → **stream 3** – Ø 1000 mm – Q_{max} = 90 l/s и Q_{min} = 30 l/s;
- → **stream 4** – egg-shaped profile with dimensions 130/195 cm from OS.

FIGURE 3.2-2: LAYOUT SCHEME OF THE DISCHARGE PLACES OF THE WASTE WATERS FROM KOZLODUY NPP

The layout scheme of the places for discharge of waste waters from Kozloduy NPP is shown on **Figure 3.2-2**

These waters are discharged via the NPP sewerage system into MDC of the Kozloduy drainage system, owned by "Irrigation Systems" EAD – Mizia branch. From the main drainage channel the water is pumped back into the Danube River via the reconstructed drainage Kozloduy pumping station, which is also managed by "Irrigation Systems" EAD – Mizia branch.

3.2.1.4 WASTE WATERS

3.2.1.4.1 Non-radiation aspect

3.2.1.4.1.1 Types of waste waters and streams

The non-radioactive waste waters from Kozloduy NPP site include the domestic waste water, production and rain waters. They come from the administration buildings, the energy buildings, the sanitary personnel buildings, the auxiliary buildings, the Common Purpose Building, the engineering laboratory building, the CWTF, the fuel and lubrication facilities, the diesel-generator stations, rolling stock parks, etc.

The following main streams are formed at EP-2:

→ production waste waters – these comprise acid and alkaline waste waters from the CWTF, waters, contaminated by crude petroleum products and oils, which are conveyed along separate collectors to the built local waste water treatment facilities for the various types of waters;

→ rain waters – from the drainage of the roofs, streets and greenery areas within the territory of the power plant, which are conveyed to the MDC via the rain water sewerage.

- → domestic waste water – from the sanitary facilities and laundries in the controlled area and the clean zone, which are conveyed along conveyed along separate collectors to the EP-2 WWTP;
- → production waste waters – these comprise acid and alkaline waste waters from the CWTF, waters, contaminated by crude petroleum products and oils, which are conveyed along separate collectors to the built local waste water treatment facilities for the various types of waters;
- → rain waters – from the drainage of the roofs, streets and greenery areas within the territory of the power plant, which are conveyed to the MDC via the rain water sewerage;
- → a stream of cooling non-contaminated waters from various sub-sites, which are conveyed into the rain water sewerage.

Aforementioned waste waters are discharged into the Main Drainage Channel (MDC) of the Kozloduy drainage and irrigation system, where the four streams of waste waters from the whole NPP site outflow, from which by means of a pump stations (PS) the waters from the

MDC are conveyed into the Danube River. These waste water streams are joined by all other streams, generated on the territory of EP-1.

Stream 1: Mixed from of domestic waste water (untreated), industrial and rain waste waters, conveyed to the MDC by means of a trapezoidal open channel (from the mixed sewerage of EP-1 – domestic waste waters from the energy buildings of units 1÷4, Auxiliary buildings 1 and 2, DGS and other administration and staff buildings, part of which are the property of SD DC – a subsidiary of SE RAW; industrial waters from EP-1, excluding the installations in HC-1; rain waters from EP-1; part of the industrial, domestic waste water and rain waters from the EP-2 site; domestic waste waters from the office buildings and sites of Atomenergoremont PL (AER), Atomenergo-Stroyprogress EAD, Zavodski Stroezhi – Kozloduy AD (ZS), Energomontazh OOD, Energomontazh-KNPP AD; waters from the carwash of AESP EAD and rain waters – after treatment in the local sludge and oil retainer).

Stream 2: Domestic waste waters from the so-called clean zone of EP-2, from SE RAW – Kozloduy and AESP EAD, discharged (without treatment) into the MDC by means of a collector of Ø300 mm during repair works, or in emergency situations.

Stream 3: Mixed flow of domestic waste waters from the controlled zone and the clean zone treated at the treatment complex of EP-2 (TC), industrial waste waters from the Turbine Halls (THs), DGS and the Fuel and Oil Facility (treated by the sludge and oil retainer of the TC), as well as rain waters from EP-2 and from SE RAW – Kozloduy, discharged into the MDC via collector of Ø1000 mm.

Stream 4: Domestic waste waters and rain waters, coming from the Open Switchgear, discharged into the MDC by means of collector with an egg-shaped profile of 130/195 cm and an open lined channel.

For these streams of waste waters there is a permit No13750001/20.04.2007 issued by BDWMDR for discharge into a surface water body with (discharge in MDC), extended with Decision No216/25.02.2010 of BDWMDR Director with validity deadline 20.04.2016.

In addition to above four streams, waste waters are discharged also into the Danube River by means of HC-1 /Stream HC-1/ and HC-2/Stream HC-2/, for which a permit for discharge in a surface water body with No13120037/22.11.2010 has been issued by the BDWMDR. This is primarily cooling water after the condensers and from the service water systems. Other waters, discharged via the HC, include:

- → debalance water discharges from the Reactor Water Cleanup Systems (WCS-3, WCS-5, WCS-7), including the condensate from heating steam;
- → waters from the demineralized water installations (after treatment in the neutralizing pits);
- → waters from the expansion vessels of the overflowing high-pressure deaerators (HPD) and from the expansion vessels of the steam generators blowdown (SG);
- → waters from the secondary drainage tanks II contour and from the condensate system flushing;
- → flushing water from the recirculation water filters.

3.2.1.4.1.2 Non-radioactive waste water quantities

The waste water quantities generated in 2007, 2008, 2009, 2010, 2011 and 2012 by the NPP site, measured by the Hydro-Technical Facilities and Building Structures (HTF and CC) Department, compared with the admissible values, are presented in **Table 3.2-2.**

The waste water quantities generated in 2007, 2008, 2009, 2010 and 2011 by LNRMIW are shown in **Table 3.2-3.**

From the presented information (**Table 3.2-2**) it can be deduced that after 2009 the water discharge rates applied for considerably exceed the water discharges used and, therefore, there will be no excessive operation from any specific water body, with sufficient water quantities being available for drinking, domestic and industrial water supply upon realization of the Investment proposal

From the three main streams, which form the waste waters of the four decommissioned units, namely: the conditionally clean waters – from the waters for industrial purposes, which are used mainly for cooling; from the used water for domestic needs and the rain waters, which have accidental nature, the quantity of the first waters is heavily reduced. About half of them are treated water discharges, demineralized waters and other industrial waters. The remaining ones are cooling waters, which are not necessary when the units are decommissioned. Due to the fact that upon decommissioning of the power units from EP-1 cooling waters are not used, and the quantity of the treated and demineralised waters is heavily reduced, it may be projected that as a whole the quantity of the waste waters from the existing power plant site will be significantly reduced.

TABLE 3.2-2: WASTE WATERS AMOUNTS GENERATED BY KOZLODUY NPP

<table>
<tr><th rowspan="2">STREAM</th><th rowspan="2">Waste water type</th><th rowspan="2" colspan="2">Admissible water amount /pursuant to Permit of BDWMDR/thousand m³ /</th><th colspan="6">Generated water amount / thousand m³ /</th></tr>
<tr><th>2007 г.</th><th>2008 г.</th><th>2009</th><th>2010</th><th>2011</th><th>2012 г.</th></tr>
<tr><td>Stream 1 (TC-MDC)</td><td>Industrial, domestic and rain waters from EP-1</td><td colspan="2">3900</td><td>1781</td><td>498</td><td>610</td><td>620</td><td>680</td><td>965.057</td></tr>
<tr><td>Stream 2 (Ø 300-MDC)</td><td>Domestic waters after treatment complex EP-2</td><td colspan="2">450</td><td>572,7</td><td>527</td><td>194</td><td>65</td><td>16</td><td>5.727</td></tr>
<tr><td>Stream 3 (Ø 1000-MDC)</td><td>Treated industrial waters from MH, DGS and FOF, etc.</td><td colspan="2">6600</td><td>6 639</td><td>7360</td><td>4565</td><td>1980</td><td>1895</td><td>1948</td></tr>
<tr><td>Stream 4 (OS-MDC)</td><td>Domestic waste waters from OS</td><td colspan="2">1095</td><td>Not measured</td><td>Not measured</td><td>Not measured</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Stream HC-1 –Danube River</td><td>Cooling and industrial waste waters from EP-1 and EP-2</td><td>1 050 000</td><td rowspan="2">3 280 000</td><td rowspan="2">2 250 449</td><td rowspan="2">2 536 387</td><td rowspan="2">2 383 715</td><td>1 670 452</td><td>2 114 288</td><td>1 978 865</td></tr>
<tr><td>Stream HC-2 – Danube River</td><td>Cooling and industrial waste waters from EP-1 and EP-2</td><td>2 230 000</td><td>746 004</td><td>507 647</td><td>365 654.5</td></tr>
</table>

Source: *Annual In-House Non-Radiation Monitoring (IHNRM) Report on Kozloduy NPP Environment.*

TABLE 3.2-3: WASTE WATER AMOUNTS FROM LNRMIW

MONTH	2007.		2008.		2009		2010		2011	
	IS-4 m³	IS-7 m³	IS-4 m³	IS-7 m³	IS-4 m³	IS-7 m³	IS-4 m³	IS-7 m³	IS-4 m³	IS-7 m³
Spring	120	80	144	194	195	45	97	284	120	252
Summer	70	90	75	274	222	36	40	251	87	177
Autumn	100	500	66	135	101	81	90	180	123	165
Winter	180	94	99	152	126	33	18	405	51	303
TOTAL	**470**	**764**	**384**	**755**	**644**	**195**	**245**	**1120**	**381**	**897**

Source: *Annual In-House Non-Radiation Monitoring (IHNRM) Report on Kozloduy NPP Environment for the period 2007-2011*

From the above presented Table it can be deduced that the waste water quantity from LNRMIW (annual) is negligible, compared with the remaining waste water quantities from EP-2.

The quantities of the discharged waste waters are measured with measuring devices. Annually, by 31.01 of the following year the quantities of the used and discharged waste waters are reported to Danube Region Basin Directorate – Pleven. The waste waters from Kozloduy NPP according to data from RIEW – Vratsa represent 70.8% of the total quantity of the waste waters for the Danube region and 36.5% of the total annual quantity for the whole country.

3.2.1.4.1.3 Existing treatment facilities

Various water treatment facilities have been built on the territory of the NPP for treating the waste waters coming from the individual sub-sites.

Waste Water Treatment Plant of EP-1

A Treatment Facility was designed and built for the waste waters, formed on the EP-1 site in 1975. ***The treatment facility of EP-1 has not been operating for years***. The area around it is covered with vegetation and significantly flooded. During the time, when the plant was still in operation, the qualities of the purified by it waste waters were controlled.

Waste Water Treatment Plant of EP 2 – Waste water treatment complex of Kozloduy NPP (WWTC)

Since a part of the waste domestic waters of 5-th and 6-the power units originates from a zone with a probability for radioactive pollution, they are split into two streams, which are treated in one and the same manner in facilities, fully separated from each other, as follows:

- ✓ **First stream** – domestic waste waters, generated by zones, in which there is a danger of radioactive pollution KZ (controlled zone);
- ✓ **Second stream** – domestic waste waters, generated by zones, in which there is no danger of radioactive pollution CZ (clean zone).

The treatment facilities for these two streams are analogical and differ only in relation to their volumes. The waste water treatment plant of the CZ is designed for average daily water quantity 106 m^3. The clean zone is equipped with dosimetric control installation. In case that the water radioactivity exceeds the admissible level, it is returned to the CZ for treatment. The water treatment plant from the "Clean Zone" is designed for 146 m^3 per day.

Their technological schemes include the following facilities[37]:

- ✓ Coarse grid for large size pollutant retention;
- ✓ Drawing water tank;
- ✓ pumping station to raise the waste waters to the level of the treatment facilities; on the pressure side of the pumps two water stations are installed WS 2 and WS-3 (one for each stream), which are part of the Automated information system for radiation control of treated and waste waters;
- ✓ bio-basin with surface aerator;
- ✓ secondary vertical settling tanks;
- ✓ contact reservoir;
- ✓ settler-densifier of the excessive active sediment.

The installation for dosimetric control is connected to the technological scheme for the waste waters from the first stream.

The treatment facilities are designed for

Clean zone

- Q ave daily = 146 m^3/d;
- Q ave hourly = 6.10 m^3/h;
- Q max hourly = 33.80 m^3/h.

Controlled zone

- Q ave daily = 106 m^3/d;
- Q ave hourly = 4.40 m^3/h;
- Q max hourly = 21.30 m^3/h.

The pumping of the waste waters from the drawing water tank to the bio-basins is performed by seven pumps, located in the pumping facility. For the waste waters from “clean zone” 3 operating and 1 backup pumps are envisioned, and for the waste waters from the “controlled regime zone” – respectively 2 operating and 1 reserve pumps. All pumps are of one and the same type and operate in an automatic mode, depending on the water level in the drawing water tank.

The surface aerator in the bio-basin for waste waters from the “controlled zone” has a diameter of the impeller 1000 mm, power N- 7.5 kW, and revolutions n = 98 min^{-1}.

The surface aerator in the bio-basin for waste waters from “clean zone” has diameter of the impeller 1500 mm, power N – 17 kW, and revolutions n = 64 min^{-1}.

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[37] EIAR of Kozloduy NPP -1999

The bio-basins operate with 100% active sediment recirculation.

During the visit of the experts, preparing this EIAR at Kozloduy NPP (20 and 21.02.2013), the bio-basin were operating with duration of 3 hours and quantity of dissolved oxygen 2 g/m^3.

The secondary settling tanks for the waste waters are vertical – two for each of the zones.

For "controlled regime" zone:

- Total area of the working part of the settling tank – 12.0 m^2 ;
- Working height – 2.65 m;
- Settling part volume – 11.80 m3;
- Settling speed in the working part – 0.0005 m/s.

For "clean" zone":

- Total area of the working part of the settling tank – 18.8 m^2;
- Working height – 2.90 m;
- Settling part volume – 20.10 m^3;
- Settling speed in the working part – 0.0005 m/s.

The dosimetric control installation consists of two couples of reservoirs, connected to the three drainage pumps. The useful volume of each of the control reservoirs is 125 m^3. After the filling of one of the reservoirs from the first couple, the inflowing waters are automatically transferred to a reservoir from the other couple. The way of treatment of the received waters shall be determined depending on the obtained result from the examination of the taken control sample from the already filled reservoir.

When the activity of the control sample does not exceed more than 10 times the admissible value, the collected treated waste waters from the filled reservoir are transferred to the empty one from the same couple, where dilution with the service water supplied to the spray ponds is performed.

According to information from the Control Direction of EP-2 for the whole period of operation, there has been no radioactive pollution of the treated waters.

In the treatment complex, which unites waste water treatment plant for domestic waste waters from both zones, the following analyses of the untreated and treated waste waters are being performed on a daily basis: pH, temperature, permanganate oxidability, COD and dissolved oxygen quantity in the bio-basin.

The treated waters from both zones are discharged through a collector Ø 1000 into MDC of the Kozloduy drainage system.

The registered and reported values, exceeding the IEL of the organic indicators and of biogenic elements such as BOD_5, common phosphorous (e.g. PO_4) and common nitrogen have been due to a large extent to the operation regime of the WWTP for domestic waste water for EP-2 (low organic loading and high hydraulic loading – i.e. dilution with waters, which do not contain organic pollutants – e.g. rain waters), which disturbs the biological treatment process. During the recent years this trend has been removed and there is an improvement in the operation of the WWTP. Measures have been taken, related to the reduction in the quantity of the inflowing waste waters.

The proper operation of the waste water treatment plants is ensured by instructions which state the requirements for normal operation mode in and in case of potential failures. In emergency situations or in case of repair works carried out, a possibility is provided to discharge the domestic waste waters from the CA into the MDC without treatment.

Neutralization pit for the waste waters from CWTF of EP-1

The neutralization pit consists of two chambers, located in the east part of the Kozloduy NPP site, south from the nitrogen-oxygen station. When one of the chambers is operating, the other is standby, or is being cleaned from the formed in it sediments.

The waste waters from CWTF of EP-1 are being supplied to this facility. The neutralization of the waters in the pit is controlled through the pH values, which should fall within the range of 6.5÷ 8.5. The neutralization processes are automated.

Neutralization pit for the waste waters of EP-2

The neutralization pits are located on the territory of EP-2, north from the Chemical Department. The waste waters from the installations for chemical water treatment (CWTF) of Electricity Production 2 (units 5 and 6) of Kozloduy NPP EAD. CWTF treats the raw water from the Danube River. The water passes through mechanical treatment (reactor-settling tanks) and filtering through mechanical and ion-exchange filters. The waste waters from this treatment, as well as the solutions from the filters regeneration may contain sulfuric, hydrochloric and nitric acids, sodium hydroxide, calcimine, ferrous chloride.

The designation of the neutralization pits is to average the pH values of the forming acid and alkaline waters from CWTF.

The neutralization pits include the following facilities:

- ✓ Two chambers, each having volume of m^3 (working chamber); when one of the two chambers is operating, the other is standby or is being cleaned from the formed in it sediments;
- ✓ Pumping premise with 4 sludge pumps and one ejector;
- ✓ Collector shafts near CWTF (2 pcs.), each one having 3.0 m^3 volume;
- ✓ Automatic regulators, safeguards, interlocks.

The neutralization of the waters in the pits is controlled through the pH values, which should be within the range 6.5 ÷ 8.5. In the facility, automatic regulation of pH values of the waste waters is achieved through the automatic regulators of recirculation until the reaching of the admissible levels. In case that they do not meet the aforementioned requirement, the waters are retained to achieve the needed neutralization degree. The mixing of the waste waters is accomplished using compressed air in the pits. It has to be with normal pressure to achieve continuous mixing of the sediments and good averaging. The neutralization of the inflowing acid and alkaline waters is accomplished without reagents. Calcium hydroxide is introduced into the pits only upon necessity. After neutralization, the waters are pumped out and discharged in IS-1 of low-pressure channels, and from there – in HC-1 or HC-2, from where they are flow into the Danube River. Twice per year the pits are cleaned from the sediments, formed during neutralization. Technological instruction for proper operation of the facilities and for ensuring the neutralization process has been developed, which is strictly observed.

Other local treatment facilities of EP-1

On the sites of the fuel and oil facilities there are built: one separating shaft (for the fuel) and one oil retainer (for the oil), which take in only the waste waters from the containments of the reservoirs, excluding these, which have been generated by the discharge area. They have a low treatment effect due to their small volume. As of now, there is no inflow to these facilities.

On Kozloduy NPP site, as well as on other places, there are small treatment facilities – separating shafts and oil retainers, which do not operate efficiently, but as of now there is almost no inflow to them.

Sludge and oil retainer for waste waters from MC and DGS of EP-2

Immediately next to the Waste Water Treatment Complex /WWTC/ for EP-2, a sludge and oil retainer for treatment of industrial waste waters from TH, DGS and fuel and oil facility was built in 2011. The new sludge and oil retainer has 3 sections – retainer, coalescent filters, complete treatment stage with adsorption filter. The facility is dug in the ground. Its capacity is up to 50 l/s, with treatment indicators by oil products at the exit of the facility – up to 0.5 mg/l. The sludge and oil retainer consists of several mutually connected containers.

The main parts of the facility are:

- ✓ Space for precipitation of the sediment substances – primary coalescent filter
- ✓ Space for separation of the petroleum products and their storage – complete treatment stage with adsorption filter.

The sludge and oil retainer meets the requirements of the European standards EN 858, DIN 1999, ONORM B 5101. It operates efficiently and is run appropriately pursuant to the instructions for operation, and this guarantees the qualities of the treated in it waste waters. The waters treated in the sludge and oil retainer flow into collector Ø 1000 of the sewerage system, via which they are discharged into the MDC.

A separating shaft for retaining of petroleum products has been built on the site of DGS (EP-2).

Old fuel and oil retainer adhering to EP-2

The former fuel and oil retainer is used nowadays for treatment of separate small water quantities, contaminated with petroleum products (e.g. from the washing of different engines, greased parts, etc.), delivered with a cistern. The maximum admissible flow rate of the oil-containing waste waters under normal operation of the fuel and oil retainer is 14.0 l/s for oil concentration of 100.0 mg/l. The fuel and oil retainer includes two simultaneously operating sections – concrete reservoirs, each with volume 150 m^3. The contaminated with oils waste waters flow into them and stay there for at least 3 hours.

Immediately next to the separating walls (which do not reach the bottom) two semi-pipes are located, which are used to catch the retained oils and their removal by the fuel and oil retainer into a separating tank, which represents a dug in the earth cistern with volume 25 m^3, equipped with an oil-heating serpentine. The treated waste waters pass through perforated pipes into a spillway, and then are discharged into the rain water sewerage and from there –into the MDC. The fuel and oil retainers are serviced by the maintenance staff of the Treatment Complex of EP-2.

The fuel and oil retainer represent a part of the installations of the Treatment Complex of the EP-2 site and are serviced by the maintenance staff of the treatment complex of EP-2

3.2.1.4.1.4 Own non-radiation monitoring of the waste waters from Kozloduy NPP EAD

For the needs of the EIAR, detailed results for the quality of the surface waters, collected by the monitoring of Kozloduy NPP, have been provided. Kozloduy NPP EAD has organized and is implementing regular and mandatory in-house non-radiation monitoring of the waste waters, pursuant to the terms in the permits for discharge in the separate sewerage collectors and at the places for discharge into the MDC, as well as into HC-1 and HC-2 at their discharge into the Danube River, as well as of the temperature and the physico-chemical indicators of the water in CC-1, flowing from the Danube River. Additional internal monitoring and control of all points of discharge into MDC, HC-1, HC-2 and the Danube River, as well as of the quantity and quality of the waste waters discharged into the sewerage system by external consumers on the territory of the power plant, is also performed. The layout scheme of the monitoring posts for the waste waters of Kozloduy NPP is shown on **Figure 3.2-3**.

FIGURE 3.2-3: LAYOUT SCHEME OF THE MONITORING POSTS OF KOZLODUY NPP"

The characteristics of the contaminated waste non-radioactive waters, as summarized results from the analyses for 2007, 2008, 2009, 2010, 2011 and 2012 by streams, are provided in *Annex 9-1*[38], *Tables from 1 to 7***.** The waste water samples are selected and analyzed by accredited laboratory – Regional Laboratory – EEA, city of Vratsa, and the laboratories of Kozloduy NPP – sector EC to ILB (accredited) and PCC laboratory

From the presented results in the Annex and the summary, contained in Table 7, it is seen that:

Stream–1 – contaminated waste non-radioactive waters have incidentally exceeded the individual emission limits (IEL), related to the following indicators:

- Insoluble substances – for IV quarter of 2007 and III and IV quarter of 2008. There have been no exceedances during the following years.
- BOD – exceedances have been detected during I and IV quarter of 2007, as well as during III and IV quarter of 2008.
- COD – exceedances have been established during IV quarter of 2008.
- Regarding the “boron” indicator individual values are registered every year, for which the IEL is violated, that “boron” is inadmissible. These exceeding values are observed almost during the whole sampling period but they are within the range of the values, reported for in relation with the drinking water of the city Kozloduy and the water in the Danube River (Protocol No 1-E/24.01. 2012).
- For the indicator “tritium” there is no IEL, but it appears during IV quarter of 2011 (63.7 mBq/dm^3). The tritium is an indicator for presence of radionuclides in the surface, as well as in the groundwaters.

Stream–2 – waste non-radioactive contaminated waters have incidental exceedances of the individual emission limits (IEL), related to the following indicators:

- Insoluble substances – exceedances have been established only during month VII of 2008;
- BOD – exceedances have been detected during I and IV quarter of 2007, II, VII and IX month of 2008, and I quarter of 2009;
- Common phosphorous – since the beginning of 2008 there have been relatively frequent exceedances of the IEL with regard to this indicator; exceedances have been established during I, III and IV quarter of 2008, as well as during I and IV quarter of 2009;
- With regard to the “Boron” indicator, for which “IEL” is not allowed there are exceedances during III and IV quarter of 2007, II and III quarter of 2008 and I quarter of 2009.

For 2010 and 2011, no analyses have been made of Stream–2, since there has been no flow.

[38] Summarized results from the physico-chemical studies of the waste waters in the region of Kozloduy NPP, pursuant to Annual Non-Radiation Monitoring Reports of Kozloduy NPP EAD

Stream–3 – waste industrial waters, rain waters and treated domestic waste waters from EP-2 (Ø 1000) have exceedances of the individual emission limits (IEL), related to the following indicators:

- Insoluble substances – for I quarter of 2009
- With regard to the "boron" indicator, for which the IEL is "not admissible", on an annual basis individual values are registered, violating EIL – i.e. there are exceedances, although minimal.
- With regard to the "tritium" indicator, there is no IEL, but it appears during IV-quarter of 2011 (185 mBq/dm^3) and irrespective of the fact that the total indicative dose of the tritium will fall within limits, this means that there is a movement of radionuclides in the waters.

Stream–4 – waste domestic and rain waters from OS in channel 130/195 cm have exceedances of IEL, related to the following indicators:

- BOD5 – exceedances have been established during October 2008
- Total phosphorous – exceedances have been established during IV quarter of 2008
- Total nitrogen – exceedances have been established during IV quarter of 2008
- In relation with the "boron" indicator, for which the IEL is "not admissible", there have been exceedances, only during III quarter of 2008.

Stream HC-1 – waste cooling and industrial waters from HC-1 have exceedances of the individual emission limits (IEL), related to the following indicators:

- COD – exceedances have been established during III quarter of 2007
- Residual chlorine – exceedances have been established during II quarter of 2007, I and II quarter of 2009
- Petroleum products – exceedances have been established during II quarter of 2008
- Chlorine ions – exceedances have been established during III quarter of 2007.

In 2010 and 2011 there were no established IEL exceedances of the waters in HC-1.

Stream HC-2 – waste cooling and industrial waters from HC-2 – exceedances of the individual emission limits (IEL) are registered only with regard to the "Residual chlorine" indicator – for II month of 2009.

There are no exceedances of the individual emission limits for streams 5 and 6, determined with the waste water discharge permit.

In 2012, there were no established IEL exceedances in the streams, discharged in the MDC only with regard to the "boron" indicator, for which IEL is "not admissible". These exceedances are present during the whole sampling period, but they stay within the value ranges, reported for the drinking water of Kozloduy city and for the Danube River water (Protocol No 1-E/24.01.2012).

It should be taken into consideration, that the registered exceedances account for the transitory status of the waste waters during the sampling, which is performed with the frequency, prescribed by the competent authority /see **Table 3.2-4**; **Table 3.2-5** and **Table 3.2-6**/.

3.2.1.4.1.5 Periodicity for the testing of the waste non-radioactive waters

TABLE 3.2-4: WASTE WATERS, DISCHARGED INTO THE MDC AND THE DANUBE RIVER, VIA HC-1 AND HC-2

STREAM, discharged in		**Main drainage channel of the Kozloduy drainage system**				**Danube River**
No discharged via		**STREAM-1 Trapezoidal open channel (TC)**	**STREAM 2 Sewerage collector ø 300**	**STREAM 3 Sewerage collector ø 1000**	**STREAM 4 Sewerage collector 130/195**	**HC-1 HC-2**
STREAM generated by		Domestic, industrial and rain waters from ЕП-1,-2	Domestic, waste waters from EP 2	Industrial and rain waters from EP 2	Domestic and rain waters from OS	
	Measure	**PERIODICITY**				
Water temperature	°C	-	-	-	-	3 m
Total beta activity	mBq/dm³	1 m.	3 m	3 m	3 m	3 m
Insoluble substances	mgO₂/dm³	3 m.	3 m	3 m	3 m	3 m
BOD_5	mg/dm³	3 m.	3 m	-	-	
COD(dichromate)	mg/dm³	3 m.	3 m	3 m	3 m	3 m
Common phosphorous (PO_4)	mg/dm³	3 m.	3 m	3 m	3 m	-
Residual chlorine	mg/dm³	3 m	3 m	3 m	3 m	3 m
Petroleum products	mBq/dm³	3 m	3 m	3 m	3 m	3 m
Common nitrogen	mg/dm³	3 m	3 m	3 m	3 m	3 m
Detergents	mg/dm³	3 m	3 m	3 m	3 m	-
Extractable substances	mg/dm³	1 y	1 y	1 y	1 y	-
Sulfate ions	mg/dm³	1 y	1 y	1 y	1 y	-
Active reaction	-	3 m	3 m	3 m	3 m	3m
Zinc	mg/dm³	3 m	3 m	3 m	1 y	3m
Boron	mg/dm³	3 m	3 m	3 m	1 y	3m
Cobalt	mg/dm³	3 m	3 m	3 m	1 y	3m
Manganese (common)	mg/dm³	3 m	3m	3 m	1 y	-
Nickel	mg/dm³	3 m	3 m	3 m	1 y	-
Iron (common)	mg/dm³	3 m	1 y	1 y	1 y	3m
Arsenic	mg/dm³	1 y	1 y	1 y	1 y	-
Cadmium	mg/dm³	1 y	1 y	1 y	1 y	-
Copper	mg/dm³	1 y	1 y	1 y	1 y	-
Lead	mg/dm³	1 y	1 y	1 y	1 y	-
Strontium 90	mg/dm³	1 y	1 y	1 y	1 y	-
Tritium	mBq/dm³	1 y	1 y	1 y	1 y	-
Gamma	mg/dm³	1 y	1 y	1 y	1 y	-

STREAM, discharged in	Main drainage channel of the Kozloduy drainage system					Danube River
spectrometry						

LEGEND: ***1y*** *– analysis, performed once per year;* ***1m (3m);*** *–analysis, performed once per 1 month (per 3 months).*

On the territory of the Landfill for Non-Radioactive Municipal and Industrial Waste (LNRMIW)[39] two types of waste waters are formed, for whose collection two separate shafts have been built – IS-4 (for infiltrate) and IS-7 (for domestic and surface waters from the landfill site). After radiation control, the waters from the two shafts are transported with a cistern to the neutralization pit of EP-2, accompanied with a radiation control protocol, from where via low-pressure channels they flow into HC-1. End water receiver for the waters is the Danube River. The quantity of the waste waters from the Landfill represents about 0.3% – 0.4 % of the waste water quantity from the neutralization pit at EP-2.

The quality of the waters from the Landfill for Non-Radioactive Municipal and Industrial Waste is characterized with regard to the following indicators: PH, insoluble substances and petroleum products, while no trend towards a lasting change in the controlled indicators is observed.

- Insoluble substances – in 2012, with regard to this indicator the measured values were moving between H.B.=43÷81mg/l for IS-4 and 27÷53mg/l for IS-7;
- Petroleum products – in 2012, values for IS-4 and IS-7 <.1mg/l were reported
- PH of 7.12÷8.6 for IS-4, and PH of 7.56÷7.89 for IS-7.

TABLE 3.2-5: WASTE WATERS FROM THE OT LANDFILL FOR NON-RADIOACTIVE MUNICIPAL AND INDUSTRIAL WASTE (LNRMIW)

Formed from →		Infiltrate from waste and rain waters from LNRMIW	Domestic, industrial and rain waters from LNRMIW
	Measure	PERIODSЧНОСТ	
Insoluble substances	mg/dm^3	3 m.	3 m.
Petroleum products	mg/dm^3	3 m.	3 m.
Detergents (anion SASs)	mg/dm^3	-	3 m.

[39] *Annex 9-1*, Tables 8 and 9.

TABLE 3.2-6: WASTE WATERS FROM EXTERNAL ORGANIZATIONS, DISCHARGING INTO THE SEWERAGE SYSTEM OF KOZLODUY NPP

STREAM		Domestic waste waters	Industrial waste waters from the galvanic department of Atomenergoremont”
	Measure	PERIODICITY	
Insoluble substances	mg/dm³	1 y	И
BOD_5	mg/dm³	1 y	-
COD (dichromate)	mgO_2/dm^3	1 y	-
Total phosphorous (PO_4)	mg/dm³	1 y	-
Chlorine ions	mg/dm³	1 y	-
Sulfate ions	mg/dm³	1 y	-
Cyanides	mg/dm³	-	E
Petroleum products	mg/dm³	1 y	E
Boron	mg/dm³	1 y	-
Detergents (anion SASs)	mg/dm³	1 y	-

LEGEND:*1y* – *analysis, performed once per year;* ***1m (3m)*** – *analysis, performed once per 1 month (once per 3 months); E – extraordinary analysis, performed upon request*

3.2.1.4.1.6 Individual emission limits (IEL) of the waste water indicators

IEL of the waste water indicators are defined by streams and by discharge places, specified in the Water Body Use Permits for waste water discharge into surface water bodies.

TABLE 3.2-7: IEL OF THE INDICATORS FOR WASTE WATERS FROM STREAM 1, 2, 3 AND 4, DISCHARGED INTO THE MAIN DRAINAGE CHANNEL (MDC) OF THE KOZLODUY DRAINAGE SYSTEM, PURSUANT TO PERMIT NO 13750001 / 20.04.2007 (VALIDITY PERIOD: UNTIL 20.04.2016)

Indicator		
Name	Measure	Norm
Total β-Activity	mBq/dm³	750
Insoluble substances	mg/dm³	50
BOD_5 (only for domestic waters)	mg/dm³	15
COD (dichromate)	mgO_2/dm^3	70
Common phosphorous (PO_4)	mg/dm³	2
Chlorine ions	mg/dm³	300
Petroleum products	mg/dm³	5
Detergents	mg/dm³	1
Boron	mg/dm³	Not allowed

TABLE 3.2-8: IEL OF THE INDICATORS FOR WASTE WATERS FROM HOT CHANNEL 1 AND 2, DISCHARGED INTO THE DANUBE RIVER, PURSUANT TO PERMIT NO 13120037 / 22.11.2010(VALIDITY PERIOD: UNTIL 15.12.2015)

Indicator		
Name	**Measure**	**Norm**
Total β-Activity	mBq/dm^3	750
Undissolbed substances	mg/dm^3	100
COD (dichromate)	mgO_2/dm^3	100
Residual chlorine	mg/dm^3	0.1
Petroleum products	mg/dm^3	0.5
Boron	mg/dm^3	1

3.2.1.4.1.7 Additional internal control

The additional internal control is accomplished by chemical laboratories of NPP, and its objective is to supplement the mandatory control in the months, during which no mandatory analyses are envisioned, pursuant to the water use permits and the permits for using water bodies for waste water discharge.

TABLE 3.2-9: PERIODICITY OF THE ADDITIONAL CONTROL ON THE WASTE WATERS, DISCHARGED INTO MDC AND THE DANUBE RIVER VIA HC-1 AND HC-2

STREAM, discharged into		**Main Drainage Channel of the Kozloduy drainage system**				**Danube River**
No Discharged via		**STREAM 1 Trapezoidal Open Channel (TC)**	**STREAM 2 Sewerage collector ø 300**	**STREAM 3 Sewerage collector ø 1000**	**STREAM 4 Sewerage collector 130/195**	**HC-1 HC-2**
STREAM generated from		Domestic, industrial and rain waters from EP-1,-2	Domestic waste waters from EP 2	Industrial and rain waters from EP 2	Domestic and rain waters from OS	
	Measure	**PERIODICITY**				
Active reaction	-	1 m	1 m	1 m	1 m	1 m
Insoluble substances	mg/dm^3	1 m	1 m	1 m	1 m	1 m
Petroleum products	mg/dm^3	1 m	1 m	1 m	1 m	1 m
COD	mg/dm^3	1 m	1 m	1 m	1 m	1 m
Common phosphorous	mg/dm^3	1 m	1 m	1 m	1 m	-
Detergents	mg/dm^3	1 m	1 m	1 m	1 m	-
BOD_5	mg/dm^3	1 m	1 m	-	-	-
Residual chlorine	mg/dm^3	-	-	-	-	1 m

LEGEND: ***1m*** *–analysis, performed once per month*

Conclusions:

The mandatory in-house monitoring of the waste non-radioactive contaminated waters, as shown, includes measurement of the quantities and the concentration of the pollutants in them, for which IELs are determined in the Permits for discharging into a surface water body, issued by BDWMDR. The sample selection and the tests within the scope of the mandatory monitoring are carried out by an accredited laboratory. The monitoring program for own non-radiation monitoring, which is implemented by Kozloduy NPP EAD accounts for the operation of the existing WWTPs and of the local treatment facilities, built on the site.

The results from the performed monitoring show that the waste waters are characterized by:

- ✓ Low organic pollution (values higher than the normative have been established in single cases). The slight waste water organic pollution is expressed in single cases of minimal exceeding of IEL for organic indicators and biogenic elements, such as COD, BOD_5, total phosphorous (such as PO_4) and total nitrogen. These recorded and reported cases of exceeded values are largely due to a operation mode of WWTP for domestic waste waters for EP-2 /low organic loading and high hydraulic loading, i.e. dilution with water not containing organic pollutants, such as rain water), which disturbs the biological treatment process. During the recent years this tendency has been removed, as a result of which the performance of the WWTPs has improved. Measures have been taken, related to the reduction of the quantity of inflowing waste waters.
- ✓ Incidental presence of petroleum products in HC-1 (for 1 month during 2008). The waste waters containing petroleum products are generated at the Turbine Halls of EP-1 and EP-2, the Fleet park, the Fuel and Oil Facility, the Diesel Generator Stations (DGS) of EP-2, etc. The available local treatment facilities process large waste water amounts. There is a periodical presence of petroleum products exceeding IEL in the infiltrate and in the domestic and surface waters from the LNRMIW, respectively dumped in IS-4 and IS-7 of the site sewerage system. Although negligible as a quantity compared with the remaining waste waters, they may yet have certain impact.
- ✓ There is a lasting trend for non-observance of IEL with regard to the "boron" indicator in the waste waters, discharged in MDC. Boron is present in almost all samples of waste waters, which are discharged into MDC. In relation with the "boron" indicator, for which IEL is "not admissible" there are exceedances almost during the whole sampling period, but they are within the frameworks of the values, recorded for the drinking water of the city of Kozloduy and the waters in the Danube River (Protocol No 1-E/24.01. 2012).
- ✓ IEL for HC-1 and HC-2 for the most recent five years show that only during 2009 there has been one-off default with regard to the "residual chlorine" indicator. The control on the observance of IEL by the physical-chemical pollution of the waste and by the Danube River is performed by the Regional Laboratory – Vratsa at EEA, while

during the most recent several years more than 100 sample takings have been accomplished, accompanied with protocols for the conducted tests by the separate indicators:

- One-off cases of exceeded values, related to residual chlorine in the waste waters, discharged into HC-1 and HC-2 (during 2007 and 2009).
- The established values for heavy metal contents for the whole reviewed period are much **lower than IEL.**

Annual Non-Radiation Monitoring Programs should be prepared to perform the monitoring. The control monitoring of all waste water discharge points in the NPP region is performed by the bodies of MEW/EEA- RL – Vratsa (Letter of MEW, RIEW – Vratsa, outgoing number. NoB2975/10.01.2013).

It should be stated that the above mentioned data were compared with IEL, determined by BDWMDR, compliant with Regulation No 6/09.11.2000 on Emission Norms for Admissible Contents of Harmful and Hazardous Substances in the Waste Water, discharged in water bodies at a moment of time, when Regulation No 7 of 1986 on the Indicators and Norms for Definition of the Running Surface Water Quality (SG, No 96 of 1986)[40] was valid, according to which the competent authority had written in the permit MDC – II category, and Danube River – III category water receiver. Since 05.03.2013, Regulation No-4 of 14.09.2012 on the characterization of surface waters has been enacted (SG, No 22 of 5 March 2013), which stipulates the terms and procedure for characterization, classification and presentation of the status/potential of the surface water bodies, determination of the anthropogenic pressure on them, whereas through the monitoring system their ecological status/ecological potential is evaluated and the chemical status is classified with the help of given quality standards for the physico-chemical elements of specific pollutants, chemical and other substances, and in combination with the biological and hydro-morphological quality elements, will determine the ecological status of any water body.

It is visible that there is no trend for increase in the values of the controlled indicators and no significant exceedances of the admissible norms have been recorded. The values of these indicators have been comparable during the last years. Information on the performed monitoring are sent periodically and once per annum in a summarized format to BDWMDR, and IEL observation control is performed by RIEW – Vratsa, pursuant to the requirements of the Water Act.

The issued permits for discharge, according to the WA for water intake and use of a water body for discharge, will be modified upon a decision of the competent authority, as well as if during the materialization and operation of the IP, all parameters and conditions, included in these permits, cannot be observed. The prohibition for new discharges of waste water into the irrigation drainage systems shall also be taken into consideration as per

[40] Regulation No. 7/1986, repealed SG, No 22 of 05.03.2013

art.6, par.1, it.3, it.4. from Regulation No2 of 08.06.2011 (SG, No 47 of 21.06.2011) concerning the issue of permits for discharge of waste waters into water bodies and determination of individual emission limits of point sources of pollution.

This monitoring, which at present is performed at NPP, will also continue to be performed in the future, after the realization of the IP for introduction of new unit, being supplemented and expanded to trace the observation of the terms and requirements, which will be set up by the competent authority of the New Nuclear Unit (NNU), related to IEL and the envisioned measures for improving the status of the water bodies, listed in the RBMP, as well as to the regulatory changes.

CONTROL MEASUREMENTS OF THE NON-RADIOACTIVE WASTE WATERS OF KOZLODUY NPP, TAKEN DURING INSPECTION CHECK-UPS BY THE REGIONAL LABORATORY – VRATSA, AND RIEW – VRATSA, DURING 2011 AND 2012

Based on the planned annual control on the sites, discharging non-radioactive waste waters into surface water bodies, in 2011 and 2012 RIEW – Vratsa and Regional Laboratory – Vratsa conducted control sample takings and study of the waste waters at the discharge points of the different waste water streams from Kozloduy NPP, which flow into MDC and the Danube River.

The sampling points are determined in the relevant permits for discharge of these streams, issued by BDWMDR. The monitoring stations have defined geographic coordinates, entered in the respective permits with determined control indicators, their IELs, and the admissible discharge waste water amount. The control measurement data are shown in *Annex 9-2*: Control test protocols.

Data analysis shows that:

- in 2011 for HC-1 and HC-2 **there were no** recorded cases of exceeded IEL values of the indicators, studied by RIEW – Vratsa, with the exception of the “boron” indicator, for Stream – 1 and Stream – 3, for which indicator EIL is “not admissible”; in this case the boron quantity is slightly lower than the limit value, obtained through quantitative calculation pursuant to the methodology;
- in 2012 for the examined Stream -1 and Stream-3 **there were no** cases of exceeded EIL values of the indicators, studied by the Regional Laboratory – Vratsa, with the exception of the “boron” indicator, for which IEL is “not admissible”; in this case the boron quantity is slightly lower than the limit value, obtained through quantitative calculation pursuant to the methodology;
- in 2012 in Stream 5 of HC-1 and Stream 6 of HC-2 there were no cases of exceeded IEL values of the indicators, studied by RL – Vratsa.

3.2.1.4.2 Radiation aspect

3.2.1.4.2.1 Waste water types and amount

During the process of operation of the nuclear power plant radioactive wastes are formed from:

- Primary circuit of the nuclear reactors;
- spent fuel ponds and storage facilities;
- decontamination facilities;
- equipment for regeneration of the ion exchange filters;
- protective laundry and hot shower; personnel access;
- radiochemistry laboratories

The main reasons for the forming of waste waters are:

- the organized and unorganized leaks from the primary cooling circuit of the nuclear reactors, which contain boric acid;
- the decontamination and flushing solvents, formed during decontamination of the equipment, pipelines, the surfaces in the working premises;
- the regeneration and flushing waters from the ion exchange filters;
- blowdown waters during steam generator repair.

Depending on their radioactivity, the liquid radioactive media are:

- highly radioactive (specific radioactivity above 0.3 MBq/dm^3);
- lowly radioactive (specific radioactivity below 0.3 MBq/dm^3).

The generated radioactive waters under production conditions are three types – the so called floor drains, boron containing waters and waters from special laundries and personnel access. These may be considered "untreated" radioactive waste waters.

These waters are processed (treated) in evaporation installations and ion exchange filter complexes (Reactor Water Cleanup Systems SVO-3) in Special buildings- 1, -2 и -3. The treated waters, called "treated water discharges", are collected in intermediate drainage tanks and after radioactivity control are discharged into HC-1 and HC-2, if they meet the norms. In the opposite case they are returned for reprocessing. Their quantity is calculated according to the volume of the intermediate drainage tanks.

- → In 2007, a total of 53 754 m^3 treated water discharges were released in the Danube River.
- → In 2008, a total of 49 910 m^3 treated water discharges were released in the Danube River.
- → In 2009, a total of 41 820 m^3 treated water discharges were released in the Danube River.
- → In 2010, a total of 41 300m^3 treated water discharges were released in the Danube River.
- → In 2011, a total of 38 800 m^3 treated water discharges were released in the Danube River.

→ In 2012, a total of 45 800 m^3 treated water discharges were released in the Danube River.

The percentage composition of the liquid releases (without ^{3}H), as a total for Kozloduy NPP based on gamma spectrometric analyses is shown on **Figure 3.2-4**[41]. The radionuclide composition and the radioactivity of the releases are given in **Table 3.2-10**.

About 5% of the total radioactivity of ^{60}Co and 37% ^{137}Cs in the released treated water discharges originate from EP-1. In 2012, compare with past years, % share of EP-1 has been reduced.

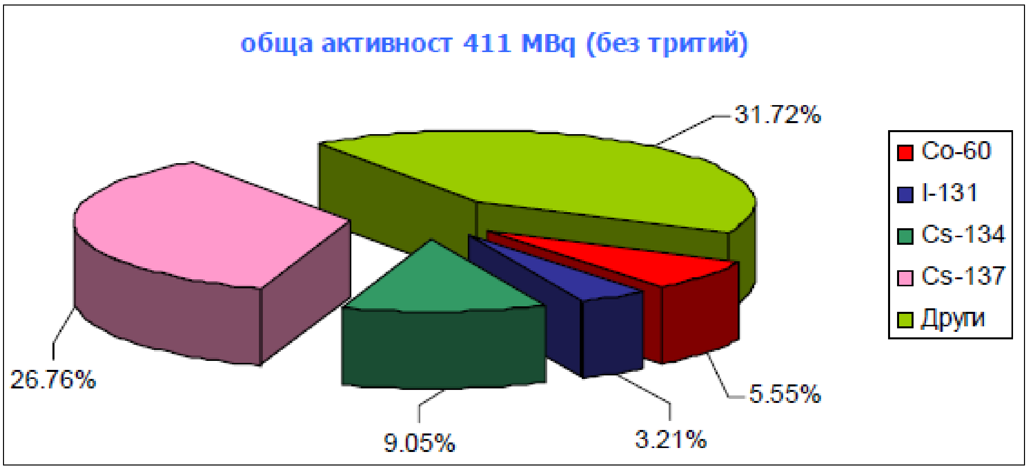


FIGURE 3.2-4: PERCENTAGE COMPOSITION OF THE LIQUID RELEASES EXCLUDING ^{3}H IN 2012

Total activity of 411 MBq (excluding tritium)

[41] Annual Radiation Monitoring Report of Kozloduy NPP EAD for 2012

TABLE 3.2-10: RADIOACTIVITY OF TREATED WATER DISCHARGES, 2005-2012

Година	2005	2006	2007	2008	2009	2010	2011	2012
Радионуклид	Активност, [MBq]							
^{51}Cr	0.33	2.31	-	-	-	-	71.0	82.3
^{54}Mn	23.18	0.62	0.28	-	1.20	30.1	10.8	15.2
^{58}Co	-	0.47	-	-	-	-	8.02	-
^{60}Co	140.87	106.13	19.18	16.2	25.6	34.4	18.9	22.8
^{90}Sr (^{89}Sr)	0.65	0.45	0.16	0.20 (0.011)	0.35 (0.13)	1.27 (0.31)	0.73 (0.47)	0.56 (0.62)
^{95}Zr	-	0.18	-	-	-	1.14	16.4	-
^{95}Nb	4.16	0.4	-	-	0.22	1.76	10.4	12.9
^{103}Ru	-	-	-	-	-	-	8.42	-
^{106}Ru	-	-	-	-	-	0.071	-	-
^{110m}Ag	19.8	28.07	20.81	4.31	0.71	-	-	-
^{122}Sb	-	-	-	-	0.64	-	-	37.9
^{124}Sb	-	-	-	8.34	5.83	2.75	16.8	11.3
^{125}Sb	-	-	-	0.43	-	0.42	21.5	29.2
^{131}I	214.14	258.52	0.034	-	5.31	67.2	34.3	13.2
^{134}Cs	310.68	116.41	31.11	11.8	11.1	7.87	57.5	37.2
^{137}Cs	1166.87	600.19	202.09	136.0	178.0	122.0	131.0	110.0
алфа-лъчители	-	-	0.019	0.018	0.0059	0.0075	0.0050	0.0086
^{55}Fe	-	-	-	2.70	4.98	8.36	4.36	21.3
^{63}Ni	-	-	-	6.10	12.6	7.22	5.00	12.6
Общо *(без тритий)*	*1 881*	*1 114*	*273*	*186*	*247*	*286*	*420*	*411*
Тритий	Активност, [GBq]							
^{3}H	17 447	20 159	22 117	18 774	23 739	22 700	22 900	24 100

Source: *"Annual report on the results from radiation monitoring of the environment of Kozloduy NPP during 2012."*
Year
Radionuclide
Activity
Alpha irradiators
Total
Tritium

The design functions of the Reactor Water Cleanup Systems (WCS) are:

- → WCS-3 – designated for the treatment of the floor drains from the controlled zone (CZ); the sources of such waters are the unorganized leaks from the primary circuit, solvents, used for decontamination of the equipment and the systems, the flushing and regeneration of the ion exchange filters, protective laundry and hot shower; personnel access, the SVO-3 itself – if the treated waters do not comply with the norms for the water chemistry of the NPP or for the treated water discharges, etc.;
- → WCS-5 – designed for treatment of the blowdown water from the steam generators – permanent and periodical; the technological scheme is based on mechanical and ion exchange filters; the recirculating system releases no waste waters in the environment; treated water is returned into the second circuit to maintain the water chemistry of the steam generator;

→ WCS-7 – designated for treatment of radioactive waters from the operation and the decontamination of the special protective clothing laundry and hot shower at EP-2; in emergency situations the capacities of the system allow flowing into it of radioactive waste waters (up to 142m^3/d); for water treatment at SVO-7 processes of distillation, mechanical filtering, precipitation and ion exchange filter are used, resulting in the formation of radioactive concentrate, which is treated as RAW, deionized water for reuse, or treated water discharge.

The waters, originating from the expansion vessels of the deaerators and from the steam generators blowdown, are also treated water discharge. These waters are treated by means of ion exchange filters and, in case they cannot be used again in the technological cycle, after dosimetric control they are discharged via the hot channel into the Danube River. The decision for the release of treated water discharge in the environment is taken by authorized officials on the base of strict radiation control.

The radioactive sludge from the Reactor Water Cleanup Systems is collected and stored in special reservoirs for evaporated concentrate. It is subject to additional treatment and burial as RAW.

3.2.1.4.2.2 In-house monitoring of the waste waters from radiation aspect

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

The volume, scope and the controlled parameters are regulated in a long-term program for radioecological monitoring under normal operation of NPP, which is coordinated with the control and supervisory authorities in the country – NRA, the National Center of Radiobiology and Radiation Protection (NCRBRP) at the Ministry of Health (MH) and the Executive Environment Agency (EEA) to the Ministry of Environment and Waters (MEW). The program fully meets the national and European normative requirements in the field, inclusive of art.35 of the EURATOM Agreement, EU Recommendations 2000/473/EURATOM and 2004/2/EURATOM.

The monitoring zone includes the territory of the industrial site of NPP, 2-kilometer zone for Precautionary Action Zone (PAZ), 30-kilometer Urgent Protective Action Planning Zone (UPAPZ) 00-kilometer radius around the power plant. For the implementation of the radioecological and reference stations within 1 monitoring Annual Programs and Annual Activity Reports are prepared.

The establishment of the areas with a special statute around Kozloduy NPP is related to the need for creation of territorial development and management tool in compliance with the legislation and the regulations of the country and with the common European safety and security standards, pursuant to the requirements of art.104, par.1 of the Safe Use of Nuclear Energy Act (SG, No 63 2002, latest amendments SG, No 82, 2012).

The points for radioecological monitoring of the sewerage system of the Kozloduy NPP are shown on **Figure 3.2-5**.

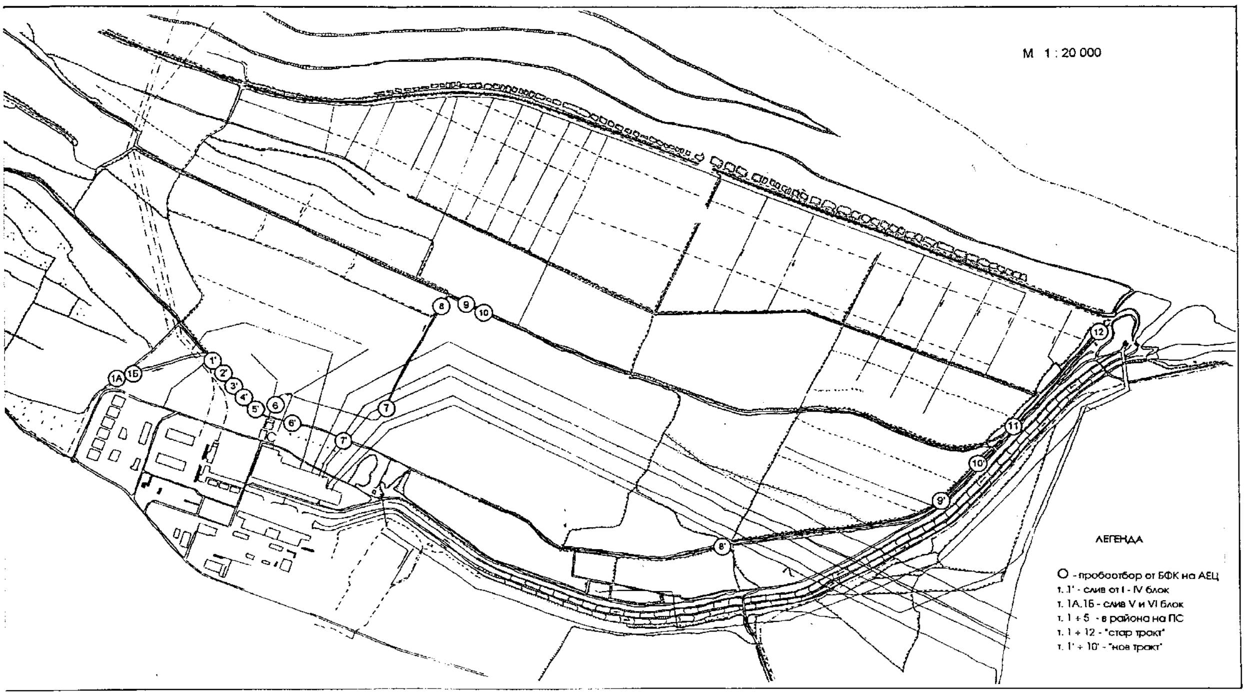


FIGURE 3.2-5: LOCATION OF THE POINTS FOR RADIOECOLOGICAL CONTROL OF THE SEWERAGE SYSTEM OF KOZLODUY NPP

The following figures (**Figure 3.2-6 ÷ Figure 3.2-9**) contain the summarized results, provided by the Client from the radioecological monitoring of the domestic sewerage of the Kozloduy NPP for the period 2007 ÷ 2012 at the specified in the scheme monitoring points, **pursuant to the Annual Radioecological Monitoring Reports of Kozloduy NPP.**

Drinking water norm – 100 Bq/l (Regulation No 9, MEW)

FIGURE 3.2-6: ACTIVITY OF ^{3}H (BQ/L) IN THE WATERS FROM HFS OF KOZLODUY NPP, 2007 ÷ 2012

The data from **Figure 3.2-6** show that the tritium content in the waters, released via HFS during the reviewed period (2007 ÷ 2012), has average value of 7.1 Bq/l, which is quite close to the minimum detectable activities (<3.1÷<7.7 Bq/l). In single cases, higher tritium values have been measured, while the maximum measured value is 53 Bq/l, which is below the norm even of 100 Bq/l for the drinking water (Regulation No9 on the quality of water, intended for domestic and potable purposes, MEW).

Limit for annual average volume activity of drinking water – 1.9 Bq/l (BRPN-NRA)

FIGURE 3.2-7: ACTIVITY OF ^{90}SR (BQ/L) IN THE WATERS FROM HFS OF KOZLODUY NPP, 2007 ÷2012

The specific activity of ^{90}Sr (**Figure 3.2-7**) in the measured waste water samples has values near to the minimum detectable ones (<0.0008 ÷ <0.0014), and the average value for the reviewed period (2007 ÷ 2012) is 0.0021 Bq/l. These are values, which are typical for the natural basins, and in practice with regard to this indicator (^{90}Sr) no impact of Kozloduy NPP on the waste waters is reported. The annual average volume activity limit (AAVAL) for drinking water for a critical population group, compliant with the Basic Radiation Protection Norms (BRPN) of the Nuclear Regulatory Agency (NRA) is 1.9 Bq/l.

FIGURE 3.2-8: ACTIVITY OF ^{134}CS (BQ/L) IN THE WATERS FROM HFS OF KOZLODUY NPP, 2007 ÷ 2012

FIGURE 3.2-9: ACTIVITY OF ^{137}CS (BQ/L) IN THE WATERS FROM HFS OF KOZLODUY NPP, 2007 ÷ 2012

The waters, released by 5 and 6 power unit almost during the whole period (2007 ÷ 2012), have been with specific activity concerning ^{134}Cs (**Figure 3.2-8**) and ^{137}Cs (**Figure 3.2-9)** near the minimum detectable ones, as follows: for ^{134}Cs <0.0007÷<0.017 Bq/l and ^{137}Cs <0.0008÷<0.016 Bq/l. There have been one-off measured values for ^{134}Cs and ^{137}Cs quite close to the minimum detectable ones, mainly in point 1B. Relatively higher radiocesium activity has been registered in the waters, released by the collector of 1÷6 unit into the "new" channel – MDC. The highest measured contents of ^{137}Cs in the water from HFS during the reviewed period (2007 ÷ 2012) is 0.25 Bq/l, which is many times smaller than the normative annual average volume activity limits (AAVAL) even for drinking waters – 11 Bq/l (BRPN, NRA).

Summarized conclusions related to the results for the radioactivity of the waste waters during the reviewed period 2007 – 2012:

- ✓ The registered technogenic activities (^{3}H, ^{134}Cs, ^{137}Cs, excluding ^{90}Sr) in the waste waters from the drainage channels (HFS) are due to the operation of Kozloduy NPP, but the levels are close to the background ones.
- ✓ The values measured throughout the years are many times lower than the established norms even for the drinking water (BRPN-NRA – annual average volume activity limit (AAVAL) for drinking waters for a critical population group; Regulation No9-MEW – on the quality of the water, intended for domestic and potable purposes).
- ✓ The radioecological situation in the Blatoto neighbourhood is stable, and the radiation impact of Kozloduy NPP through the released waste waters is minimal. There is no danger for the environmental status in the drainage channels area.

3.2.1.5 Monitoring of natural and technogenic radioactivity of the surface waters in the region of Kozloduy NPP, carried out by Kozloduy NPP PLC

The radiological monitoring carried out by Kozloduy NPP includes all environmental components: air, water, soil, vegetation, crops, typical foods produced in the area, etc.

EU requirements regarding the application of art. 35 of the EURATOM Treaty on monitoring of the levels of radioactivity in the environment for the assessment of dose 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 the standardization and unification of the practices applied in radiological monitoring in the member states of the EU. Concepts are defined therein and the general requirements of the types of monitoring, the network monitoring and the sampling (dense and diluted), the frequency of monitoring, the volume of monitoring and the requirements for sampling and analysis of the main controlled objects of the environment. This also includes regulation of the volume of the information, management and communication of monitoring data accompanying the sample.

The official radiological environmental monitoring is regulated by the long-term program of the Kozloduy NPP regarding radiation monitoring of the environment. The program is based on the legal requirements in the area, as well as on international best practices and the operational experience of the PM Department. The program is coordinated with the Ministry of Environment and Water /MEW/, the Ministry of Health /MH/ and the Agency for Nuclear Regulatory Agency /NRA/and is in compliance with the international recommendations in the field, art. 35 of the EURATOM Treaty and Recommendation 2000/473/EURATOM. In order to provide independent control programs radiation monitoring programmes are implemented by the control authorities EEA/MEW and NCRRP/MH.

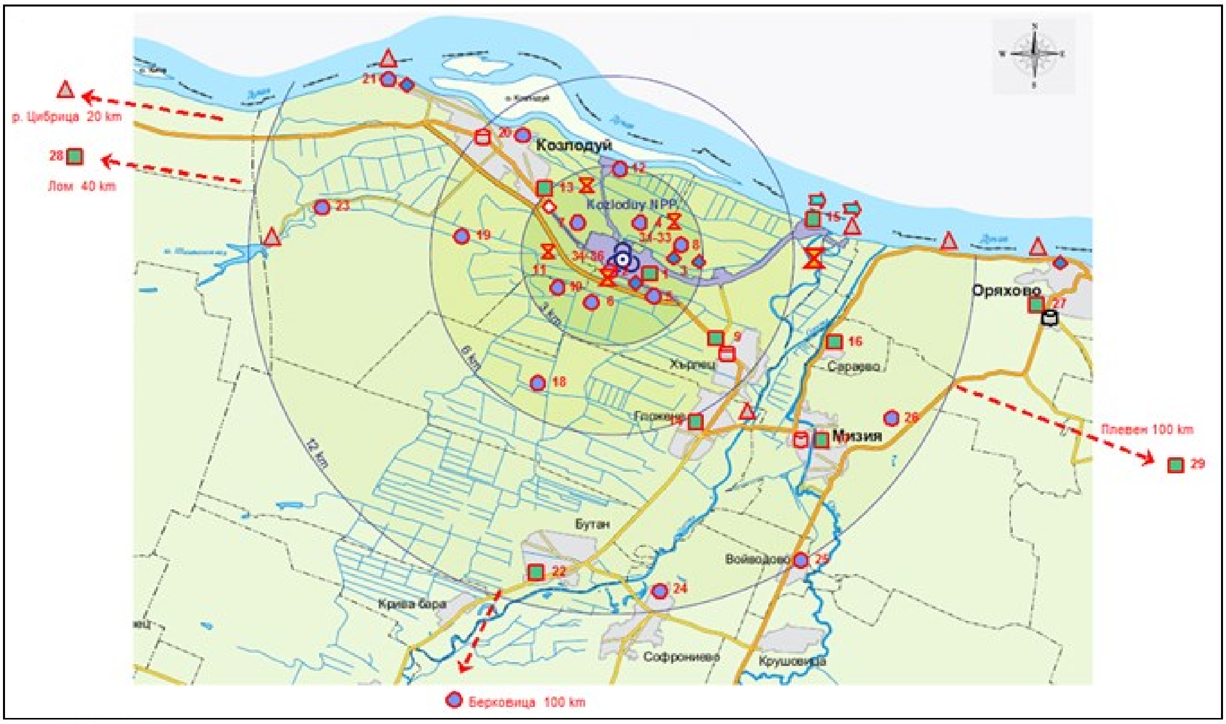
The area of the Kozloduy NPP is characterized by relatively low background activity, i.e. contents of uranium, thorium and products of the decomposition thereof are below the national average. This is due to the predominant sedimentogenic origin of the geological formations on which the region under study is situated.

The frequency of sampling is in compliance with the design requirements and the long experience in radiological monitoring in the Kozloduy NPP as well as with the practice of other countries.

The studied benchmark radionuclides are fission products and activated corrosion products whose absorption by air, drinking water and food or objects into the environment (part of the food chain) would cause further internal exposure of the population.

Methods, standardized and validated by practice, such as gamma-spectrometry, low background radiometry of the total beta activity and isolated radiochemical radiostrontsium, liquid scintillation spectrometry of tritium and alpha-spectrometry of transuranium elements. Generally, these are methods well tested in practice and summarized in analytical procedures for environmental samples used by leading laboratories around the world or recommended.

To locate and assess the potential impact of the Kozloduy NPP on the environment and the population, around the plant there are 2 separate control zones with different radii: Protective Measures Zone – PMZ/2 km/ and Urgent Protective Measures Zone (UPMZ) /30 km/. The industrial site itself is under monitoring. For comparison purposes, sampling and measurements are carried out in the benchmark points up to 100 km around the NPP, where there is no expected impact from the operation of the plant. Laboratory and automated control of the components of the environment is performed as well.



Легенда:

- контролен пост тип "А": аерозоли, атмосферни отлагания, почва, растителност, гама-фон (ТЛД) – 11 броя
- контролен пост тип "В": атмосферни отлагания, почва, растителност, гама-фон (ТЛД) – 15 броя
- контролен пост тип "С": вода, дънни утайки, водорасли, гама-фон – 7 броя
- продукти от хранителната верига: - питейна вода; - мляко; - риба; - зърнено-житни култури

Tsibritsa River 20 km *Pleven 100 km*
Lom *Kozloduy* *Oryahovo* *Harlets*
Saraevo *Glozhene* *Mizia* *Butan*
Voyvodovo *Kriva bara* *Sofronievo*
Krushovitsa *Berkovitsa 100 km*

Key:
control point type A: aerosols, atmospheric sediments, soil, vegetation, gamma background (TLD) – 11 nos.
control point type B: atmospheric sediments, soil, vegetation, gamma background (TLD) – 15 nos.
control point type C: water, bottom sediments, algae, gamma background – 7 nos.
products of the food chain: drinking water; milk; fish; grain cultures

FIGURE 3.2-10: SCHEME OF THE LAYOUT OF THE RADIATION MONITORING POINTS AROUND THE KOZLODUY NPP

Within the 30 km zone there is a total 36 monitoring points for the terrestrial ecosystem and 7 points for the water ecosystem, where sampling is carried out for laboratory analysis and activity measurements of technogenic radionuclides in the samples. Samples of air, soil, vegetation, water and bottom sediments are taken and analysed and the radiation gamma background is measured. Beyond those point samples are analysed for the drinking water, milk, fish, agricultural grain cultures and other crops in the region. The location and type of the points is shown in **Figure 3.2-10**.

Water from surface water bodies – natural and artificial, in the vicinity of the plant are the main object of radiological monitoring, and indicator of the ecological situation in the region. The radioactivity of the water from the Danube River is tested, along with the water from inland rivers and reservoirs near the nuclear plant – the Ogosta River, the Tsibritsa River and the Kozloduy Dam. Particular attention is paid to the Danube River since it is a waste water intake from the NPP and a boundary river between our country and the Republic of Romania.

Practice shows that the results of radiological monitoring show values significantly lower than those established by the regulations. Therefore, the current results obtained from previous years of operation are most often used for comparison with those from before the commissioning of the NPP. This approach allows to record and analyze even the smallest change in the radiation trends.

Natural radioactive elements are divided into primary and secondary according to the origin and their availability in the environment. Primary elements – uranium, thorium and the decomposition products thereof – radium, radon, polonium, actinium, and others, as well as potassium (^{40}K) and rubidium (^{87}Rb), determine mainly the radioactive impact on living organisms in natural conditions. The secondary natural radioactive elements – beryllium (^{7}Be and ^{10}Be), carbon (^{14}C), tritium (^{3}H) etc., have a very low content in the environment and virtually no contribution to the radiation exposure of living beings. Therefore this assessment of the natural radiation exposure of living organisms is based on primary natural radioactive elements.

For the purposes of the EIA detailed results of the water quality of the Danube River was provided (Annual reports for radiological monitoring of the Kozloduy NPP).

Samples from the Danube River were taken from four control points (1 before and 3 downstream after the NPP), respectively from the Radetski Port, discharge canal at the Bank Pump Station (BPS), the Batatovets territory (before the town of Oryahovo) and from the Oryahovo Port. Weekly sampling of water from three points is performed (Radetski, discharge canal, and Oryahovo), and the total monthly samples are then analysed. Once a year, an analysis is carried out for the waters of inland water bodies – the Ogosta River, the Tsibritsa River and the Kozloduy Dam, and twice a year – for the waters of the Batatovets territory. For all samples the total beta activity and tritium are determined, and for those of the Danube River – ^{90}Sr and ^{137}Cs are determined in addition.

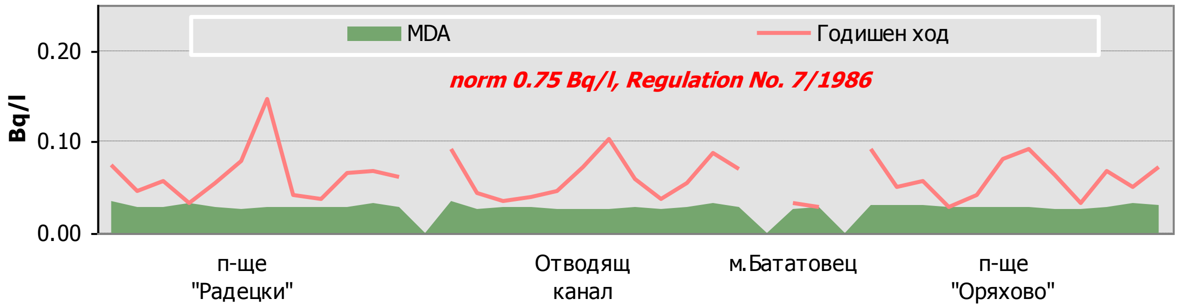
The total beta activity provides an estimate assessment for the presence of radionuclides (natural and technogenic) in water.

DATA FOR THE MONITORING OF SURFACE WATERS, 2007

TABLE 3.2-11: SUMMARY OF DATA OF MONITORING OF SURFACE WATERS, 2007.

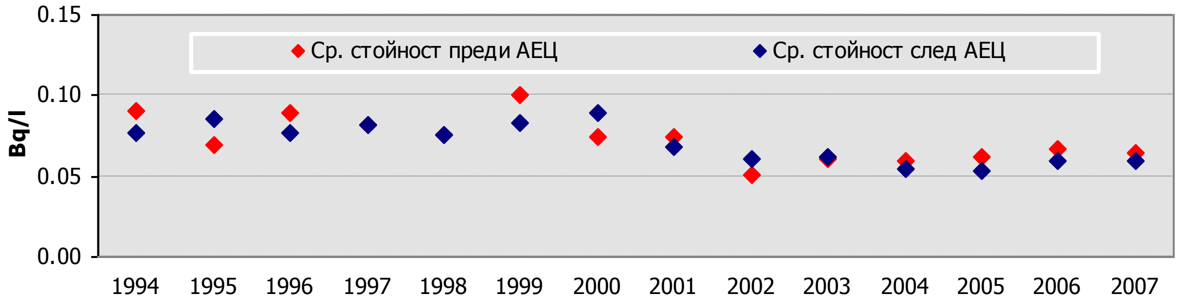
SURFACE WATER BODIES	✓ Weekly sample taking along the Danube River ✓ Annual sample taking along the Ogosta River, Tsibritsa River and the Kozloduy Dam ✓ This includes: **41 samples** for **134 analyses** /*38 gamma-spectometric, 41 radiometry for general beta activity and 14 with radiochemistry of Strontium, 41 liquid-scintillation*

	of Tritium / **RESULTS** ✓ **Within normal range, characteristic for natural water sources:** ▪ general beta activity 0.027 ÷ 0.16 Bq/l, average annual – 0.065 Bq/l ▪ activity of ^{90}Sr – 1.2 ÷ 7.9 mBq/l, average annual – 3.2 mBq/l ▪ activity of ^{3}H – <1.8 ÷ 13.1 Bq/l ▪ activity of ^{137}Cs – <0.5 ÷<1.3 mBq/l
CONCLUSION: results are comparable with those of previous years. There is no registered impact from the NPP on the water ecosystem in the region.	



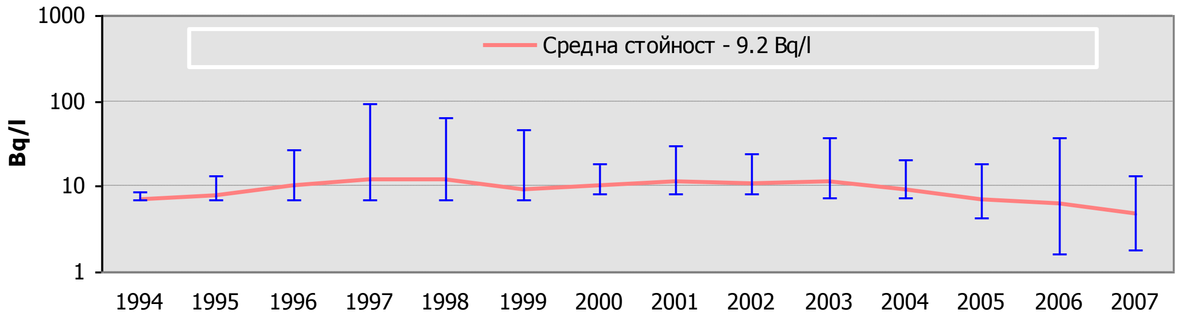
Annual behaviour,Radetski Port,Discharge canal,Area of Batatovets,Oryahovo Port

FIGURE 3.2-11: TOTAL BETA ACTIVITY (BQ/L) OF WATER IN THE DANUBE RIVER, 2007



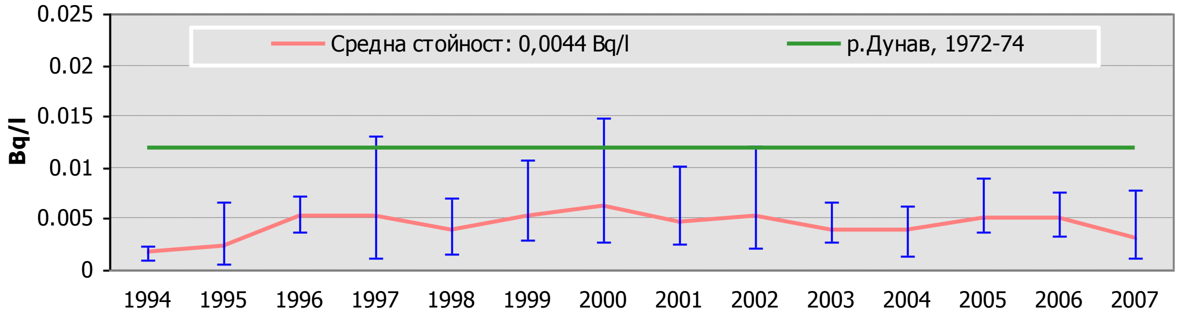
Average value before the NPP, Average value after the NPP

FIGURE 3.2-12: TOTAL BETA ACTIVITY (BQ/L) OF WATER IN THE DANUBE RIVER, 1994 ÷2007



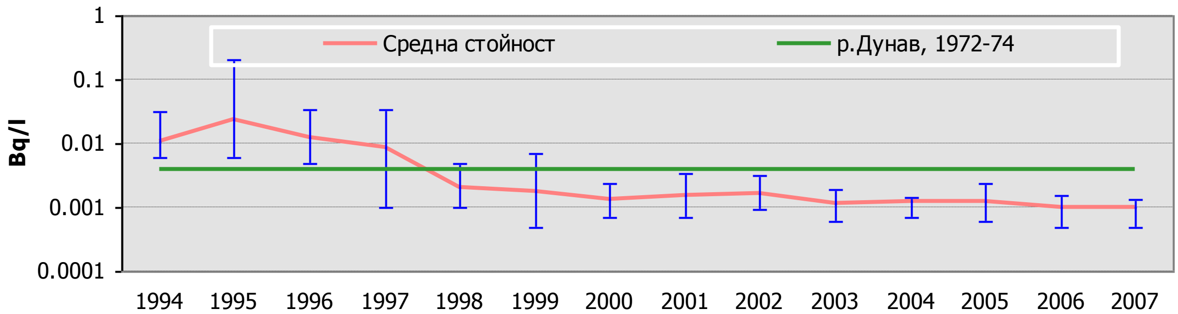
Average value 9.2 Bq/L,

FIGURE 3.2-13: ACTIVITY OF TRITIUM (BQ/L) OF WATER IN THE DANUBE RIVER AFTER THE KOZLODUY NPP, 1994÷2007



Average value 0.0044 Bq/L, Danube River, 1972-74

FIGURE 3.2-14: Activity of ^{90}Sr (Bq/L) of water in the Danube River in the region of the Kozloduy NPP, 1994÷2007



Average value, Danube River, 1972-74

FIGURE 3.2-15: Activity of ^{137}Cs (Bq/L) of water in the Danube River in the region of the Kozloduy NPP, 1994÷2007

Conclusions:

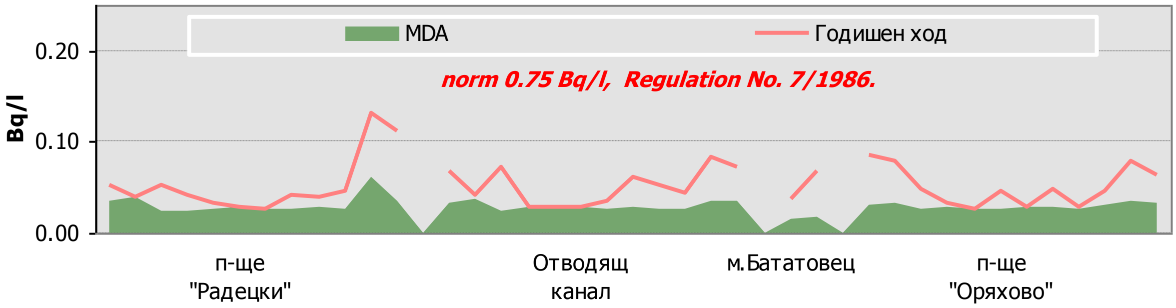
- ✓ The operation of the Kozloduy NPP did not influence the radiological status of the waters of the Danube River and of other water basins in the region;
- ✓ The results are within the normal limits, and are several times below the established standards.

DATA FOR THE MONITORING OF SURFACE WATERS FOR 2008

TABLE 3.2-12: SUMMARISED DATA FOR THE MONITORING OF SURFACE WATERS FOR 2008.

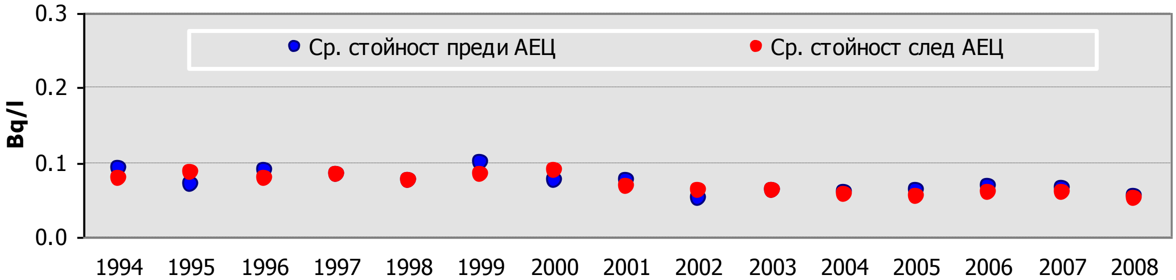
SURFACE WATER BODIES	✓ Weekly sample taking along the Danube River ✓ Annual sample taking along the Ogosta River, Tsibritsa River and the Kozloduy Dam ✓ This includes: **41 samples** for **134 analyses** /*38 gamma-spectometric, 41 radiometry for general beta activity and 14 with radiochemistry of Strontium, 41 liquid-scintillation*

	of Tritium / **RESULTS** ✓ **Within normal range, characteristic for natural water sources:** ▪ general beta activity 0.027 ÷ 0.13 Bq/l, average annual – 0.054 Bq/l ▪ activity of ^{90}Sr – 0.8 ÷ 8.4 mBq/l, average annual – 2.5 mBq/l ▪ activity of ^{3}H – <2.5 ÷ 23.1 Bq/l ▪ activity of ^{137}Cs – <0.6 ÷<1.4 mBq/l
SUMMARY: results are comparable with those of previous years. There is no registered impact from the NPP on the water ecosystem in the region.	



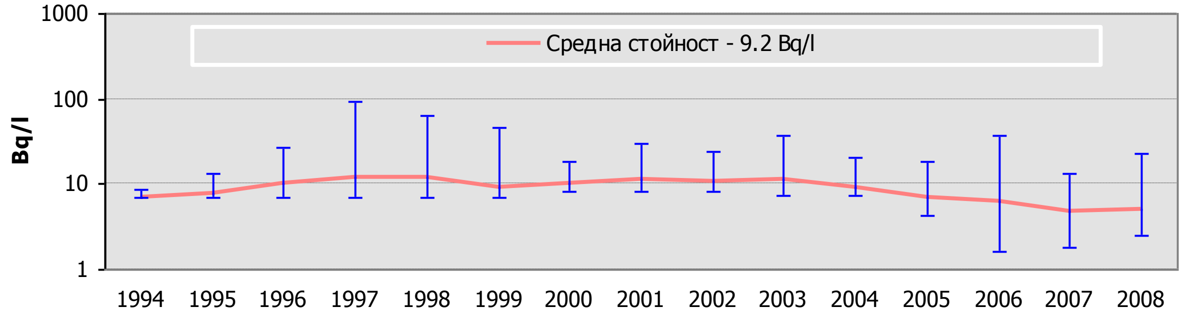
Annual behaviour,Radetski Port,Discharge canal,Area of Batatovets,Oryahovo Port

Figure 3.2-16: Total beta activity (Bq/l) of water in the Danube River, 2008



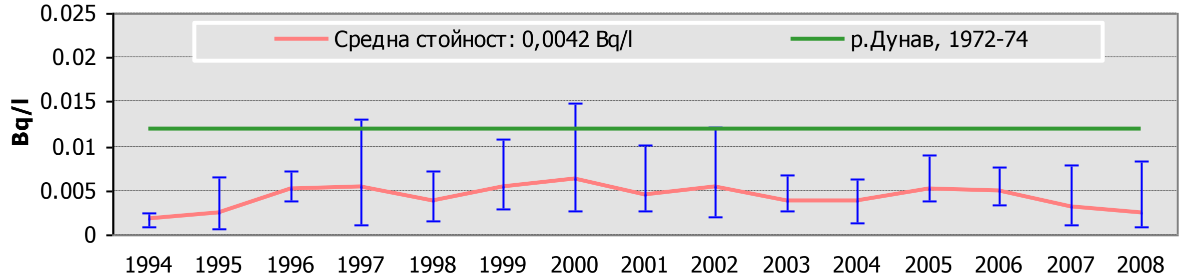
Average value before the NPP,Average value after the NPP

Figure 3.2-17: Summarised results for total beta activity (Bq/l) of water in the Danube River, 1994 – 2008



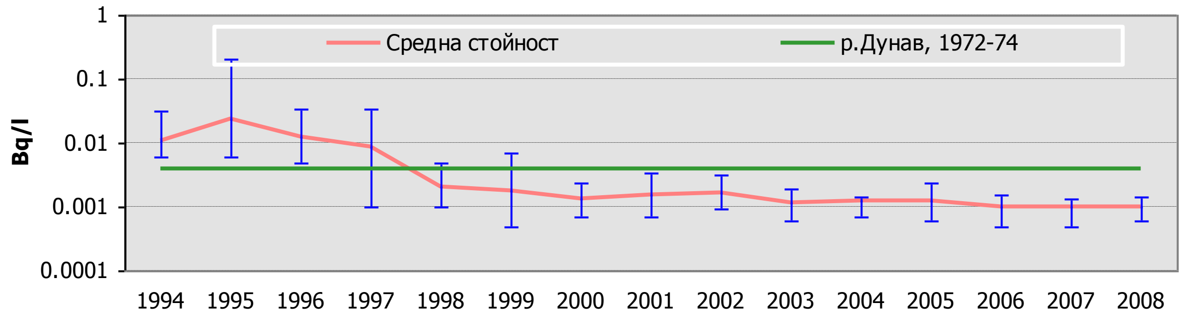
Average value 9.2 Bq/L

FIGURE 3.2-18: SUMMARISED DATA FOR ^{3}H (BQ/L) OF WATER IN THE DANUBE RIVER AFTER THE KOZLODUY NPP, 1994-2008



Average value 0.0042 Bq/L,Danube River, 1972-74

FIGURE 3.2-19: SUMMARISED DATA FOR ^{90}Sr (BQ/L) OF WATER IN THE DANUBE RIVER AFTER THE KOZLODUY NPP, 1994-2008



Average value, Danube River, 1972-74

FIGURE 3.2-20: ACTIVITY OF ^{137}Cs (BQ/L) OF THE HC OF THE NPP, 1994–2008.

Conclusions:

- ✓ The minimum activities of tritium were measured only for some periods in the water in the discharge channel /HC/ of the NPP. This fact reflects the negligible influence of the plant discharge of debalanced water in the canal. The values are even below the standards for drinking water and pose no threat to the environment in the region.

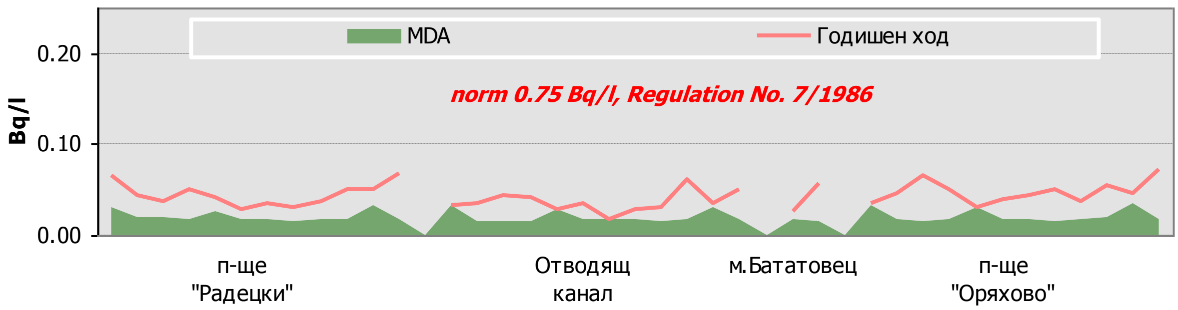
- ✓ The operation of the Kozloduy NPP has not affected the radiological status of the waters of the Danube River and of other water basins in the region.
- ✓ The technogenic activity shows results within normal limits for natural water basins, which are several times below the established standards.

DATA FOR THE MONITORING OF SURFACE WATERS FOR 2009

In 2009, 41 samples were taken and a total of 134 analyzes were carried out for tritium and 14 – with radiochemical separation of strontium.

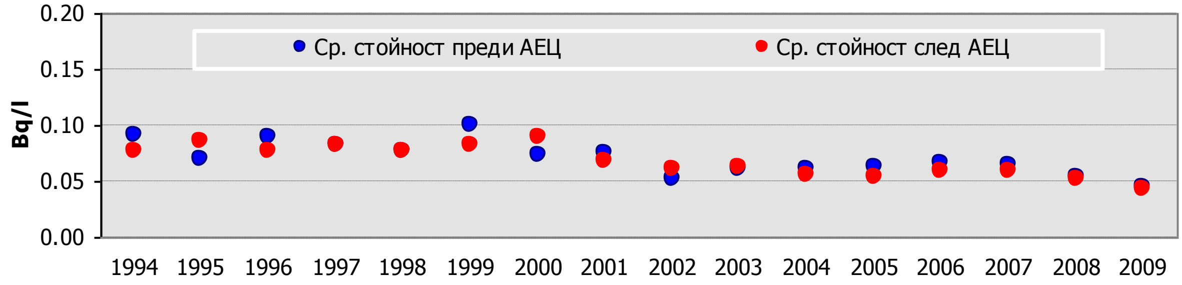
TABLE 3.2-13: SUMMARISED DATA FOR THE MONITORING OF SURFACE WATERS FOR 2009

SURFACE WATER BODIES	✓ Weekly sample taking along the Danube River ✓ Annual sample taking along the Ogosta River, Tsibritsa River and the Kozloduy Dam ✓ This includes: **41 samples** for **134 analyses** /*38 gamma-spectometric, 41 radiometry for general beta activity and 14 with radiochemistry of Strontium, 41 liquid-scintillation of Tritium* / **RESULTS** ✓ **Within normal range, characteristic for natural water sources:** ▪ general beta activity 0.018 ÷ 0.14 Bq/l, average annual – 0.047 Bq/l ▪ activity of ^{90}Sr – 1.5 ÷ 3.4 mBq/l, average annual – 2.5 mBq/l ▪ activity of ^{3}H – <4.1 ÷ 15.7 Bq/l, average annual – 5.8 mBq/l ▪ activity of ^{137}Cs – <0.3 ÷<2.0 mBq/l, average annual – 0.9 mBq/l
SUMMARY: results are comparable with those of previous years. There is no registered impact from the NPP on the water ecosystem in the region.	



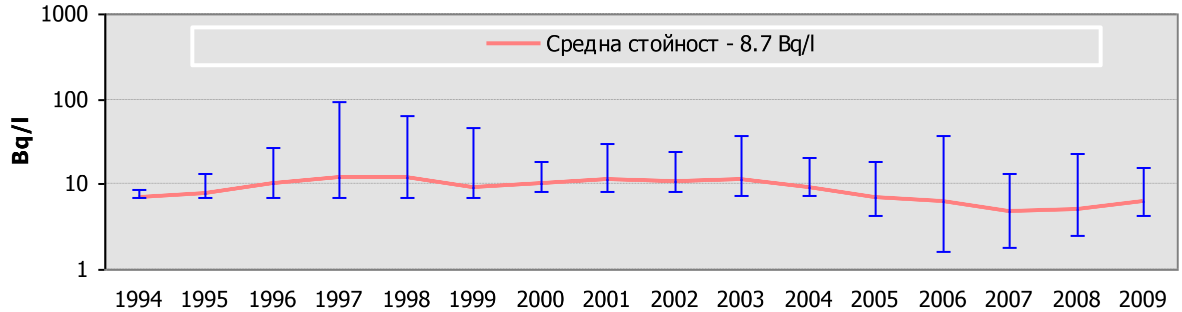
Annual behaviour,Radetski Port,Discharge canal,Area of Batatovets,Oryahovo Port

FIGURE 3.2-21: TOTAL BETA ACTIVITY (BQ/L) OF WATER IN THE DANUBE RIVER, 2009



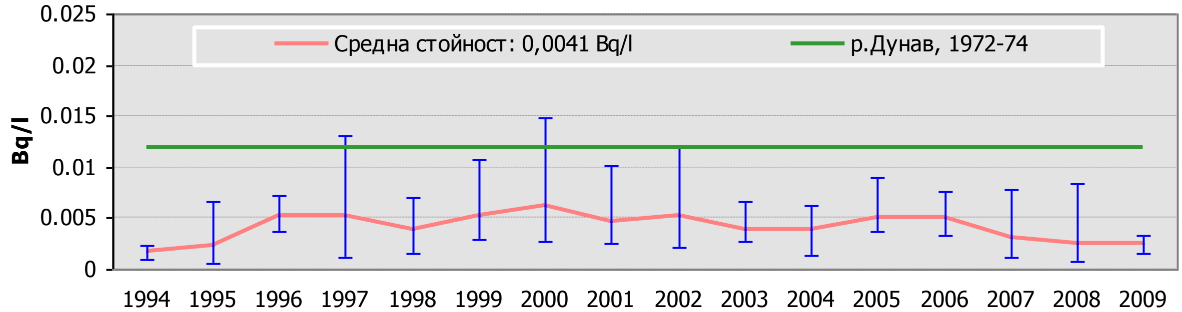
Average value before the NPP, Average value after the NPP

FIGURE 3.2-22: SUMMARISED DATA FOR TOTAL BETA ACTIVITY (BQ/L) OF WATER IN THE DANUBE RIVER, 1994 – 2009



Average value 8.7 Bq/L

FIGURE 3.2-23: SUMMARISED DATA FOR ^{3}H (BQ/L) OF WATER IN THE DANUBE RIVER AFTER KOZLODUY NPP, 1994-2009



Average value 0.0041 Bq/L, Danube River, 1972-74

FIGURE 3.2-24: SUMMARISED DATA FOR ^{90}Sr (BQ/L) OF WATER IN THE DANUBE RIVER IN THE AREA OF THE KOZLODUY NPP, 1994–2009

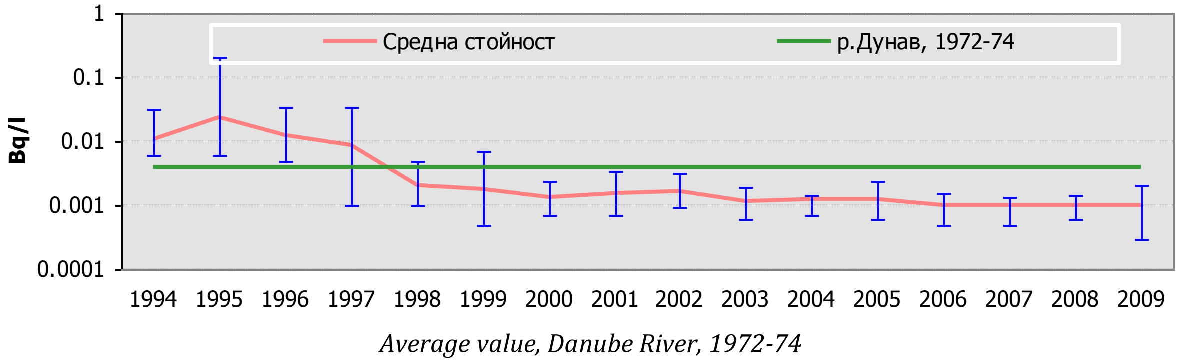


FIGURE 3.2-25: ACTIVITY OF ^{137}CS (BQ/L) OF WATER IN THE DISCHARGE CANAL OF THE NPP, 1994–2009

Radioactivity of water from inland rivers, the Ogosta River, the Tsibritsa River and the Kozloduy Dam show typical values for natural water basins. The total beta activity is in the range 0.051 – 0.14 Bq/l, while the content of tritium is under the MAC (<4.4 ÷ <4.7 Bq/l).

Conclusions:

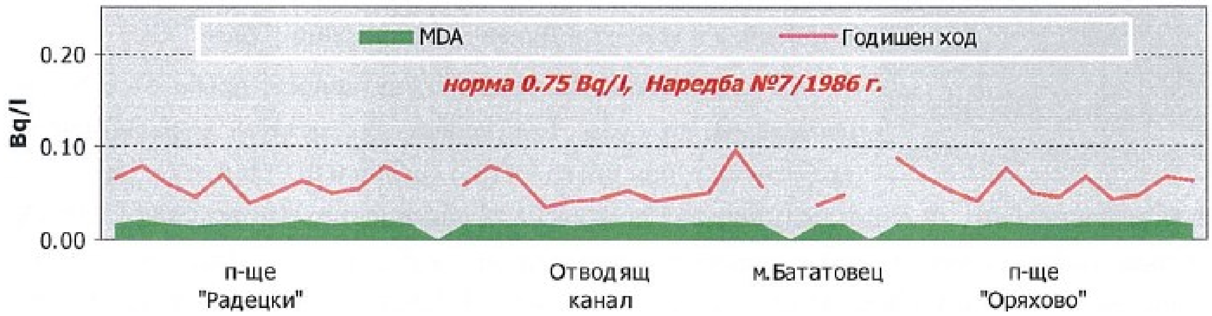
- ✓ The minimum activities of tritium and ^{137}Cs were measured only for some periods in the water in the discharge channel of the NPP and the Oryahovo Port. The registered tracing values of technogenic activity are much lower than the standards for drinking water. The high sensitivity of the analysis, which allows registering of activities close to the background reflects the negligible impact of the plant on the Danube River by discharge of debalanced water in the canal. This does not pose a threat to the environment in the region.
- ✓ The operation of the Kozloduy NPP has not affected in a measurable degree the radiological status of the waters of the Danube River and of the other water basins in the region.
- ✓ The technogenic activity shows results within normal limits for natural water basins, which are several times below the established standards.

DATA FOR THE MONITORING OF SURFACE WATERS FOR – 2010

Samples from the Danube River were taken from four control points (one before and 3 after the NPP) downstream: from km 704 – the Radetski Port, from the discharge canal at the BPS (km 687), the Batatovets territory before the town of Oryahovo (km 682) and from the Oryahovo Port (km 678). Twice a year samples were taken to test the waters of the Batatovets territory and once a year for the waters of the inland water bodies – the Ogosta River, the Tsibritsa River and the Kozloduy Dam.

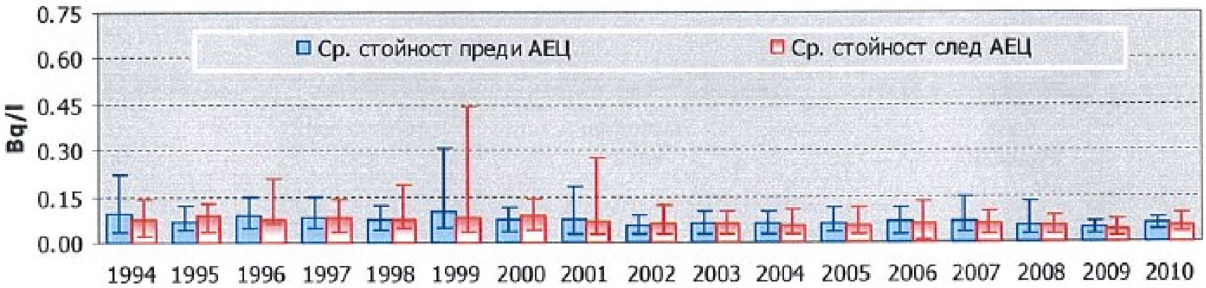
TABLE 3.2-14: SUMMARISED DATA FOR THE MONITORING OF SURFACE WATERS FOR 2010

NATURAL WATER BASINS	✓ Weekly sample taking along the Danube River ✓ Annual sample taking along the Ogosta River, Tsibritsa River and the Kozloduy Dam ✓ This includes: **<u>46 samples</u>** for **<u>149 analyses</u>** /*43 gamma-spectometric, 46 radiometry for general beta activity and 14 with radiochemistry of Strontium, 46 liquid-scintillation of Tritium* / **<u>RESULTS</u>** ✓ **<u>Within normal range, characteristic for natural water sources:</u>** ▪ general beta activity 0.025 ÷ 0.15 Bq/l, average annual – 0.059 Bq/l ▪ activity of ^{90}Sr – 1.6 ÷ 6.4 mBq/l, average annual – 3.0 mBq/l ▪ activity of ^{3}H – <4.6 ÷ 53.8 Bq/l, average annual – 7.7 mBq/l ▪ activity of ^{137}Cs – <0.3 ÷ <1.0 mBq/l, average annual – 0.6 mBq/l
<u>SUMMARY</u>: results are comparable with those of previous years. There is no registered impact from the NPP on the water ecosystem in the region.	



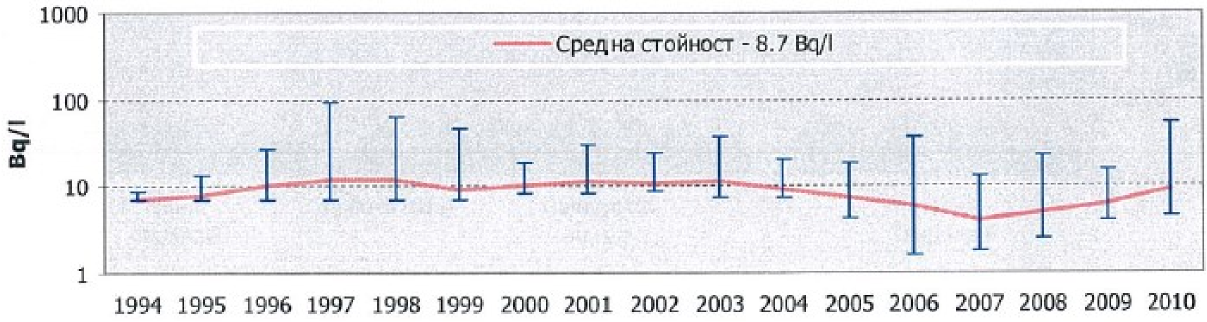
Annual behaviour, Radetski Port, Discharge canal, Area of Batatovets, Oryahovo Port

FIGURE 3.2-26: TOTAL BETA ACTIVITY OF WATER IN THE DANUBE RIVER FOR 2010



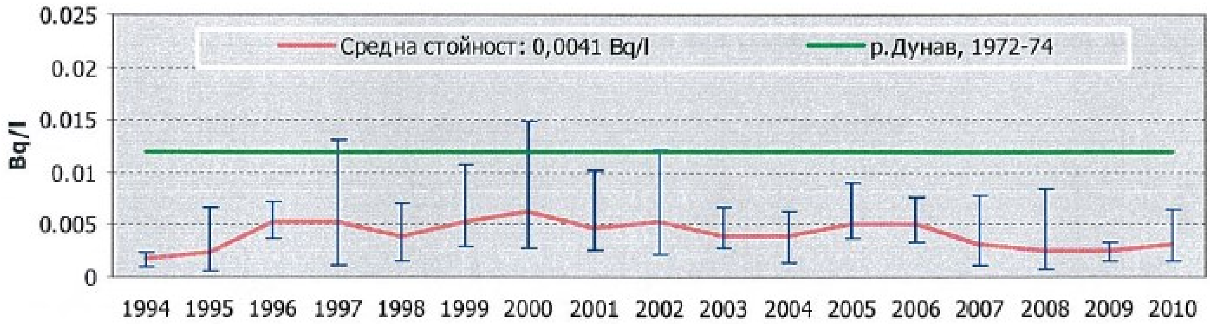
Average value before the NPP, Average value after the NPP

FIGURE 3.2-27: SUMMARISED RESULTS OF TOTAL BETA ACTIVITY OF WATER IN THE DANUBE RIVER FOR 1994-2010



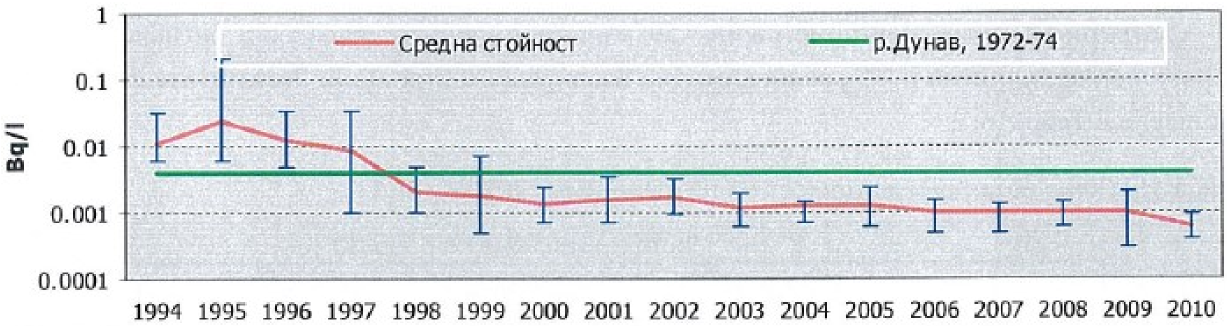
Average value 8.7 Bq/L

FIGURE 3.2-28: SUMMARISED DATA FOR ^{3}H (BQ/L) OF WATER IN THE DANUBE RIVER FOR 1994-2010



Average value 0.0041 Bq/L,Danube River, 1972-74

FIGURE 3.2-29: SUMMARISED DATA FOR ^{90}Sr (BQ/L) OF THE DANUBE RIVER FOR 1994-2010



Average value, Danube River, 1972-74

FIGURE 3.2-30: SUMMARISED DATA FOR ^{137}Cs IN THE DISCHARGE CANAL FOR THE NPP FOR 1994-2010

Conclusions:

- ✓ The minimum activities of tritium were measured only for some periods in the water in the discharge channel of the NPP. The registered tracing values of technogenic activity are much lower than the standards for drinking water. The high sensitivity of the analysis, which allows registering of activities close to the background reflects the negligible impact of the plant on the Danube River by discharge of debalanced water in the canal. This does not pose a threat to the environment in the region.
- ✓ The operation of the Kozloduy NPP has not affected the radiological status of the waters of the Danube River and of other water basins in the region.

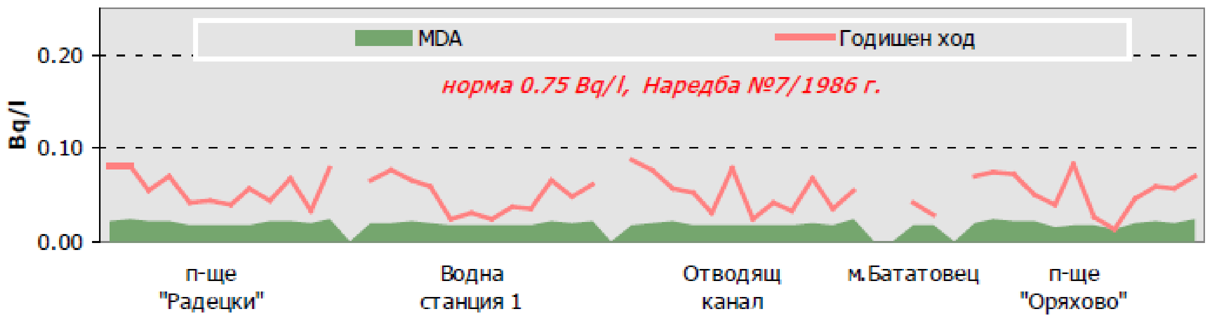
- ✓ The results are within normal limits for natural water basins, which are several times below the established standards.

Data for the monitoring of surface waters for 2011

In 2011, 53 samples were taken and a total of 179 analyses were carried out: 50 – for gamma spectrometry, 53 – radiometric for total beta activity, 53 – liquid scintillation for tritium and 26 – with radiochemical separation of strontium.

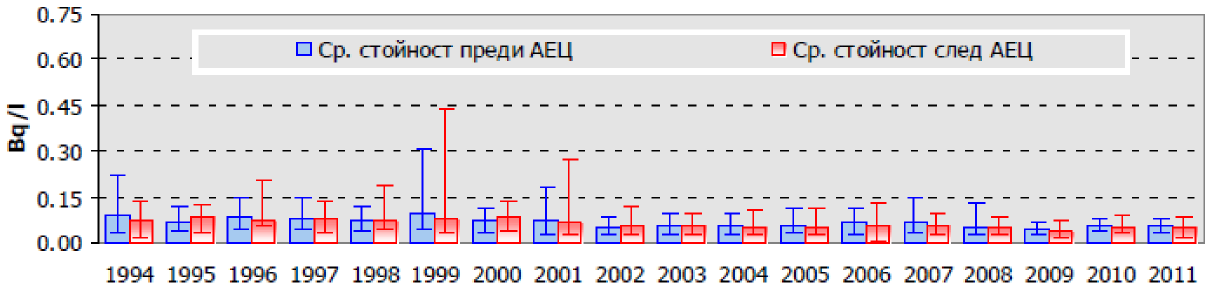
Table 3.2-15: Summarised data for the monitoring of surface waters for 2011

NATURAL WATER BASINS	✓ Weekly sample taking along the Danube River ✓ Annual sample taking along the Ogosta River, Tsibritsa River and the Kozloduy Dam ✓ This includes: **53 samples** for **179 analyses** */50 gamma-spectometric, 53 radiometry for general beta activity and 26 with radiochemistry of Strontium, 53 liquid-scintillation of Tritium /* **RESULTS** ✓ **Within normal range, characteristic for natural water sources:** ▪ general beta activity 0.012 ÷ 0.15 Bq/l, average annual – 0.056 Bq/l ▪ activity of ^{90}Sr – 0.9 ÷ 3.9 mBq/l, average annual – 1.8 mBq/l ▪ activity of ^{3}H – <4.0 ÷ 22.3 Bq/l, average annual – 7.2 mBq/l ▪ activity of ^{137}Cs – <0.3 ÷< 1.1 mBq/l, average annual – 0.6 mBq/l
SUMMARY: results are comparable with those of previous years. There is no registered impact from the NPP on the water ecosystem in the region.	



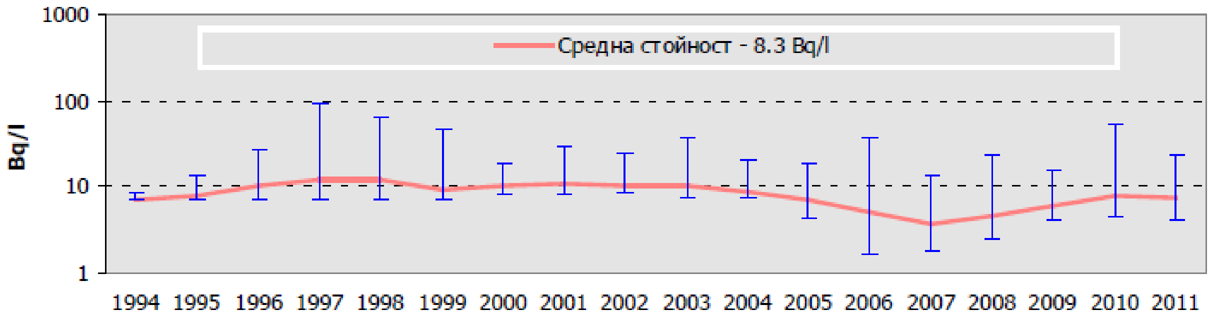
Annual behaviour, Norm 0.75 Bq/l, Regulation No. 7/1986, Radetski Port, Water station 1, Discharge canal, Area of Batatovets, ,Oryahovo Port

Figure 3.2-31: Total beta activity of water in the Danube River for 2011



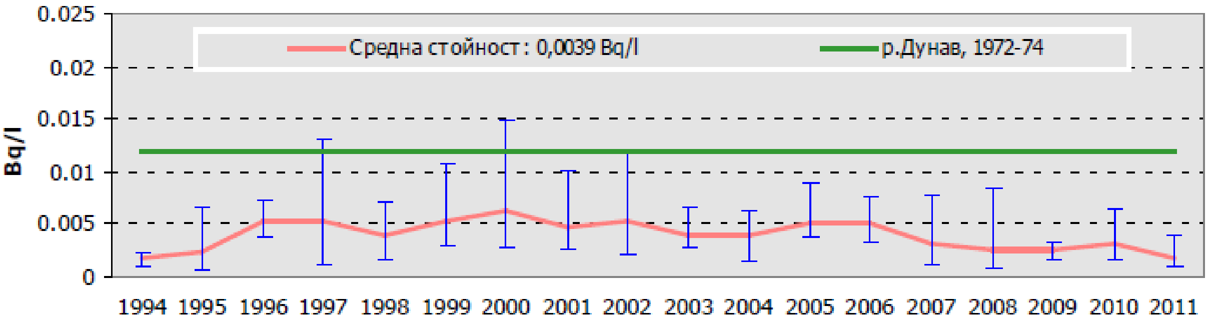
Average value before the NPP, Average value after the NPP

FIGURE 3.2-32: SUMMARISED RESULTS OF TOTAL BETA ACTIVITY (BQ/L) OF THE DANUBE RIVER, 1994-2011



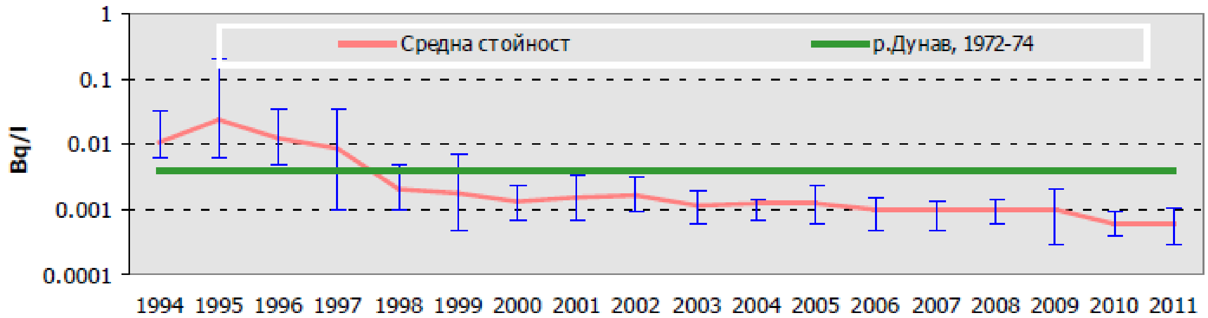
Average value 8.3 Bq/L

FIGURE 3.2-33: SUMMARISED RESULTS FOR ^{3}H (BQ/L) IN THE DANUBE RIVER AFTER THE NPP FOR 1994-2011



Average value 0.0039 Bq/L, Danube River, 1972-74

FIGURE 3.2-34: SUMMARISED DATA FOR ^{90}Sr (BQ/L) IN THE DANUBE RIVER FOR 1994-2011



Average value,Danube River, 1972-74

FIGURE 3.2-35: SUMMARISED DATA FOR ^{137}Cs (BQ/L) IN THE DISCHARGE CANAL OF NPP FOR 1994-2011.

Conclusions:

The total beta activity measured in the waters of the open water basins is within the normal range: from <0.012 to 0.087 Bq/l, which is up to 11.6% from the norm (0.75 Bq/l as specified in Regulation No. 7/1986). The maximum measured value of the Danube River is 0.087 Bq/l, measured in the NPP discharge canal.

- ✓ The minimum activities of tritium were measured only for some periods in the water in the discharge channel of the NPP and at Water station – 1. The registered tracing values of technogenic activity are much lower than the standards for drinking water and reflect the negligible impact of the plant on the Danube River by discharge of debalanced water in the canal.
- ✓ The operation of the Kozloduy NPP has not affected the radiological status of the waters of the Danube River and of other water basins in the region. The results are within normal limits for natural water basins, which are several times below the established standards.
- ✓ The results at various points along the course of the river (before and after the NPP) are very similar, demonstrating no measurable impact from the release of debalenced discharge water in terms of total activity.
- ✓ The measured activity of tritium in the discharge canal demonstrates minimum impact of the plant due to discharged debalanced water in the canal. Even compared to the norm for tritium in drinking water (100 Bq/l, Regulation No. 9/2001) the results for the discharge canal are lower (<23%).

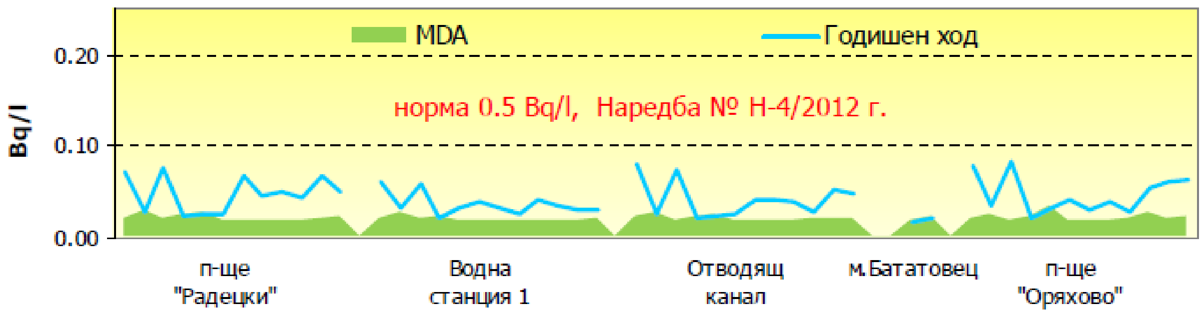
Overall, the total beta activity in the waters of the Danube River, the Ogosta River, the Tsibritsa River and the Shishmanov Val Dam is 0.012 Bq/l up to 0.15 Bq/l, which is about 30% of the control level (0.5 Bq/l, Regulation No. N-4/2012). For the Danube River the maximum measured value is 0.087 Bq/l, according to the Annual Report of the Kozloduy NPP for 2011 The content of tritium in samples of surface water basins is approximately the minimum detectable activity – up to 8.0 Bq/l.

DATA FOR THE MONITORING OF SURFACE WATERS FOR 2012

In 2012 also, surface waters are the main object of radiological monitoring as an indicator of the environmental situation in the area of the NPP. The radioactivity of the water from the Danube River is tested, along with the water from inland rivers and reservoirs near the nuclear plant – the Ogosta River, the Tsibritsa River and the Kozloduy Dam. Particular attention is paid to the Danube River since it is a waste water intake from the NPP and a boundary river. Samples were taken from 7 control points, type C. Samples from the Danube River are taken from four locations (1 before and 3 downstream, after the NPP): respectively from the Radetski Port (km 704), from the discharge canal at the BPS (km 687) and from the Oryahovo Port (km 678). Twice a year samples were taken to test the waters of the Batatovets territory and once a year for the waters of the Ogosta River, the Tsibritsa River and the Kozloduy Dam. Since September 2010 a continuous sampling and additional control of the water from the Water Station (WS-1) was introduced for the discharge canal before the connection thereof. For all samples the total beta activity and tritium are determined, and for those of the Danube River – ^{90}Sr and ^{137}Cs are determined in addition.

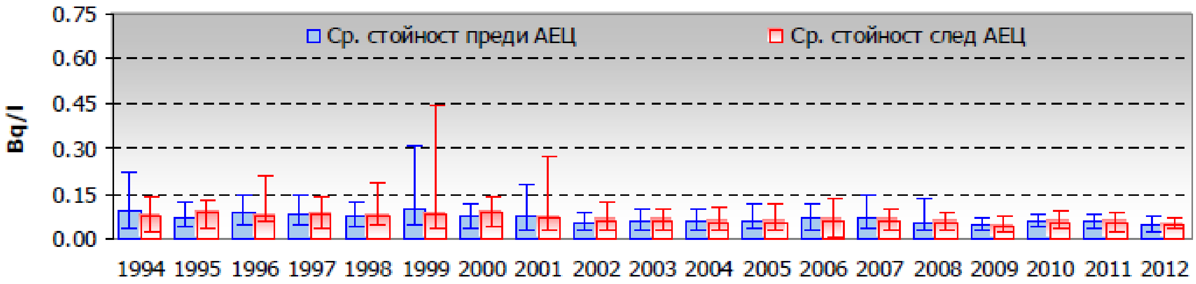
TABLE 3.2-16: SUMMARISED DATA FOR THE MONITORING OF SURFACE WATERS FOR 2012.

NATURAL WATERS	✓ Weekly sample taking along the Danube River ✓ Annual sample taking along the Ogosta River, Tsibritsa River and the Kozloduy Dam ✓ This includes: **50 samples** for **176 analyses** /*50 gamma-spectometric, 50 radiometry for general beta activity and 26 with radiochemistry of Strontium, 50 liquid-scintillation of Tritium* / **RESULTS** ✓ **Within normal range, characteristic for natural water sources:** ▪ general beta activity 0.018 ÷ 0.084 Bq/l, average annual – 0.043 Bq/l ▪ activity of ^{90}Sr – < 0.9 ÷ 8.4 mBq/l, average annual – 2.3 mBq/l ▪ activity of ^{3}H – < 3.3 ÷ 33.0 Bq/l, average annual – 9.0 mBq/l ▪ activity of ^{137}Cs – 0.2 ÷< 0.9 mBq/l, average annual – 0.6 mBq/l
SUMMARY: results are comparable with those of previous years. There is no registered impact from the NPP on the water ecosystem in the region.	



Annual movement , Norm 0.50 Bq/l, Regulation No. H-4/2012, Radetski Port, Water station 1, Discharge canal, Area of Batatovets, Oryahovo Port

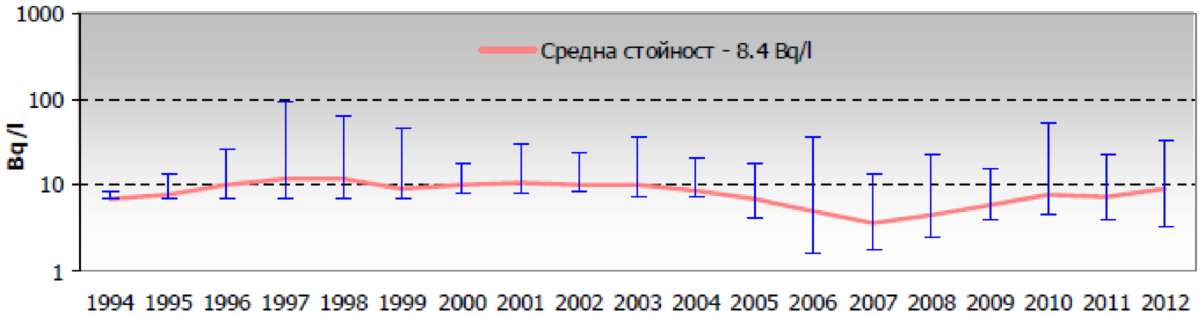
FIGURE 3.2-36: TOTAL BETA ACTIVITY (BQ/L) OF THE WATER IN THE DANUBE RIVER



Average value before the NPP, Average value after the NPP

FIGURE 3.2-37: SUMMARISED RESULTS OF TOTAL BETA ACTIVITY (BQ/L) OF THE DANUBE RIVER, 1994-2012

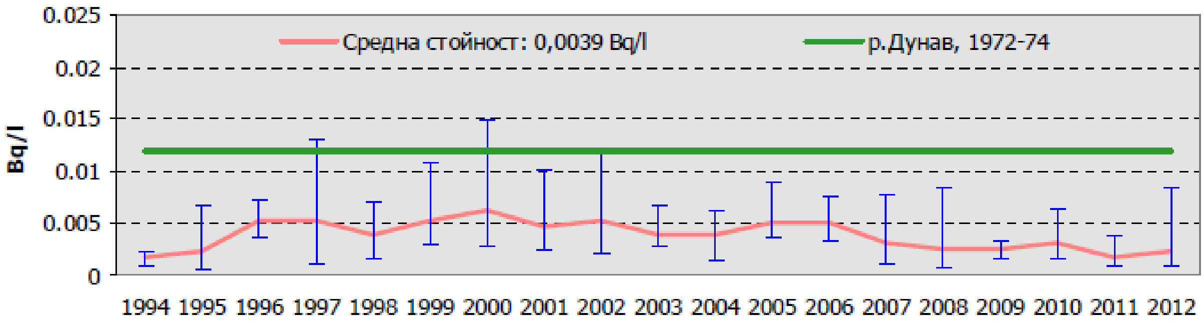
The total beta activity measured in the waters of the open water basins is within the normal range: from <0.018 to 0.084 Bq/l, which is up to 16.8% from the norm (**0.50 Bq/l**) as specified in Regulation No. H-4/14.09.2012. The maximum measured value of the Danube River is 0.087 4Bq/l, measured at the Oryahovo Port. It is evident that the results at various points along the course of the river (before and after the NPP) are very similar, demonstrating no measurable impact from the release of debalenced discharge water in terms of total activity.



Average value 8.4 Bq/L

FIGURE 3.2-38: SUMMARISED RESULTS FOR ^{3}H (BQ/L) IN THE DANUBE RIVER AFTER THE NPP FOR 1994-2012

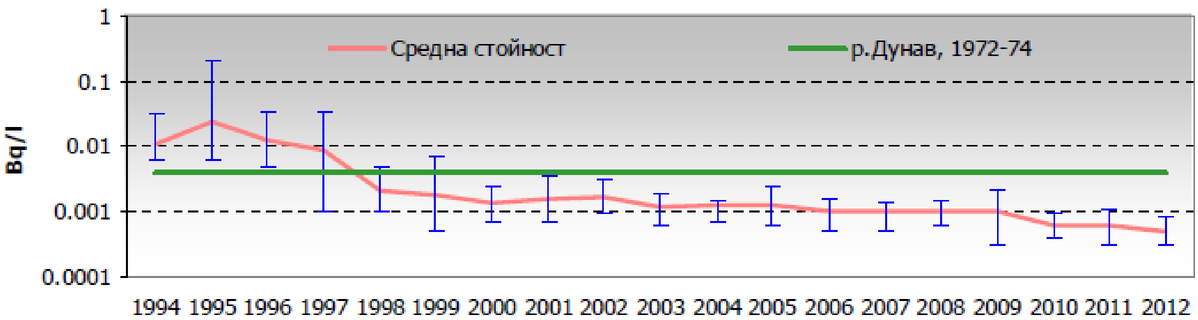
The measured activity of tritium in the discharge canal demonstrates minimum impact of the plant due to discharged debalanced water in the canal. Even compared to the norm for tritium in drinking water (100 Bq/l, Regulation No. 9/2001) the results for the discharge canal are lower (<23%). Summarised data from long-term studies of tritium in the Danube River – after the NPP are shown in the figure above.



Average value 0.0039 Bq/L, Danube River, 1972-74

FIGURE 3.2-39: SUMMARISED DATA FOR ^{90}SR (BQ/L) IN THE DANUBE RIVER FOR 1994-2012

Activity of ^{90}Sr in 2012 varies within the range of 0.9 ÷ 8.4 mBq/l. Summarised data from long-term studies are shown in the figure above. The figure shows data consistency during the period, and the activity in recent years, is lower than that before commissioning of the NPP in the period 1972 – 1974. The technogenic activity of ^{90}Sr is a consequence of global pollution, with typical levels for the natural water basins. Values range from high river water, respectively suspended organic and inorganic material, containing radioactivity. Prior to commissioning of the Kozloduy NPP according to the NCRRP for 1972 – 1974, the technogenic activity of values was 12.0 ± 2.0 mBq/l of ^{90}Sr and 4.0 ± 1.2 mBq/l of ^{137}Ss.



Average value, Danube River, 1972-74

FIGURE 3.2-40: SUMMARISED DATA FOR ^{137}CS (BQ/L) IN THE DISCHARGE CANAL OF THE NPP FOR 1994 – 2012

The analysis shows that in 2012, traces of ^{137}Cs above background levels are registered in some samples from the Water Station (BPS) – 1, the Radetski Port, the Oryahovo Port and the discharge canal. Activity is very low, varies from background levels (< 0.2 to 0.9 mBq/l) for water from the Danube River. These activities are lower than those recorded in the pre-commissioning period. In accordance with EU Recommendation 2004/2 Euratom, Cesium-137 is crucial for the control of radionuclide discharges into the environment. Summarized results for the last years for the activity of ^{137}Cs in the water in the discharge canal – for NPP are shown above. Data for 2012 and for previous years has demonstrated that no significant impact was reported by debalanced discharge water from the NPP on the technogenic activity of water in the Danube River. Radiation status of the water is stable, within normal limits. Over the past 13 years, the activity of ^{137}Cs varies and is under the levels of the pre-commissioning period, 1972-1974.

Radioactivity of water from the inland rivers, the Ogosta River, the Tsibritsa River and the Kozloduy Dam shows typical values for natural water basins. The total beta activity is in the range 0.022 – 0.13 Bq/l, while the content of tritium is under the MDS (<4.5 Bq/l).

Conclusions:

- ✓ The minimum activities of tritium were measured only for some periods in the water in the discharge channel and the BPS-1. The registered tracing values of technogenic activity are much lower than the standards for drinking water and reflect the negligible impact of the plant on the Danube River by discharge of debalanced water in the canal.
- ✓ The operation of the Kozloduy NPP has not affected in a measurable degree the radiological status of the waters of the Danube River and of the other water basins in the region. The results are within normal limits for natural water basins, which are several times below the established standards.

The implementation of the radiation monitoring program is verified with the criteria for self-assessment – implementation of the planned volume with guaranteed reproducibility and accuracy of results. The accuracy of the analyses was checked repeatedly in prestigious national and international laboratory comparisons by the World Health Organization (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 internal radiation monitoring are verified annually by an independent research by the MEW and the NCRRP (MH). The main findings are available to the general public.

3.2.1.6 MONITORING OF SURFACE WATERS IN THE REGION OF THE KOZLODUY NPP, CARRIED OUT BY THE MOEW/EEA-RL VRATSA, MONTANA AND THE RIEW

The river is an international waterway transport corridor. In connection with the threat for the ecological status of its water, assessed by the countries neighbouring the river due to increased technogenic impact of human activities on the banks thereof and the traffic, as well as the care for the preservation of many protected areas and habitats that are affected by the waters of the river, in 1992 it was decided to establish the International Commission for the Protection of the Danube River River/ICPDR/.

The Republic of Bulgaria has ratified the Convention for the Protection of the Danube River. Both the first Danube River Basin Management Plan for the entire international basin and the Danube River Basin District Management Plan in the Republic of Bulgaria have become effective.

In compliance with the Bulgarian legislation – the Water Act (WA) and the EU WFD 2000/60, the developed River Basin Management Plan (RBMP) for the Danube River determines our section of the Danube River as a river category designated as

DanubeRWB01, code BG1DU000R001, and type R6, under the B system of the WFD typology of rivers in the country[42]. This water body is classified as highly modified water body with moderate ecological potential and poor chemical status. The objectives and the measures specified in the RBMP require these parameters to be adjusted during the following annual plans in order to achieve good status and good potential. The Danube River and the whole Danube River region for basin management in the country has been identified as a sensitive area in terms of technogenic pollution, according to the Order No. РД-970/28.07.2003 of the Minister of Environment and Water, therefore the requirements for users of water bodies are more stringent. These requirements are also included in the permits issued by the MOW/DRWMBD for the NPP for discharges of wastewater from production activities in the Danube River.

The assessment of the status of the surface waters is mainly associated with the main source of industrial water supply for the plant – the Danube River, serving as the recipient of the wastewater from the site. The cold and hot canals, which are part of the technological plant cycle cooling connecting the power plant directly to the Danube River. The protection of the Danube River and its rational use and management is of vital importance for the sustainable development of the countries neighbouring on the big river. The technogenic impact has caused quantitative depletion and pollution of the water resources. It is therefore essential to comply with all the IEL specified in the permits for discharging wastewater for the Danube River in the area of the Kozloduy NPP.

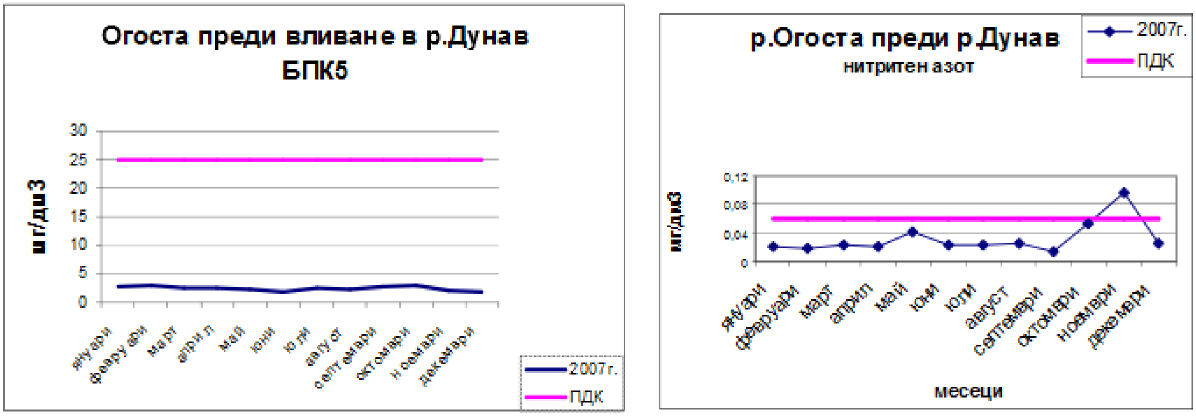
Physicochemical and operational monitoring are carried out for the Danube River according to a special Programme for national monitoring of basic physiochemical parameters of priority and specific pollutants and of hydromorphological quality elements according to the Programme of the ICPDR, which is included in the NEMS and implemented by the EEA and the Regional laboratories. Control and operational hydro-biological monitoring is carried out in compliance with the same programme. The implementation of the monitoring programme for the Danube River and the monitoring of the condition of the Ogosta River and of the other rivers in the area of the NPP is in accordance with Order No. РД-715/02.08.2010 of the Minister of the MEW, and as of 01.03.2013 a new Order No. РД-182/26.02.2013 is in force, for the regulation of the implementation of the monitoring programmes in the four water basin management regions in the Republic of Bulgaria and for specifying the frequency of sampling for the different types of water monitoring and the responsible institutions thereof.

- ✓ **Information from the non-radiation monitoring, carried out by EES/RL-Vratsa and RIEW-Vratsa**

All tested indicators comply with the standards of the water basin category and there are no registered values exceeding the norm in the laboratory analyzes of water samples from the Ogosta River at the points in the village Sofronievo **in 2007**. For the Ogosta River

[42] Regulation No. H-4 for description of surface waters, State Gazette, issue No. 22 of 05.03.2013.

before entry into the Danube River, there is one registered value exceeding the nitrite nitrogen indicator in November – 0.097 mg/dm³, all other indicators are under the norm for MAC. It is believed that excess content of nitrite nitrogen in the Skat River after the town of Byala Slatina is due to the discharge of untreated wastewater from the urban sewage.



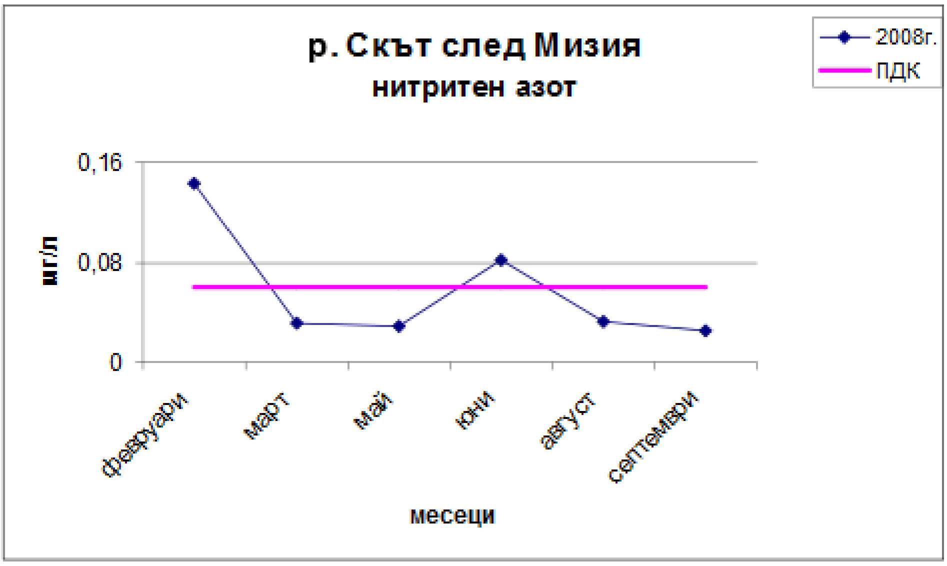
SOURCE: ANNUAL REPORT OF RIEW-VRATSA – 2007

Ogosta River before discharge in the Danube River;
Ogosta River before the Danube River; BOD5; nitrite nitrogen; mg/dm3;MAC; months, January,February, March,April, May, June, July, August, September, October, November, December.

FIGURE 3.2-41: DATA FROM THE MONITORING OF THE OGOSTA RIVER 2007

In 2008, at the point at the Skat River before it flows into the Ogosta River (Skat after the town of Mizia) there are also recorded values for nitrite nitrogen over MAC.

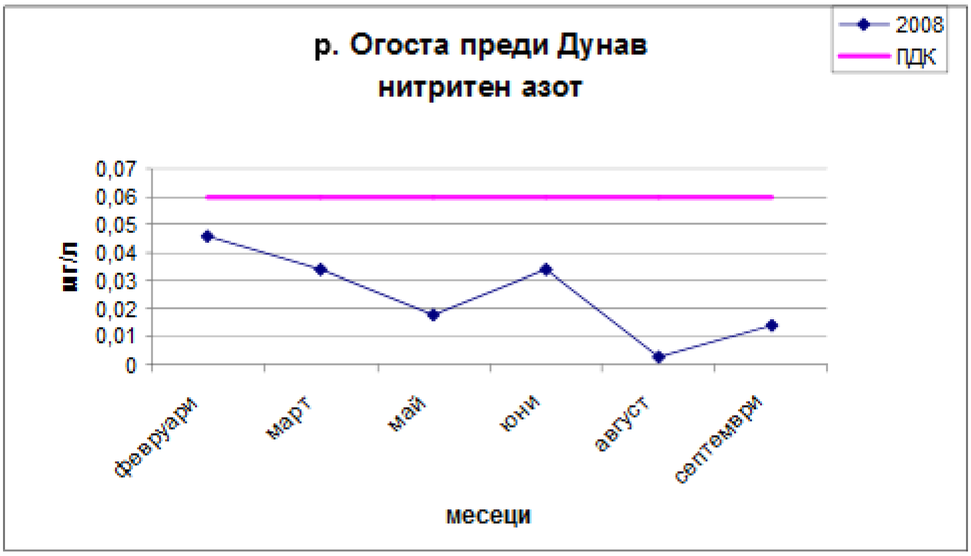
In 2008, at the points of the Ogosta River, near the village of Sofronievo, and the Ogosta River before it flows into the Danube River, there are no registered values above the MAC and all tested indicators meet the design category of the water receiving basin.



SOURCE: ANNUAL REPORT OF RIEW-VRATSA FOR 2008

Skat River after the town of Mizia, nitrite nitrogen mg/l, MAC months, February, March, May, June, August, September

FIGURE 3.2-42: DATA FROM THE MONITORING OF THE SKAT RIVER FOR 2008



SOURCE: ANNUAL REPORT OF RIEW-VRATSA FOR 2008

Ogosta River before the Danube River, nitrite nitrogen mg/l, MAC months, February, March, May, June, August, September

FIGURE 3.2-43: DATA FROM THE MONITORING OF THE OGOSTA RIVER FOR 2008

In 2009, the tendency for the Skat River water is maintained in the points in the town of Byala Slatina as in previous years with values higher than the MAC for nitrite nitrogen indicator. The higher levels of nitrite nitrogen in the Skat River after the town of Byala Slatina are mainly due to the discharge of untreated wastewater from the urban sewerage of the town of Byala Slatina. At the point at the Skat River before it flows into the Ogosta River, the Skat River after the town of Mizia, there are also registered values for nitrite nitrogen higher than the MAC. In general, there is improvement of the water quality of the Ogosta River in the section of the river that passes through RIEW-Vratsa, and it complies with the design category.

In 2010, at the points at the Ogosta River at the village of Sofronievo and at the Ogosta River before it flows into the Danube River there are no registered values above the MAC and all tested indicators comply with the design category of the receiving water basin.

In 2011, the course of the Ogosta River on the territory of RIEW – Vratsa is controlled at the following points of the National Environmental Monitoring System (NEMS).

Quantitative monitoring of surface waters

- ✓ Ogosta River at the village of Hayredin;
- ✓ Botunya River at the village of Golyamo Babino;
- ✓ Varteshnitsa River at the town of Krivodol;
- ✓ Barzina River before the village of Lipnitsa;
- ✓ Skat River at the village of Malo Peshtene;

- ✓ Skat River after the town of Byala Slatina.

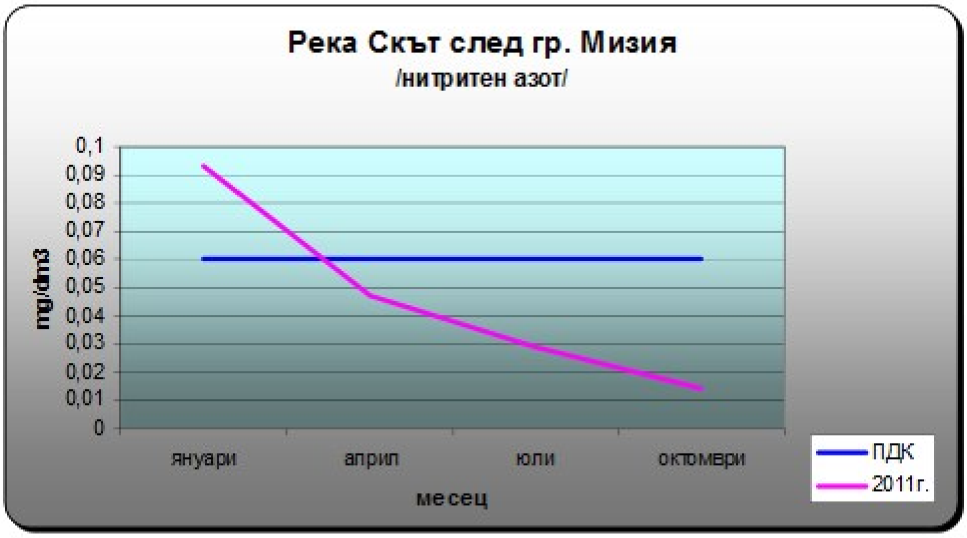
Operational monitoring of surface waters

- ✓ Skat River after the town of Mizia;
- ✓ Skat River after the town of Byala Slatina;
- ✓ Skat River at the village of Malo Peshtene.

Control monitoring of surface waters

- ✓ Ogosta River at the town of Oryahovo before flowing into the Danube River;
- ✓ Botunya River at the village of Golyamo Babino before flowing into the Varteshnitsa River;
- ✓ Asparouhov Val Dam;
- ✓ Barzina Dam;
- ✓ Three Kladentsi Dam.

The control and operational monitoring performed during 2011 at the monitoring points of NEMS shows that all tested surface water parameters comply with the design category with the exception of the nitrite nitrogen indicator. The Skat River water after the town of Byala Slatina maintains the tendency from previous years for regular higher values than the limit concentration values /MAC/ for the nitrite nitrogen indicator. The maximum recorded value is 0.199 mg/dm^3, when the standard for this indicator for III-category water basin, such as the river, is 0.06 mg/dm^3. The higher levels of nitrite nitrogen in the Skat River after the town of Byala Slatina is mainly due to the discharge of untreated wastewater from the urban sewerage of the town of Byala Slatina. Regarding all other tested indicators for the river in this section comply with the design category thereof. At the point of the Skat River after the town of Mizia there is a single registered higher value of the nitrite nitrogen indicator in January. The reported value is 0.093 mg/dm^3, and the norm is 0.06 mg/dm^3.



SOURCE: ANNUAL REPORT OF RIEW-VRATSA

Skat River after the town of Mizia, nitrite nitrogen, MAC month, January April, July, October

FIGURE 3.2-44: DATA FOR THE MONITORING OF THE SKAT RIVER

At point of the Ogosta River before flowing into the Danube River, there are no registered higher values for the tested indicators and this tendency is permanently maintained.

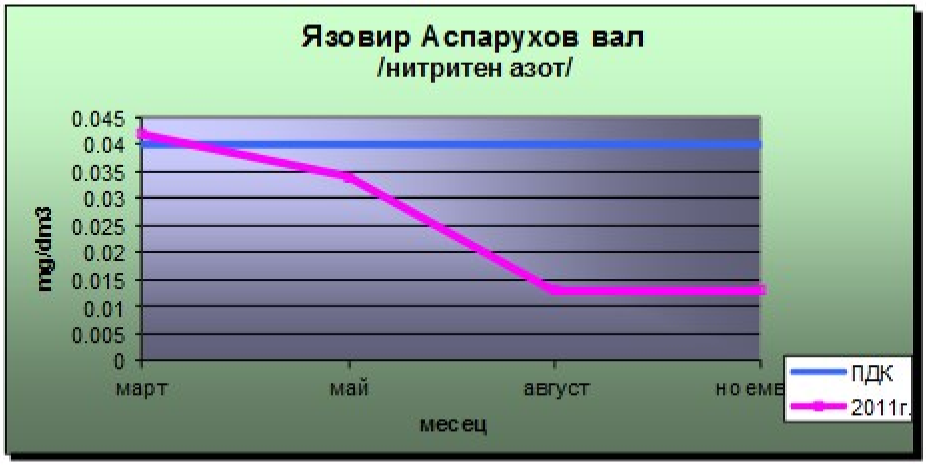
The laboratory control of the Danube River water is performed for every two months at the NEMS point, on the territory of RIEW – Vratsa, at the town of Oryahovo. The tested indicators are within the permissible concentration ranges and the river water complies with the design category for all tested indicators.

The analysis of the indicators for BOD_5 and dissolved oxygen at the points controlled by NEMS on the territory of the Vratsa region for the past years there has been a steady trend towards improving the quality of surface waters, and for 2011 there is no registration of any higher values for these indicators.

SOURCE: ANNUAL REPORT OF RIEW-VRATSA FOR 2011

Ogosta River before entry in the Danube River, (nitrite nitrogen), MAC month, February, May, August, November

FIGURE 3.2-45: DATA FROM THE MONITORING OF THE OGOSTA RIVER FOR 2011



SOURCE: ANNUAL REPORT OF RIEW-VRATSA

Asparuhov Val dam, (nitrite nitrogen), MAC month, March, May, August, November

FIGURE 3.2-46: DATA FROM THE MONITORING OF THE ASPARUHOV VAL DAM (SHISHMANOV VAL) FOR 2011

The control and operational monitoring performed during 2012 at the monitoring points of NEMS shows that all tested surface water parameters comply with the design category with the exception of the nitrite nitrogen indicator. The Skat River water after the town of Byala Slatina maintains the tendency from previous years for regular higher values than the limit concentration values /MAC/ for the nitrite nitrogen indicator. The maximum recorded value is 0.410 mg/dm^3 for July, when the standard for this indicator for III-category water basin, such as the river, is 0.06 mg/dm^3. The higher levels of nitrite nitrogen in the Skat River after the town of Byala Slatina is mainly due to the discharge of untreated wastewater from the urban sewerage of the town of Byala Slatina. Regarding all other tested indicators for the river in this section comply with the design category thereof. At the point of the Skat River after the town of Mizia there are no registered higher values of nitrite nitrogen indicator.

All tested specific indicators are lower than the limit of quantitative determination for the method.

Control monitoring was performed during 2012 for the point at the mouth of the Ogosta River and there are no registered higher values not corresponding to the water basin category. For many of the tested indicators the established concentrations correspond to the requirements for a higher category.

Control monitoring was carried out during the year for the Asparouhov Val Dam, the Barzina Dam and the dam Three wells. No exceedances of the studied parameters.

The laboratory control of the Danube River is performed every two months at the point of NEMS within the RIEW – Vratsa, at the town of Oryahovo. The tested indicators are within the permissible concentrations and the river water complies with the design category for all the tested parameters.

There is a steady trend of improvement in the quality of surface waters in the region for BOD5 and dissolved oxygen.

- ✓ **Information for the non-radiation monitoring of surface waters, intended for drinking-household water supply of RL-Montana in the 100 km zone of the Kozloduy NPP**

In connection with the implementation of the provisions of Regulation No. 2/2002 on the quality requirements for surface water intended for drinking-household water supply categories are determined jointly by the DRWMBD and the MH bodies for classification of the surface water catchments in the region. 29 catchments are identified in total and 10 of these are Category A-1 (the highest), and the rest are Category A-2. According to the specific monitoring programs for these sources, RL performs sampling and testing of 27 physicochemical parameters, organichlorine and nitrogen-containing pesticides as well as polycyclic aromatic hydrocarbons (PAH). The water quality of all catchments is tested monthly. The largest source of drinking water in the region is the Srecheska bara Dam with code BG1OG00744MS041D2, according to the Danube River RBMP for basin water management. From this source, identified as the Category A-2 [requirement for mechanical and chemical water treatment and disinfection, e.g. availability of a water treatment plant for the drinking water (WTTP)], monthly samples are taken from two levels – surface sample and sample from 5 m depth. The water quality for all tested indicators complies with the defined category. There is no data for pollution caused by the activities of the NPP. For the radiological indicators of drinking water, the requirements of Regulation No. 9/2001 shall be applied, specifying the indicators subject of control by the health authorities, such as: total beta activity – 1 Bq/l, tritium – 100 Bq/l, alpha activity – 0.5 Bq/l, natural uranium – 0.03 mg/l.

- ✓ **Data from EEA regarding the biological monitoring of the Ogosta River, the Skat River and the Tsibritsa River for the period from 2010 to 2012**

Table 3.2-17: Hydrobiological monitoring from NEMS for the Ogosta River, the Skat River, and the Tsibritsa River for the period 2010-2012

River	Point	Value BI-2010	Value BI-2012	Value BI-2012	Assessment of the BIO Ecological status
Ogosta	Village of Kobilyak	3-4	3-4	3-4	Good
Ogosta	After the town of Montana	2-3	3	3	Moderate
Ogosta	Town of Montana after the Ogosta Dam	3	3	3-4	Moderate good
Ogosta	Village of Gorno Tserovene, before the Ogosta Dam	3	3	3-4	Moderate good
Ogosta	Skat River after the town of Mizia	2-3	2-3	3	Moderate
Ogosta	Skat River after the town of Byala Slatina	3-4	3	3	Moderate
Ogosta	Skat River after the village of Gorno Peshtene	3-4	3-4	3-4	Good
Rivers, west of	Tsibritsa River, before the village	4	3-4	3	Good

the Ogosta River	of Razgrad, from 2012 –before the village of Dolni Tsibar				
Rivers, west of the Ogosta River	Tsibritsa River at the village of Yakimovo	3-4	3-4	3-4	Good

Source: EEA.

Analysis data was obtained using the methodology for BI (biotic index), according for the Order No. РД591/26.07.2012. The assessment is based on the same order of macrozoobenthos as a biological quality element.

- ✓ **Presentation of information for non-radiation monitoring carried out during the three years for the Danube River by NEMS**

The information provided in its processed form by DRWMBD – Pleven, and is provided to the Employer by letter No. 453/23.05.2013, and acceptance protocol No. 36/23.05.2013.

The results from NAEMS for 2010, 2011 and 2012 are presented for the following points: Danube River – at Novo Selo – right bank, Danube River – at Novo Selo – middle of Danube River – at Novo Selo – left bank /Republic of Romania and the Danube River near the village of Baykal before flowing into the Iskar River. This processed information is presented on the basis of the measurements presented by RL – Montana, Vratsa and Pleven in the DRWMBD from the points determined by NEMS points for the last three years.

The information is presented in tabular form for the tested physicochemical parameters, oxygen indicators, non-organic and organic chemical indicators, specific and priority substances identified in the monitoring program of the Danube River.

The complete information may be found in *Annex 9-3.*

TABLE 3.2-18: PHYSICOCHEMICAL INDICATORS OF THE DANUBE RIVER FOR 2010-2012

Name of the monitoring point	Type	Year	Water temperature ,°C	PH	Oxygen content mg/l	Electrical conductivity mS/cm	BOD5, mg/l	COD, mg/l	N-NH4, nitrogen ammonium, mg/l	N-NO2- nitrogen ammonium, mg/l	N-NO3 nitrogen amonium, mg/l	Petroleum products, mg/l	Total phosphorous, mg/l	Phosphorus such as ortophosphates, PO4, mg/l	Chlorine ions, mg/l
Danube at Novo Selo – right bank-BG	R6	2012	16.12	7.6	7.32	379	2.9	12.0	0.133	0.024	1.31	0.10	0.06	0.078	0.076
Danube at Novo Selo – right bank	R6	2011	14.47	8.1	7.53		3.6	15.5	0.192	0.024	1.94	0.20	0.151	0.075	27
Danube at Novo Selo – right bank	R6	2010	13.38	7.7	8.33	418	4.3	16.9	0.149	0.026	1.85	0.08	0.246	0.105	23
Danube at Novo Selo – middle	R6	2012	16.40	7.6	7.26	374	3.1	11.8	0.140	0.023	1.40	0.10	0.168	0.107	18
Danube at Novo Selo – middle	R6	2011	14.48	8.1	7.80		3.6	15.7	0.146	0.026	2.14	0.19	0.138	0.062	24
Danube at Novo Selo - middle	R6	2010	16.39	7.9	7.39	408	4.3	16.8	0.128	0.026	1.47		0.224	0.094	22
Danube at Novo Selo – left bank-RO	R6	2012	17.04	7.8	7.27	376	3.2	11.9	0.131	0.024	83.16	0.10	0.147	0.056	19
Danube at Novo Selo – left bank	R6	2011	15.48	8.0	7.71		3.8	16.3	0.173	0.027	1.68	0.17	0.150	0.077	23
Danube at Novo Selo – left bank	R6	2010	15.89	7.9	7.63	410	4.4	17.2	0.119	0.029	1.44	0.10	0.202	0.079	21
Danube before Baykal before the Iskar inflow	R6	2012	16.04	7.8	8.21	433	2.8	8.4	0.126	0.022	0.96	0.04	0.094	0.073	16
Danube before Baykal before the Iskar inflow	R6	2011	14.74	7.8	7.71	426	2.9	8.5	0.123	0.022	0.98	0.05	0.097	0.075	16
Danube before Baykal before the Iskar inflow	R6	2010	15.15	7.8	7.35	393	3.0	8.8	0.135	0.022	0.94	0.06		0.076	16

Source: Danube Region Waters Management Basin Directorate with a main office in the town of Pleven.

TABLE 3.2-19: SPECIFIC POLLUTANTS AND CHEMICAL SUBSTANCES IN THE DANUBE RIVER FOR 2010-2012

Name of the monitoring point	Type	Year	PCB 28, Trichloribiphenyl	PCB 52, Tetrachloribiphenyl	PCB 101, Pentachloribiphenyl	PCB 138, Hexachloribiphenyl	PCB 153 Hexachloribiphenyl	PCB 180 Heptachloribiphenyl	Manganese, Mn, mg/l	Arsenic, µg/l	Cu /Copper/, µg/l	Zn /Zinc/, µg/l	Cr,total chrome, µg/l	Total iron, Fe, mg/l	Detergent, mg/l	Hlorophyll A
Danube at Novo Selo – right bank-BG	R6	2012							0.006	1.71	3.67	11.24	0.35	0.080	0.126	7.3
Danube at Novo Selo – right bank	R6	2011	0.010	0.010	0.010	0.010	0.010	0.010	0.010	1.95	5.32	9.81	0.39	0.133	0.111	6.9
Danube at Novo Selo – right bank	R6	2010							0.014	1.91	8.10	15.56	5.64	0.187	0.069	6.0
Danube at Novo Selo - middle	R6	2012	0.010	0.010	0.010	0.010	0.010	0.010	0.003	1.79	2.17	10.06	0.27	0.075	0.067	7.8
Danube at Novo Selo - middle	R6	2011	0.010	0.010	0.010	0.010	0.010	0.010		1.89	2.90	10.60	0.30		0.100	6.3
Danube at Novo Selo - middle	R6	2010	0.008	0.070	0.006	0.070	0.006	0.070	0.010	1.95	4.15	9.97	4.78	0.141	0.054	6.4
Danube at Novo Selo – left bank-RO	R6	2012	0.010	0.010	0.010	0.010	0.010	0.010	0.003	1.86	1.96	14.14	0.29	0.091	0.080	7.9
Danube at Novo Selo – left bank	R6	2011			0.010	0.010	0.010	0.010	0.007	1.93	3.06	13.06	0.43	0.093	0.096	8.8
Danube at Novo Selo – left bank	R6	2010	0.008	0.070	0.006	0.070	0.006	0.070	0.008	1.99	3.87	9.63	4.77	0.187	0.053	5.6
Danube before Baykal before the Iskar inflow	R6	2012	0.008	0.008	0.008	0.008	0.008	0.008	0.014	2.28	5.15	17.17	0.76	0.064	0.016	4.6
Danube before Baykal before the Iskar inflow	R6	2011	0.007	0.007	0.007	0.007	0.007	0.007	0.016	2.37	5.55	18.37	0.83	0.058	0.017	5.0
Danube before Baykal before the Iskar inflow	R6	2010	0.008	0.008	0.008	0.008	0.008	0.008	0.019	2.46	6.34	21.13	0.96	0.054	0.019	5.5

Source: Danube Region Waters Management Basin Directorate with a main office in the town of Pleven.

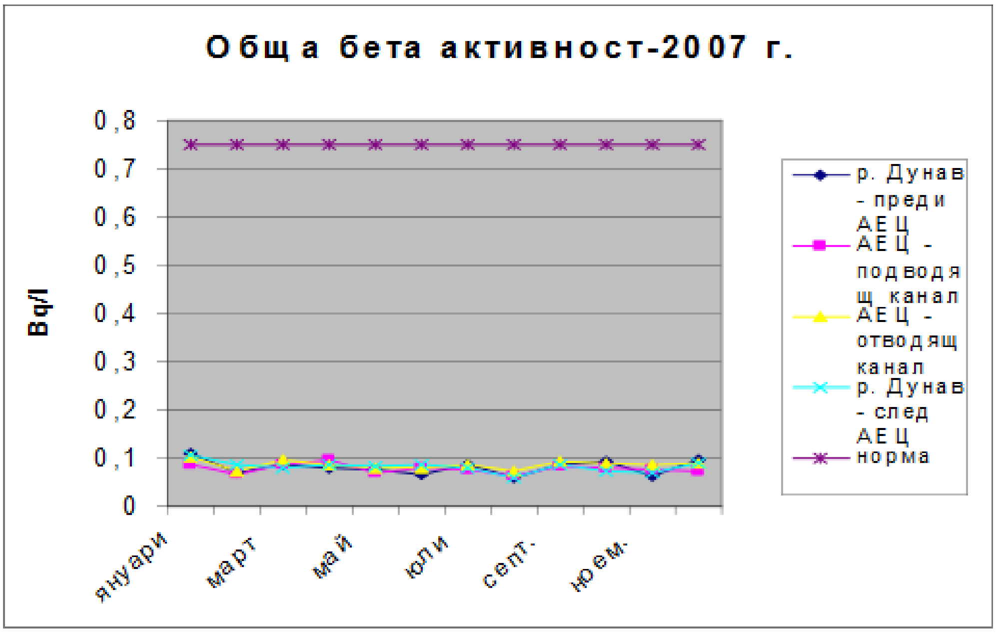
Table 3.2-18 shows that pursuant to the previously effective Regulation No. 7/86 on the indicators and standards for determining the quality of surface waters, according to which the Danube River in the Bulgarian section thereof is Category III, and the water according to its total physical, non-organic and organic indicators in almost all cases is in compliance or very close in value to a river of Category I. The indicator BOD5, however, is still between Category II and III, indicating organic pollution from sewage systems discharging wastewater from settlements without proper water treatment. The values of the indicators in the table show annual averages. There are no sharp fluctuations in the temperature regime of the river. Detailed information about all kinds of indicators included in the monitoring program of the Danube River, which are measured by EEA RL in the tested section, is given in Annex 9-3. The new Regulation No. H -4, which is in force from 05.03.2013, the Danube River is designated as a Type-R6, in the Danube River sub-ER/Subecoregion/. The Annexes do not include physicochemical quality elements nor biological elements for this type of river and these shall be supplemented. If we use the table from Annex No. 6 for physicochemical quality elements for river type R7 – the large Danube River tributaries and the plane type, we can see that the above indicators also vary between "good" and "very good". As noted in Section 3.2.1, in the Management Plan for the Danube River Basin in our country /RBMP 2010-2015/, based on the available information and expert judgment, the river is designated as strongly modified water body with moderate ecological condition and poor chemical status. As specified in the plan steps during the next planning period to 2021, the river should have a good ecological potential and good chemical status.

The table shows some specific pollutants and other chemical elements that have been monitored over the past three years in the monitoring program of the Danube River. Pursuant to the recently effective Regulation No. 7/86, the chemicals shown with average values are far below the limits for these indicators. All the information is given in *Annex 9-3*. Regulation No. H-4 – Annex No. 7, lists AAV /average annual values/ and MAC /maximum admissible concentrations/ for the specific pollutants and chemical elements, which will be assessed regarding the status of water bodies in the next monitoring period, pursuant to Order No. РД-182/26.2.2013.

SUMMARISED INFORMATION FOR THE PERFORMED RADIOLOGICAL CONTROL AND MONITORING OF THE SURFACE WATERS DURING RECENT YEARS BY RL-VRATSA AND RIEW-VRATSA

In 2007, RIEW – Vratsa, has performed continuous and periodic monitoring of the radiation status of water:

The total beta activity (Bq/l) – 30 km zone around the Kozloduy NPP in the nine points was measured each month. The control of the Danube River water – before and after the NPP and of the waste water from the plant showed that the radiological characteristics of the river are not altered by the operation of the plant.



	Януар.	Февр.	март	Апр.	Май	Юни	Юли	Авг	Септ.	Окт.	Ноем	Дек.
р. Дунав-преди АЕЦ	0,109	0,070	0,088	0,079	0,077	0,066	0,085	0,061	0,086	0,094	0,065	0,097
АЕЦ-подводящ канал	0,088	0,066	0,088	0.097	0,071	0,080	0,077	0,065	0,083	0,080	0,077	0,074
АЕЦ-отводящ канал	0,102	0,072	0,097	0,088	0,080	0,081	0,085	0,075	0,095	0,089	0,087	0,091
р. Дунав - след АЕЦ	0,107	0,087	0,080	0,087	0,082	0,086	0,081	0,059	0,087	0,072	0,071	0,091
норма	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75

SOURCE: ANNUAL REPORT OF RIEW-VRATSA

Total beta activity - 2007
Danube River before the NPP
NPP intake canal
NPP discharge canal
Danube River after the NPP
Norm
January, February, March, April, May, June, July, August, September, October, November, December

FIGURE 3.2-47: TOTAL BETA ACTIVITY OF THE DANUBE RIVER FOR 2007

Twice a year the 100 km zone around the NPP territory which is under the control of RIEW, undergoes radiological monitoring for the total beta activity of the surface waters at the following points:

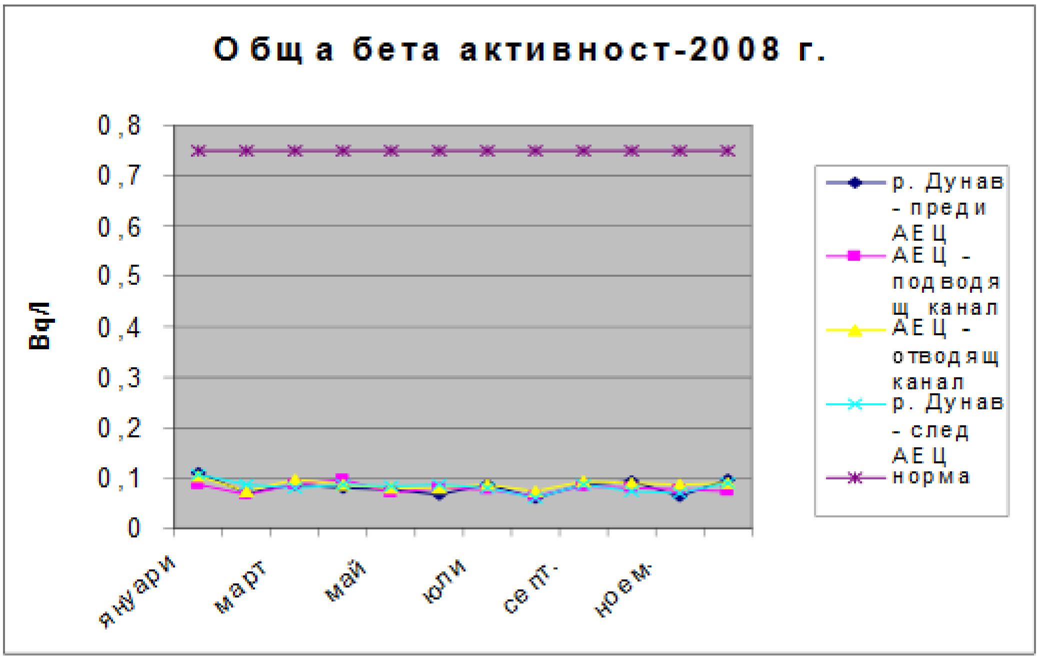
- ✓ Ogosta River, before flowing in the Danube River;
- ✓ Leva River, town of Vratsa;
- ✓ Iskar River, village of Rebarkovo;
- ✓ Iskar River, town of Roman.

In 2008, RIEW – Vratsa and RL-Vratsa perform continuous and periodic monitoring of the radiation status of water regarding the total beta activity in the 30 km zone and in the 100 km zone around the NPP. There is no change of the radiological characteristics in control points.

TABLE 3.2-20: MONTHLY VALUES OF THE TOTAL BETA ACTIVITY (BQ/L) FOR 2008

	Януар.	Февр.	март	Апр.	Май	Юни	Юли	Авг	Септ.	Окт.	Ноем	Дек.
р. Дунав-преди АЕЦ	0,073	0,051	0,063	0,072	0,084	0,074	0,071	0,080	0,067	0,078	0,093	0,076
АЕЦ-подводящ канал	0,082	0,069	0,084	0.068	0,089	0,080	0,067	0,079	0,073	0,100	0,072	0,099
АЕЦ-отводящ канал	0,083	0,070	0,083	0,086	0,080	0,081	0,075	0,073	0,088	0,082	0,111	0,049
р. Дунав - след АЕЦ	0,085	0,101	0,089	0,077	0,075	0,081	0,073	0,073	0,081	0,094	0,083	0,076
норма	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75	0,75

Danube River before the NPP
NPP intake canal
NPP discharge canal
Danube River after the NPP
Norm
January, February, March, April, May, June, July, August, September, October, November, December



SOURCE: ANNUAL REPORT OF RIEW-VRATSA

Total beta activity - 2008
Danube River before the NPP
NPP intake canal
NPP discharge canal
Danube River after the NPP
Norm
January, February, March, April, May, June, July, August, September, October, November, December

FIGURE 3.2-48: TOTAL BETA ACTIVITY B THE DANUBE RIVER FOR 2008

In 2011, RL-Vratsa took 6 nos. of bottom sediments at the points of NEMS in the 3 km and the 100 km zone around the Kozloduy NPP. The sample analysis showed that there are no significant deviations in the measured specific activity of radionuclides in comparison with the characteristic values for the area. The indicator for total beta activity was analyzed in 106 water samples in the higher areas. There were no identified deviations from the normal values of the indicator for the respective points.

Analysis was performed also for 14 nos. of water samples from wastewater and groundwater from the NPP in relation to the control exercised by RIEW-Vratsa. The analyzes did not show deviations from the normal values for the total beta activity.

The water samples taken for determination of cesium-137 from Units 5 and 6 – clean area 1 ÷ Unit 4, the discharge canal /HC/and the intake canal/CC/, the "old" and the "new" CDC, and from the Danube River at the town of Kozloduy and the town of Oryahovo did not show any deviations.

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

- new Valyata canal – CDC;
- old Valyata canal – not used;
- intake canal of the Danube River;
- Danube River at the Kozloduy port;
- Danube River at the Oryahovo port.

57 samples were taken for the total beta activity of water at the points during the year. The results thereof are shown in **Table 3.2-21**.

TABLE 3.2-21: TOTAL BETA ACTIVITY –SURFACE WATERS IN 2012 FOR THE KOZLODUY NPP IN BQ/L

No.	Point	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	New Valyata Canal	0.082	-	0.088-0.089		0.103	0.094	0.059-0.054	0.126		0.163	0.092	0.095
2.	Old Valyata Canal	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 Canal	0.075	-	0.068-0.090		0.049	0.062	0.067-0.076	0.09		0.085	0.088-.096	0.082
4.	The 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.	The 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 from the Ogosta River, before it flows into the Danube River with the corresponding values for the total beta activity: 0.091 Bq/l and 0.104Bq/l.

From the results it can be seen that the values of the tested water are far below the limit specified in the standard – 750Bq/l (pursuant to Regulation No. 7/1986, repealed in the State Gazette, issue No. 22 from 05.03.2013).

7 samples were taken during the year for cesium-137. All results were below the limit of the quantitative determination of the method.

During the year control measurements were carried out for the wastewater from the Kozloduy NPP at the following locations:

- Units 5 and 6 – clean area;

- 1 ÷ 4 of the Kozloduy NPP;
- discharge canal.

33 samples were taken during the year at the points. The results thereof are shown in **Table 3.2-22**.

TABLE 3.2-22: TOTAL BETA ACTIVITY FOR WASTE WATER IN 2012 FOR THE KOZLODUY NPP IN BQ/L

No.	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.	units 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.	discharge canal	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 clearly that the values of the tested wastewater are far below the defined admissible norm limit – 750 Bq/l.

3 samples are taken from the water for Cesium 137. The results were below the limit of the quantitative determination of the method.

For comparison – in 2002, the radiological tests carried out at the above points performed by RL-Vratsa show the following values for the Danube River that are within the range 0.044 ÷ 0.464 Bq/l for the total beta activity and for the points for the plant – within the range 0.044 ÷ 0.165 Bq/l with norm of 0.750 Bq/l.

DATA FROM THE RADIOLOGICAL MONITORING, CARRIED OUT BY THE EEA/RL-MONTANA AND RIEW-MONTANA

The radiological monitoring of the surface waters includes 9 points along the Ogosta River, the Danube River, the Timok River, the Tsibritsa River, the Koritarska Bara River, the Barziya River and the Botunya River. The monitored parameter is the total beta activity. For 2007 it is in the range 0.056 -0.417 Bq/dm^3.

From 01.04.2000, in fulfilment of the obligations of the Republic of Bulgaria to the International Commission on the Protection of the Danube River basin, **RL – Montana** provides monitoring activity for the Danube River program. Sampling is performed at Novo Selo point of the Danube River – from the Bulgarian, the Romanian banks and the midstream of the Danube River. In 2007 a total of 6 samples were taken. The total β-activity of the water is in the range 0.09 – 0.12 Bq/dm^3.

The radiological monitoring of the surface waters includes 9 points along the Ogosta River, the Danube River, the Timok River, the Tsibritsa River, the Barziya River, the Botunya River and the Koritarska Bara River. The monitored parameter is the total beta activity. For 2008 it is in the range 0.056 -0.553 Bq/dm^3.

Sampling is performed at Novo Selo point of the Danube River – from the Bulgarian, the Romanian banks and the midstream of the Danube River. In 2008 a total of 6 samples was taken. The total β-activity of the water is in the range 0.03 – 0.08 Bq/dm^3.

In 2009, the radiological monitoring of the surface waters includes 9 points along the Ogosta River, the Danube River, the Timok River, the Tsibritsa River, the Barziya River, the Botunya River and the Koritarska Bara River. The monitored parameter is the total beta activity. For 2009 it is in the range 0.042 -0.196 Bq/dm^3.

Sampling is performed at Novo Selo point of the Danube River – from the Bulgarian, the Romanian banks and the midstream of the Danube River. In 2009 a total of 6 samples was taken. The total β-activity of the water is in the range 0.03 – 0.12 Bq/dm^3.

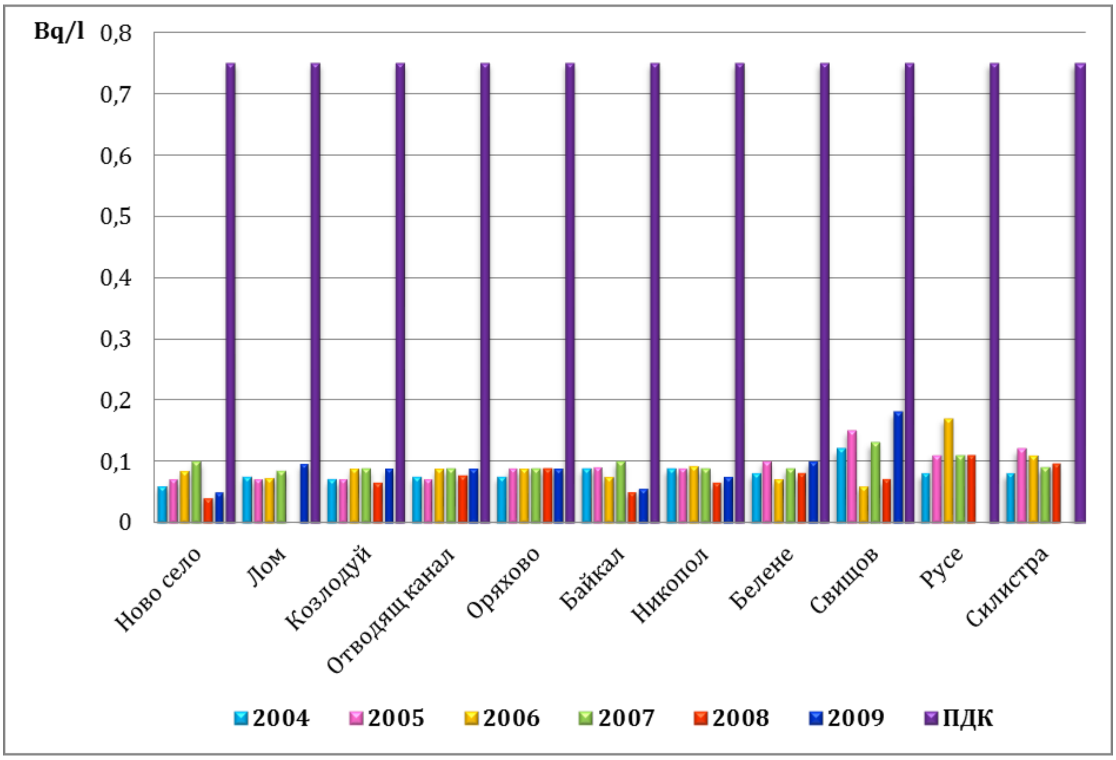
In 2010, the radiological monitoring of the surface waters includes 9 points along the Ogosta River, the Danube River, the Timok River, the Tsibritsa River, the Barziya River, the Botunya River and the Koritarska Bara River. The monitored parameter is the total beta activity. For 2010 it is in the range 0.036 -0.283 Bq/dm^3.

Sampling is performed at Novo Selo point of the Danube River – from the Bulgarian, the Romanian banks and the midstream of the Danube River. In 2010 a total of 6 samples was taken. The total β-activity of the water is in the range 0.06 – 0.15 Bq/dm^3.

In 2011, the radiological monitoring of the surface waters includes 9 points along the Ogosta River, the Danube River, the Timok River, the Tsibritsa River, the Barziya River, the Botunya River and the Koritarska Bara River. The monitored parameter is the total beta activity. For 2011 it is in the range 0.044 -0.332 Bq/dm^3. From 01.04.2000, in fulfilment of the obligations of the Republic of Bulgaria to the International Commission on the Protection of the Danube River basin, RL – Montana provides monitoring activity for the Danube River program. Sampling is performed at Novo Selo point of the Danube River – from the Bulgarian, the Romanian banks and the midstream of the Danube River. In 2011 a total of 6 samples was taken. The total β-activity of the water is in the range 0.04 – 0.06 Bq/dm^3.

SUMMARISED INFORMATION FOR RADIOECOLOGICAL MONITORING BY EEA

The data analysis for the total beta activity of water from the Danube River (from Novo Selo to Silistra), compared with the results from the discharge canal of the Kozloduy NPP during the period 2004 – 2009 (**Figure 3.2-49**) shows values significantly below the limit specified in the legislation for the quality of surface water (0.750 Bq/l). This conclusion also applies to the other tested rivers in the region.



SOURCE: EEA

Novo Selo, Lom, Kozloduy, Discharge canal, Oryahovo, Baykal, Nikopol, Belene, Svishtov, Ruse, Silistra, MAC

FIGURE 3.2-49: TOTAL BETA ACTIVITY THE DANUBE RIVER IN THE PERIOD 2004-2009, BQ/L

Monthly control is also performed for the debalanced water from Units 5 and 6 – clean and controlled area, debalanced water from units 1 ÷ 4, water from the intake and the discharge canal, the water from the old Valyata canal, the new Valyata canal /CDC/ and the water from the Danube River, before and after the plant – the Kozloduy and Oryahovo ports.

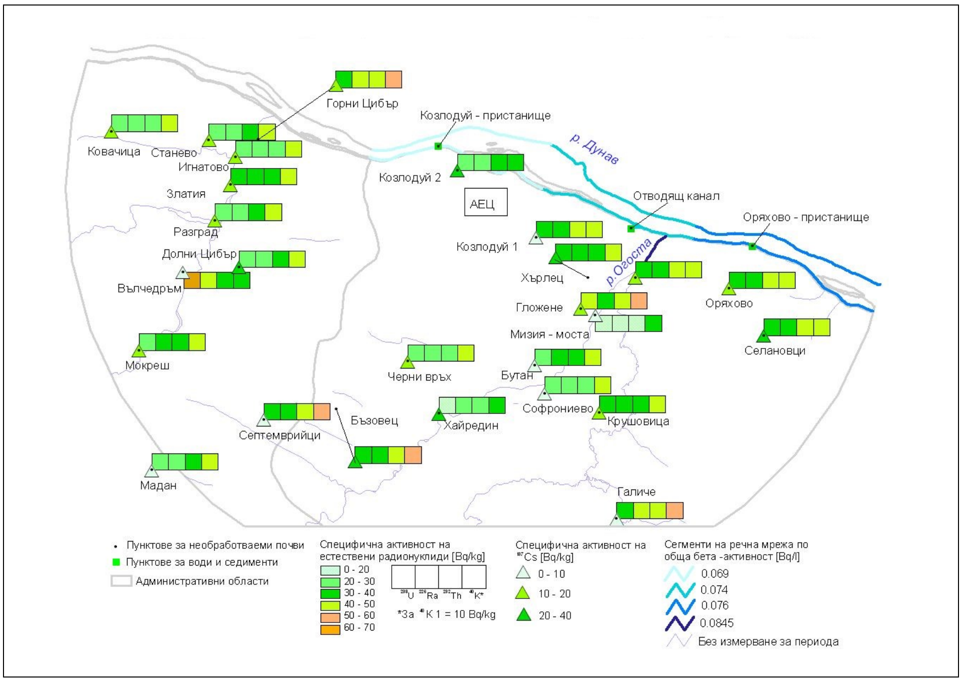
The Executive Environment Agency receives monthly reports for the scope and activities of the debalanced water as a result of the ongoing internal radiological monitoring of the plant.

The results from the analyses are comparable with registered from previous years and show no changes in the radiological characteristics of the Danube River on Bulgarian territory, due to the activity of the Kozloduy NPP.

The specific activities are identified for the natural and technogenic radionuclides in the sediments for every three months at the points along the Danube River – from Novo Selo to Silistra, including the discharge canal of the NPP – the Batatovets territory. The measured values of the specific activity of the technogenic ^{137}Cs in these samples during the year are within the range from 0.46 Bq/kg (Baykal) to 12.3 Bq/kg (Oryahovo).

During the year, presence of other technogenic radionuclides in sediments has not been observed.

The radiological monitoring performed within the system of the MEW in 2009 in the 30 km zone of the Kozloduy NPP indicates the overall status of the radiation environment in the region (**Figure 3.2-50)**.



SOURCE: EEA

Gorni Tsibar, Kozloduy Port, Danube River, Discharge canal, Oryahovo Port, Oryahovo, Selanovtsi
Kovachitsa, Stanevo, Ignatovo, Zlatia, Razgrad, Dolni Tsibar, Valchedram, Mokresh, Madan
Kozloduy 1, Kozloduy 2
NPP
Harlets, Glozhene, Ogosta River, Mizia Bridge, Butan, Sofronievo, Krushovitsa
Hayredin, Cherni Vrah
Septemvriitsi, Bazovets
Galiche
Points for non-arable soil
Points for water and sediments
Administrative regions
Specific activity of natural radionuclides (Bq/kg)
Specific activity of ^{87}Cs (Bq/kg)
River network segments for the total beta activity (Bq/kg)
No measurement for the period

FIGURE 3.2-50: RADIATION STATUS OF THE ENVIRONMENT IN THE 30 KM ZONE OF THE KOZLODUY NPP FOR 2009

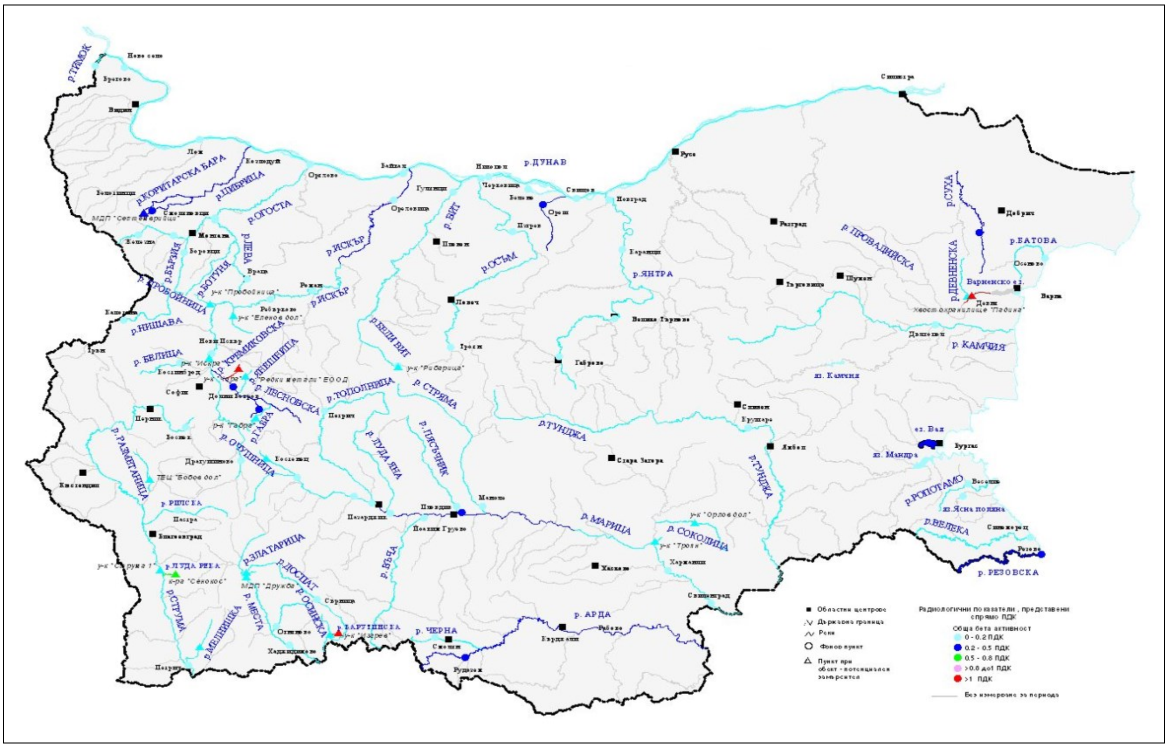
The data received in 2009 data compared with the results of the radiological monitoring from previous years showed no adverse trends in the radiation status and the environmental conditions resulting from the operation of the nuclear power plant.

In 2010 a system monitoring of the radiation condition was performed at 84 points along the big rivers and along other water basins in the country, as well as at 8 points at the Danube River.

The data analysis for the total beta activity of the Danube River and for other key rivers, lakes and dams shows values significantly lower than the MAC (Regulation No. 7/1986 on the indicators and standards for determining the quality of surface water flowing MAC - 0.75 Bq/l).

The trends is for radiological indicators to maintain their values, specific to the monitoring point in the country in comparison with previous years. This is indicative of the absence of pollution of this component of the environment.

Data on radiological parameters of surface waters resulting from the ongoing EEA radiological monitoring in 2010 are presented in **Figure 3.2-51**.



SOURCE: EEA

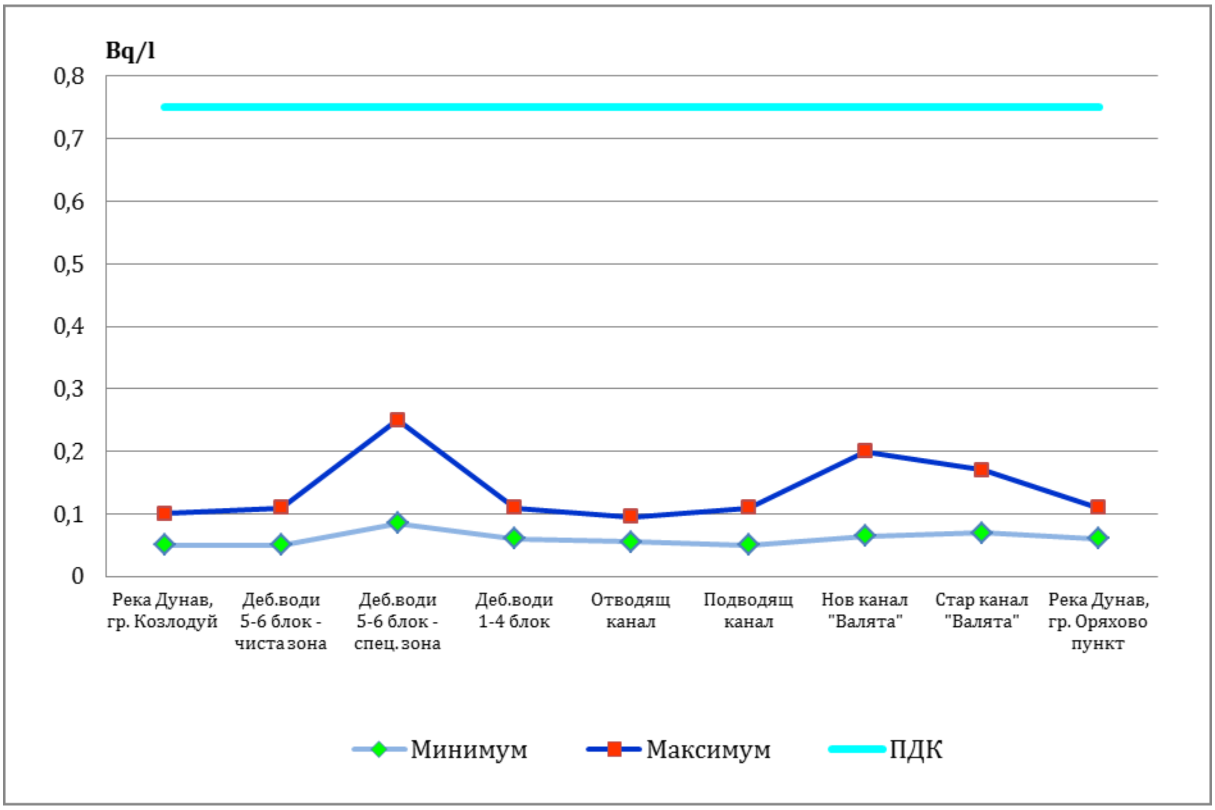
FIGURE 3.2-51: TOTAL BETA ACTIVITY FOR SURFACE WATERS FOR 2010, BQ/L

The results are comparable with the ones registered from previous years and do not show changes in the radiological characteristics of the Danube River on Bulgarian territory due to the activity of the Kozloduy NPP.

In 2010, there were no other technogenic radionuclides observed in sediments.

Liquid radioactive discharge

All observed deviations from the normal radiation status were insignificant as per their absolute value, and there is no registered upward trend. In 2010, the presence of technogenic radionuclides of reactor origin is not registered – Figure 3.2-52.



SOURCE: EEA

Danube River, town of Kozloduy
Deb. water units 5-6 – clean zone
Deb. water units 5-6 -- special zone
Deb. water units 1-4
Discharge canal
Intake canal
New Valyata Canal
Old Valyata Canal
Danube River, town of Oryahovo

FIGURE 3.2-52: TOTAL BETA ACTIVITY OF DEBALANCED WATER OF THE KOZLODUY FOR 2010, BQ/L

3.2.1.7 SUMMARISED CONCLUSIONS FOR ITEM 3.2.1. – SURFACE WATERS

- ✓ The Kozloduy NPP site has a very well-constructed water supply network for drinking-household water supply. There is no technical possibility to connect to the water supply network of the new unit to the existing water supply system of the NPP at the appropriate points.
- ✓ The water supply system of the Kozloduy NPP for technical and industrial water is designed to be appropriate and reliable, provided it is well maintained by the operation personnel. Provision of technical water for each of the alternative sites proposed for the realization of NNU is technically feasible for realization of the existing system – CC- 1 by appropriate engineering solutions and ensures removal of used cooling water and other waste water by the constructed HC-1 and HC-2 to the Danube River.
- ✓ The general condition of the existing sewerage network in the Kozloduy NPP is good. There are periodic inspections carried out for the individual sewer branches.

Occurrence of accidents is rare and quickly handled. Receiver of wastewater from the sewage network is the CDC, where water is transferred into the Danube River through the Pump Station /PS/.

- ✓ The constructed treatment facilities and the PC /Purification complex/ for the EP-2 may be used only for the current facilities and installations of units 5 and 6 of the Kozloduy NPP.
- ✓ The Kozloduy NPP has been commissioned and successfully operates within its own monitoring regarding the non-radiation aspects, radiological monitoring and control internal environmental monitoring. The purpose of the non-radiation monitoring is to maintain compliance with the regulatory requirements and the conditions specified in the permits issued by MEW, EEA, DRWMBD and RIEW-Vratsa. According to the developed and approved Programme for private non-radiation monitoring, 20 indicators are controlled regarding the quality of wastewater discharged from the plant, according to IEL specified in the issued permits from the Basin Directorate. The results show that there is a tendency to exceed the value of the controlled performance and there are no registered significant exceedances of the limit values. Separate cases of values higher than the IEL are registered /2008/ for petroleum products and for residual chlorine in HC/2009/ which is a bit higher than the IEL. The presence of Borium is established in almost all samples of waste water discharged into the CDC. The indicator for Borium, for which the requirement for water intake for IEL for Category II is not to be allowed, there are higher values for almost the entire period of sampling, but they are within the values reported in the drinking water of the town of Kozloduy. All measurements in recent years recorded levels of heavy metals which were frequently below the norm. The values are comparable with those of recent years. It is evident that there is no upward trend in the values of the controlled indicators and there are no registered significant cases of values higher than the limit values. Information for the ongoing monitoring is sent periodically and summarized annually to DRWMBD, and the control over the observance of IEL is performed by RIEW-Vratsa as per the requirements of the Water Act.
- ✓ The annual reports are submitted to the EEA and RIEW-Vratsa. Company control is done through regular internal inspections and controls. Institutional control of non-radiation monitoring is carried out during the year by the authorities of MEW, the Danube River Basin Directorate and RIEW-Vratsa.

The radiological monitoring carried out by the Kozloduy NPP EAD, as noted, covers all environmental media – air, water, soil, vegetation, crops, typical foods produced in the area, etc. EU requirements regarding the application of art. 35 of the EURATOM Treaty on monitoring of the levels of radioactivity in the environment for the assessment of dose 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 the standardization and unification of the practices applied in radiological monitoring in the member states of the EU. Concepts are defined therein and the general requirements of the types of monitoring, the network monitoring and the sampling (dense and diluted), the frequency of monitoring, the volume of monitoring and the requirements for sampling and analysis of the main controlled objects of the environment. This also includes regulation of the volume of the information, management and communication of monitoring data accompanying the sample.

The official radiological environmental monitoring is regulated by the long-term program of the Kozloduy NPP regarding radiation monitoring of the environment. The program is based on the legal requirements in the area, as well as on international best practices and the operational experience of the PM Department. The program is coordinated with the Ministry of Environment and Water /MEW/, the Ministry of Health /MH/ and the Agency for Nuclear Regulatory Agency /NRA/and is in compliance with the international recommendations in the field, art. 35 of the EURATOM Treaty and Recommendation 2000/473/EURATOM. In order to provide independent control programs radiation monitoring programmes are implemented by the control authorities EEA/MEW and NCRRP/MH.

- ✓ The results in recent years show that:
  - Registered technogenic activities in the wastewater from the Kozloduy NPP are due to plant operation. The measured values in 2010, 2011, 2012 are among the lowest in recent years, as a result of improvements in the radiation emission control in the HFS waste water;
  - Most of the measured activities of ^{137}Cs are the result of past contamination of bottom sediments and the transfer of the suspended part thereof in aqueous phase. These samples do not show presence of the other isotope ^{134}Cs, and the measured values of ^{137} Cs along the course of the canal is higher than at the discharge collectors;
  - The registered presence of the two isotopes of radiocesium in the wastewater collector for rain water from the site indicates that these are probably non-fixed contamination in dust and other particles that are flushed with rainwater;
  - The radiological situation in the Blatoto territory is stable and the radiological impact of the Kozloduy NPP with wastewater discharges has been reduced significantly in recent years. There is no danger to the environment in the area of drainage canals;
  - The operation of the Kozloduy NPP did not influence the radiological status of the waters of the Danube River and other water basins in the area;
  - The technogenic activity shows results within the normal limits for natural ponds, several times lower than the established standards;
  - Radioactivity of water from the inland rivers of Ogosta, Tsibritsa and the Kozloduy Dam shows typical values for natural water basins. Total beta activity is in the range 0.051 – 0.14 Bq/l, while the tritium content is under the MAC (<4.4 ÷ <4.7 Bq/l).

- The minimum activities of tritium and ^{137}Cs were measured for some periods only in the water in the discharge canal of the NPP and the Oryahovo port. Traces of technological activity that were registered are even lower than the standards for drinking water. Even compared to the norm for tritium in drinking water (100 Bq/l, Regulation No. 9/2001) the results for the discharge canal are lower (< 23%).
- The high sensitivity for the analysis allowing to register activities close to background activities reflects the negligible impact of the plant on the Danube River to the discharge canal water. This does not pose any danger to the environment in the area.
- The results at various points along the course (before and after NPP) are very similar, demonstrating no appreciable impact from the discharge water in terms of overall activity.
- Overall, the total beta activity in the waters of the Danube River, the Ogosta River, the Tsibritsa River and the Shishmanov Val is 0.012 Bq/l to 0.15 Bq/l, which is about 30% of the control level (0.5 Bq/l, Regulation No. H-4/2012). For the Danube River the maximum measured value is 0.087 Bq/l, according to the Annual Report of the Kozloduy NPP for 2011 The content of tritium in samples of surface water bodies is about the minimum detectable activity, to 8.0 Bq/l.
- The implementation of the radiation monitoring program is verified with the criteria for self-assessment – implementation of the planned volume with guaranteed reproducibility and accuracy of results. The accuracy of the analyses was checked repeatedly in prestigious national and international laboratory comparisons.

Based on the ongoing self-monitoring of wastewater and the environment from the Kozloduy NPP and the ongoing control monitoring by the competent authorities – MEW, EEA-RL, DRWMBD and RIEW-Vratsa it can be concluded that the plant operation does not endanger the status of surface waters in the region, especially for the Danube River, the reception basin of all waste water from the NPP, whose condition is not affected by the operation of the plant.

3.2.1.8 HYDROLOGY OF THE DANUBE RIVER

The Danube River is crucial for the operation and safety of the Kozloduy NPP. The plant site is located on the terrace of the Danube River. The elevation of the site is formed on a large deposition area as defined in the design of the plant with reserve against flooding for 10 000 – annual high wave along the Danube River.

Flood protection with security of 1% (over 100 years period) for the valley is provided by a protective dike, with an average elevation of 30.5 m. The width of the canal of the Danube River varies in the range 800-1300 m. The depth in the fairway is up to 14 m, and the minimum depth for low levels reached 1.8 m. The maximum speed of the river is about 2.5 m/s (9 km/h). The Kozloduy Island (701.5 km – 690.5 km, with a width of 1 km and a length of about 11 km) is located within the boundaries of the studied section of the river, and it divides the river into two branches.

Service water for the provision of cooling water /circulation – for the turbine condensers, and technical – for other equipment/ is from the main branch of the river at km 687 through three coastal pumping stations on the Danube River, and from 6 sump pump stations located in the terrace of the Danube River – for an emergency supply of units 5 and 6. The catchment of the Danube River and the coastal pumping stations are located at km 687 from the mouth of the Danube River, after the island in the town of Kozloduy. The catchment is in deep water. The constructed BPS-1, -2 and -3 provide the NPP with technical water. The water used by the power units is returned to the Danube River using a discharge hot canal, HC-1 and HC-2.

The Danube River collects water from a catchment area of 584 400 km^2 before reaching the western border of the Republic of Bulgaria and from another 101 300 km^2 of the territory of Bulgaria and Romania within the general area of the river. The catchment area of the river is located in the European continental climate zone, but the formation of the flow of the river is carried out as a result of many influences. In implicit form, this process contains information about the physical processes that develop both in the atmosphere and in the water basin. These processes are developed under the influence of two main groups of factors – natural and human activities. The river is an important international waterway transport corridor.

In 1992 it was decided to establish the International Commission for the Protection of the Danube River River/ICPDR/. The Republic of Bulgaria has ratified the Convention for the Protection of the Danube River. Both the first Danube River Basin Management Plan for the entire international basin and the Danube River Basin District Management Plan in the Republic of Bulgaria have become effective. This plan for the Danube River determines our section of the Danube River as a river category designated as DanubeRWB01, code BG1DU000R001. The river is classified as highly modified water body with moderate ecological potential and poor chemical status. There is a Programme with the measures in order to achieve good status and good potential during the next planning period until 2021 and 2027 These requirements shall apply in respect of the environmental obligations in the realization of this IP.

3.2.1.8.1 Level of hydrological study

The Bulgarian section of the Danube River has always been interesting in terms of the hydrological regime, which is determined by the importance of the river to the economic development of the country. There are numerous scientific works that relate to the analysis of the hydrological data on the Danube River. The beginning of the modern hydrological studies may refer to 1970 and the research and publications of Marinov I., Mladenov N., Nikolov J., Renchev P., Betsinski, Panaiotov T., Pechinov D., Mandadjiev D., Modev St., Guergov G., Nenov I. and others can be identified as regards the regime for the flow characteristics of the Danube River, the river hydrometric, the key curves, etc. Much of the research related to the use of the energy of the Danube River was carried out within the

University of Architecture, Construction and Geodesy (UACG), the Department of Hydraulic Engineering, in the period 1973 – 2008. Until now there are over 60 scientific papers and field reports published in relation to the Kozloduy NPP, the Belene NPP, the hydraulic complex Nikopol – Turnu Magurele, HTK Silistra – Calarasi, the Danube River Bridge – Ruse, the Danube River Bridge – Vidin, different ports and others, which were conducted by Raynov, Ninov, Kazakov, Modev, Lissev, Pechinov, Mandadjiev, Marinov, Nikolov N., Nikolov J., and others. Several these works were also related to characteristics of the Danube River (Nikolov, Pechinov, Modev), and studies of other authors strongly converge to these (Marinov I., Pechinov D., Pechinova M. Ninov Pl., Ninov I., Ruseva I.) and others.

In connection with the assessment of the condition of the Kozloduy NPP by the committee of the IAEA, a series of hydrological, hydrogeological and hydraulic calculations and assessments of the selection of the elements of the plant site was conducted during the period 1991-1992. Part of these results are analyzed and assessed in the EIA for the Kozloduy NPP, from 1999. After this mission there is no mutual hydrological study assigned and prepared. There have been some studies that do not cover the same period, so the results thereof are used without being fully reliable, interpreted or compared.

The EIAR of the Kozloduy NPP has paid special attention to the characteristics of the maximum and minimum flow of the Danube River. In this respect, Bulgaria has officially published the results of only one study of the maximum flow (J. Nikolov, BAS – 1981). For the purpose of designing various sites along the Danube River, the UACG and NIMH, IWP-BAS[43] and Energoproekt AD conducted various studies that vary in volume and the analysis of information for the maximum flow and probability estimates. Actually in Bulgaria there are no official publications on the use of stochastic models to determine the maximum dimensional water quantities for the section from the town of Silistra to the town of Novo Selo.

The latest summary of all the research carried out so far has been made in a report prepared by Risk Engineering AD – Research and location of the preferred site for the construction of a new nuclear power plant at the site of the KOZLODUY NPP and the neighbouring territories – from January 2013, Ref No. REL- 1000 -ST- 001-2.

It analyzes more than 25 pieces of information prepared by different institutions and for different occasions. The greater part is formed by documents prepared during the period 1987-2010. Each of these devotes a significant space to the study of hydrological and hydraulic problems in the form of reports, opinions, expertise, analytical reviews, reports on applied research assignments, reports on events related to the safety assessment of the operation of the Kozloduy NPP. Some of the items of the information concern both the existing power plant and the project for construction of the Belene NPP. Thematically, the information is grouped in several ways, as follows:

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[43] IWP - previously the Institute for Water Problems with the Bulgarian Academy of Sciences (BAS) which is currently a department of the NIMH.

- **Information for the hydrological regime of the Danube River as a whole and in particular the section of the Kozloduy NPP**. This includes the studies on the formation and the water regime of the Danube River in the Bulgarian section, obtaining representative estimates of the natural flow regime of the river (annual average, maximum and minimum water flows and matching water levels, key and permanent curves internal annual distribution of the river flow, sediment flow, chemical composition and water quality, temperature and icing of the river and some other indicators). This provides information for the system of points to monitor the condition of the river and a description of their main features, as well as operational information for hydrometric characteristics of the river at these points, with precisely cited relevant documents used in the preparation thereof[44];
- **Hydrological and engineering-hydrological studies for assessment of the extreme conditions of the river flow and the water level** (maximum and minimum water levels and quantities required by the normative legislation for provision) for different time periods in order to, on one hand, to ensure the provision of the necessary water volumes for trouble-free operation of the plant and, on the other hand, risk assessment of flooding of the plant caused by natural factors related to the Danube River, such as heavy rainfall, sudden snowmelt, ice blocks /lifting/, rough waters, etc.., and the options are considered for co-occurrence of several events. Special attention is paid to the alleged external flooding, which can occur at the site of the current nuclear power plant. This is a key issue in the design of the NPP and the event of external flooding is a risk with a high degree of danger due to adverse effects on the operation of the nuclear power plant.

The national regulations, as well as those developed by the IAEA and other relevant international institutions put first priority on this problem. For example, the Bulgarian legislation in accordance with Section II, Article 29, paragraph 3 of the Regulation for ensuring nuclear plant safety there is the following requirement on external flooding: "For the Kozloduy NPP there shall be definition of the maximum water level and the duration of the possible flooding due to rainfall, intense snow melting, high water level in the reservoir, river blocking by ice, avalanche and landslide; the following shall be evaluated for the Kozloduy NPP – characteristics of the maximum possible river floods with frequency of 10^{-4} per year combined with the high tides and waves caused by the wind. According to the IAEA SAFETY STANDARDS SERIES No. SSG- 18, Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations, IAEA, Vienna, 2011, all nuclear power plants located on sites where flooding is possible, shall withstand maximum design water level (MWL). The best design solution is the elevation of the plant and the components important for safety, so that they can be located above the MWL.

[44] Study and determination of the location of the preferred site for the construction of the new nuclear power capacity at the site of the Kozloduy NPP EAD and the neighbouring territories - review of the studies - Ref. No. REL-1000-ST-001-2, January 2013.

The analysis of the information shows that both the design of the power plant itself, and during the entire period of its subsequent operation, a number of targeted research assessments and reassessments of the potential maximum water levels in case of extreme natural events and severe disruptions in the regime of the Danube River due to the destruction of waterworks, such as existing ones and such designed above and below the site of the Kozloduy NPP.

Different options have been studied for the occurrence of risk events resulting in partial or complete destruction of waterworks (due to technogenic and/or natural causes) and the corresponding critical values of water levels and water quantities were obtained that would cause risk events (floods, flooding, destruction of protective dikes, etc.) affecting adversely the facilities and activities for the power plant. A major threat to such a scenario is considered to be the sudden rupture of the hydro complex of the Zhelezni vrata I and II, and the high wave may not destroy or may destroy the dikes on both sides under the complex next to the Kozloduy NPP site by flooding of the river valleys and versions of this event for the constructed hydro complex Nikopol – Turnu Magulare and other hydraulic structures designed in the lower reaches of the river after the NPP that also would be a potential risk of destruction[45].

Based on the summary of the studies, an assessment was prepared regarding the security of the Kozloduy NPP from the impact of the abovementioned processes and events. The critical areas, facilities, and equipment that could be damaged or their normal operation could be hindered have been identified along with the programs, measures, actions, security enhancements and performance of plant personnel in case of such events.

3.2.1.8.2 Hydrometric network of the Danube River and in the section of the Kozloduy NPP site

Studies on the flow of the Danube River have been conducted since the mid-19th century. The first hydrological station opened in 1927, near the border of Bulgaria, is the station at Orshova. The observations in this station started in 1941 and still continue till the present.

Routine observations of the hydrological elements are performed daily by EAEMDR – Ruse (water levels, water quantity, water temperature and icing).

A total of 20 hydrological posts have operated at various times in the Bulgarian-Romanian section of the Danube River (km 844 – km 375). 16 of these are permanent-establishments (**Table 3.2-23**). The hydrological observations began in the Bulgarian section of the Danube River in 1878 in the town of Ruse. The second observation yard began its operation in the town of Lom in 1911. Between 1912 and 1941 another 13 yards (stations) started operating successively. The last 5 stations are equipped and put into operation

[45] SIC at the UACG, 1991, Kozloduy NPP - Assessment of the flooding risk for the Kozloduy NPP and the Belene site, Team Leader Prof. E. Marinov.

during the period 1943-1962. The main source of hydrological information is the hydrological station at Svishtov – km 554.3.

TABLE 3.2-23: LIST OF HYDROLOGICAL STATIONS ON THE BULGARIAN SIDE OF THE DANUBE RIVER

N-	Hydrological station at:	Distance to mouth	Area of water collection basin	Zero ground of the yard acc. to the Black Sea system – Varna	Zero ground of the yard acc. to the Baltic system – Kronstad	Opened in: (year)	Elements of monitoring and measurement*
		km	km²	m	m		
1	Novo Selo**	833.6	584900	27.00	26.75	1937	H,Q,T,SSC,SOC,R,CSC
2	Vidin	790.2	585580	24.81	24.55	1920	H,Q,T,CSC
3	Archar	770.6	586420	24.00	23.76	1937	H,Q,CSC
4	Lom	743.3	588860	22.89	22.65	1911	H,Q,T,SSC,SOC,R,CSC
5	Tsibar	717.6	591900	22.50	22.27	1937	H
6	Kozloduy	703.5	592500	22.00	21.77	1937	H,CSC
7	Oryahovo	678.0	607260	21.56	21.34	1924	H,Q,T,CSC
8	Vadin	653.6	608020	20.00	19.78	1937	H
9	Baykal	640.8	608820	20.00	19.78	1927	H
10	Somovit	607.7	621780	17.86	17.64	1921	H
11	Nikopol	597.5	648620	17.23	17.02	1927	H,CSC
12	Nikopol-Turnu Magurele	581.2	648710	19.77	19.56	1972-1989	H
13	Svishtov***	554.3	650340	15.10	14.89	1913	H,Q,T,SSC,SOC,R,CSC
14	Ruse	495.6	669900	11.99	11.80	1878	H,Q,T,CSC
15	Tutrakan	433.0	673500	8.89	8.70	1943	H
16	Silistra	375.5	685700	6.50	6.27	1941	H,Q,T,SSC,SOC,R,CSC

* *Elements for observation and measurement of water levels (H), water quantities (Q), water temperature (T), suspended sediment concentration (SSC), organic material concentration (SOC), sediment quantity of suspended sediments (R), coordinates and outlines of hydrometric cross section (CSC)*
** *Main water metering points (Class I);*
*** *Points for data used in this survey.*

The stations at Novo Selo, Lom, Svishtov, Ruse and Silistra, a total of 5, are Class I. These are used to measure the main hydrological components – water levels (H), water quantities (Q), water temperature (T), suspended sediment concentration (SSC), organic material concentration (SOC), sediment quantity of suspended sediments (R), coordinates and outlines of hydrometric cross section (CSC). At present, all these stations are equipped with chart pen devices for registration of water levels (H). The stations in Vidin, Ruse and Oryahovo – are second class as they are used for measurements of the elements H, Q, T and CSC. The remaining stations are Class III and they only register the position of the water level (H). Measurements of water levels are performed as follows: in Lom from 1937, in Novo Selo and Svishtov from 1938, in Ruse – 1939 and in Silistra – from 1946. The measurements of the water temperature began in 1941 in all stations, but for some of them (Svishtov, Rouse) these measurements can be dated back to 1937. All measured and recorded data is collected and archived the Executive Agency for Exploration and Management of the Danube River with the Ministry of Transport, which is located in Ruse.

TABLE 3.2-24: LIST OF HYDROLOGICAL STATIONS ON THE DANUBE RIVER IN THE REGION OF KOZLODUY NPP

N	Hydrological station at:	Distance to mouth	Area of water collection basin	Zero ground of the yard acc. to the Black Sea system – Varna	Zero ground of the yard acc. to the Baltic system – Kronstad	Opened in: (year)
		km	km^2	m	m	
1	Lom	743.3	588860	22.89	22.65	1911
2	Kozloduy	703.5	592500	22.00	21.77	1937
3	Oryahovo	678.0	607260	21.56	21.34	1924

Individual measurements and follow-up observations in different periods of time are also performed by Energoproekt AD, the Kozloduy NPP EAD and other organisations. Expeditionary measurements of hydrological elements are conducted by NIMH, UACG and other organisations. For the purposes of the above-mentioned EIA the available data from the sources shown below was used:

- the main hydrometric stations in the section at Oryahovo – ^{km} 678 and at Lom-^{km} 749.3;
- Observations on water levels at ^{km} 704 (EAEMDR) and at ^{km} 678 (Energoproekt AD);
- Data from expeditionary measurements during the period 1978 – 1991.

In the area of Kozloduy NPP regime surveys are conducted on water levels as follows:

- ^{km} 678 – HMS Oryahovo (EAEMDR – Ruse);
- ^{km} 687.50 – bank pump station (Kozloduy NPP);
- Data from expeditionary measurements during the period 1978 – 1991.

The report by Risk Engineering AD[46] noted that the information on the basic hydrometric characteristics is fairly complete, but it is until year 2003 for the Oryahovo HMS (only water levels, for water quantities – up to 1986) and for WR at the BPS-1 there is available basis for the period 1981-2011, but only for water levels, because obviously there are no measured quantities. Data on the maximum water levels for HMS Lom and Oryahovo are for the period starting in 1941. Previously there were no measurements of water quantities for these points. Information is also presented in the form of a database for water temperatures of HMS Oryahovo and of HMS Kozloduy, but it is up to 1990. Sources relating to the Belene project, show evidence of other Bulgarian and Romanian HMS (Svishtov,

[46] Study and determination of the location of the preferred site for the construction of the new nuclear power capacity at the site of the Kozloduy NPP EAD and the neighbouring territories - review of the studies - Ref. No. REL-1000-ST-001-2, January 2013.

Nikopol, Zimnich) which, provided certain aspects of the application of the statistical methods are observed, could be used to assess the situation at Kozloduy NPP.

In accordance with the requirements of the IAEA it is required to: "have all the available hydrological information and the same shall be checked for the presence of systematic errors and technical mistakes". The requirement "It is appropriate for this information to be stored in a data base for hydrometeorological data. Currently this is organized by the Department of Hydraulic Structures of the Kozloduy NPP.

The requirement "... particular attention shall be paid to clarifying the natural hydrological characteristics and the hydro-morphological characteristics of the river bed and the river terrace, the features of roughness, etc., and also to clarify the characteristics of the river course processes." is complied with in the report according to the available information and research. The absence of an updated bathymetric and topographic map of the river bed for the section of the Danube River in the region of Kozloduy NPP does not allow full hydraulic assessment of the passage capacity of the river bed at low and high water levels.

Extending the time lines of the Bulgarian stations to the earliest observations about the regime of the Danube River has taken place through the application of correlation and regression analysis and the use of point – analogue HMS Orshova (with observations of the water levels from 1840) and later, the HMS Drobeta Turnu – Severin (after commissioning of the water supply system of the Zhelezni Vrata I hydro complex in 1970-71).

The research includes the conclusion that the Zhelezni Vrata Hydro complex does not regulate the flow for periods longer than one week due to lack of regulating volumes. Therefore, their impact on the monthly and annual flow of the river is not significant.

3.2.1.8.3 Hydrological regime of the Danube River

The hydrological regime of the Danube River in the area of the Kozloduy NPP has been the subject of study of several hydrologic and hydrologic-engineering studies. These were carried out in 1967 with the conceptual design for the future power plant and the preparation of the detailed design (Volume Hydrology from 1972 and Volume Scientific organization of the production, labour and management (SOPLM) from May 1975). Later, in the performance of other hydrological jobs, data on the modes is updated as the calculation period is extended.

Taking into account the various studies we can identify some representative periods for the study of the hydrological regime of the Danube River in its lower course, where the Kozloduy NPP is located:

- 1956-1970 – period with no significant impact on flow conditions both in the local catchment area and in the main river bed adjacent to the area of the study, i.e. it can be accepted that this period is a period of natural formation conditions of the river flow;
- 1971-1984 – period for the construction of the Zhelezni Vrata I complex and accordingly influence on the regime characteristics of the flow of the Danube River in the lower course;

- 1984-2008 – a period with influence both on the Zhelezni Vrata I, and on the Zhelezni Vrata II on the flow conditions for the lower course of the Danube River;
- 1956-1980 – a period without significant impacts due to variations (changes) of climate;
- 1981-2012 – a period of significant impacts of variations (changes) of climate or of global climate changes.

In general the hydrological regime of the Danube River can be characterized as follows:

- → The river has mixed snow and rain **feeding**, more pronounced in the upper and middle course, and less pronounced in the lower river course. Thus, the Lower Danube River spring high waters are observed during March-May (Spring waters), rarely in June, and then quickly comes the summer low water, pronounced in the period from August to October, and rarely in November.
- → **The high waters are typical of the spring high waters** (April-May) and in some years in very cold winters and freezing of the river, with present water uplifting, there are also registered catastrophically high water levels. The years with high spring water were 1944, 1965, 1970, 1979, 1980, 1981, and with winter maxima in 1942, 1954, 1974.
- → **During July to November,** regardless of the general reduction in water highs as a result of precipitation, **there are alternating separate tidal waves**, varying in intensity and size.
- → **Autumn low waters is usually observed in October-November**, with a most pronounced minimum in October. Low water levels are recorded during the winter months (January-February) during major cold periods.

3.2.1.8.4 Water quantities

The analysis of the average multi annum flow in WR Oryahovo which is used as analogue shows that for the period 1941-1980, there is Q_{av} = 5 847 m^3/s and a coefficient of variation indicating the deviation in terms of average values – C_v = 0.18. It should be noted that the flow of the Danube River in the multi-annum period ranged from 0.18 – 0.20, which speaks of uniformity.

Variation of the flow of the Danube River is defined as the highest for the months of low water levels (August to January). The most stable flow (the amount of the water passing through) of the river is during the high water period (February-July). The annual water quantity for the river is defined, with 95% probability, which is about 4300 m^3/s.

The minimum water levels with provision of 99% and C_v = 0.246 are: Qmin = 1444 m^3/s, and at provision of 90% – Qmin = 1804 m^3/s. The minimum water levels at different provision levels are shown in **Table 3.2-25**.

TABLE 3.2-25: AVERAGE ANNUAL MINIMUM WATER QUANTITY IN THE DANUBE RIVER FOR WATER REPORT POINT ORYAHOVO

Provision, P%	Danube River, Q m^3/s
Minimum at Cv = 0.246	
99%	1444
97%	1558
95%	1666
90%	1804
Minimum at contribution interval 95%	
99%	1046
97%	1249
95%	1422
90%	1613

Minimum water levels – lower limit with confidence interval of 95% at a provision of 99% can reach Q_{min} = 1046 m^3/s, and at 90% – they are Qmin = 1613 m^3/s.

Maximum water quantities at provision of 0.01% and C_v = 0.18 are: Q_{max} = 19 309 m^3/s, and at provision of 5% – Q_{max} = 13 981 m^3/s. The maximum water levels at different provision levels are shown in **Table 3.2-26.**

TABLE 3.2-26: AVERAGE ANNUAL MAXIMUM WATER QUANTITY IN THE DANUBE RIVER FOR DIFFERENT WATER PROVISION LEVELS FOR WATER REPORT POINT ORYAHOVO

Provision, P%	Danube River, Q m^3/s
Maximum at Cv = 0.18	
0.01%	19309
0.1%	17572
1%	15606
5%	13981
Minimum at confidence interval 95%	
0.01%	1046
0.1%	1249
1%	1422

Maximum water levels – an upper limit with confidence interval of 95%, and with provision of 0.01% may reach Q_{max} = 21 714 m^3/s, and at provision of 1% they are Q_{max} = 17 229 m^3/s.

Figure 3.2-53 shows a comparison between recorded water levels at stations Lom and Oryahovo for the period 2002 – 2012. We can see that the period cannot be identified as a clear trend for change.

Average annual water quantity, Year, Lom, Oryahovo

FIGURE 3.2-53: Internal annual distribution of the average multi-annum monthly water levels for WP BPS1 for the period 2002-2012.

3.2.1.8.5 Water levels

The determination of water levels in various extreme conditions is of paramount importance for the security of the power plant. Elevation 0.00 for the plant site is accepted as elevation +35.00 according to the Baltic altitude system.

In determining the water levels in the river we have considered periods from 1941-1980[47] for the maximum water levels and the period 1937-1986 – for minimum water of the two water recording points at Oryahovo and at Kozloduy.

For WR Kozloduy for the period 1981-1985, the highest standing water was observed in the month of March 1981 – H 875 cm. The corresponding value for Oryahovo is H = 786 cm.

The second highest standing water level at Kozloduy is H = 825 cm in May 1980, which is due to the spring high waters. The corresponding water standing for Oryahovo is H = 780 cm, also in May 1980.

During the summer and autumn low waters, the lowest water standing in WR Kozloduy is H = 11 cm, observed in October 1947, and in WR Oryahovo, it is H = 75 cm, also observed during the same month.

For WR Kozloduy for the studied period the lowest standing water was observed in the month of January 1954, H -2 cm and the corresponding value for Oryahovo is H = – 100 cm.

[47] Study and determination of the location of the preferred site for the construction of the new nuclear power capacity at the site of the Kozloduy NPP EAD and the neighbouring territories - review of the studies - Ref. No. REL-1000-ST-001-2, January 2013.

The average multi annum water standing for WR Kozloduy is H=387 cm, and this for WR Oryahovo is H=296 cm.

These characteristics of water levels of water recording points are shown in **Table 3.2-27** and **Table 3.2-28**.

TABLE 3.2-27: WATER LEVELS FOR THE DANUBE RIVER AT DIFFERENT LEVELS OF PROVISION

Provision, P%	Danube River, H cm	Danube River, level, m
Minimum 1937-1986 at Cv = 1.41		
99%	-88	20.46
97%	-68	20.66
95%	-53	20.81
90%	-34	21.00
Maximum 1941-1986 at Cv = 0.14		
0.01%	942	30.76
0.1%	886	30.20
1%	818	29.52
5%	758	28.92
10%	726	28.60

TABLE 3.2-28: WATER LEVELS FOR THE DANUBE RIVER AT DIFFERENT LEVELS OF PROVISION AT THE RANGE OF THE KOZLODUY NPP

Provision, P%	Absolute level of the Danube River, m
Minimum at Cv = 1.41	
99%	20.83
97%	21.06
95%	21.20
90%	21.39
Maximum at Cv = 0.14	
0.01%	31.08
0.1%	30.53
1%	29.86

For the range of the Kozloduy NPP site are shown the water levels with a provision of 99-90% and 0.01-1%. The results are shown in **Table 3.2-28 –** the minimum at 99% is 20.83 m, and the maximum for provision of 0.01% is 31.08 m.

In[48] are shown the figures for maximum water levels in water intake facilities of Kozloduy NPP at km 687 defined in the detailed design (Volume Hydrology from 1972 and Volume SOPLM) – **Table 3.2-29**.

TABLE 3.2-29: MAXIMUM WATER LEVELS OF THE DANUBE RIVER AT KM 687 FROM THE TECHNICAL DESIGN.

Probability for exceeding values	1%	0.1%	0.01%
Water level	29.93	30.87	31.73

The thorough safety reassessment of Kozloduy NPP in light of the events of Fukushima (stress tests)[49] confirmed the maximum water levels in natural mode of operation – **Table 3.2-30**.

TABLE 3.2-30: MAXIMUM WATER LEVELS OF THE DANUBE RIVER AT KM 687.

	1%	0.1%	0.01%
Water level	30.58	31.47	32.23

In Energoproekt study for Reassessment of the maximum level of flooding. Part I, December 1991, and Part II – March 1993, the maximum water levels in case of destruction of the Zhelezni Vrata I and II hydro units. Taking into account the overflow and the destruction of dikes and the accumulation of high wave flooded plains the maximum level is 31.43 m, with 0.80 m lower than the design level of 32.23 m.

In 2010, a study was conducted in conjunction with the design of the Belene NPP in order to determine the hydrologic and hydraulic characteristics of the Danube River[50]. According to the study the maximum water level (MWL) in Kozloduy NPP in case of catastrophic wave caused by the destruction of the Zhelezni Vrata I and II hydro units is 32.53 m. This MWL is reached 28 hours and 20 minutes after the alleged destruction of the Zhelezni Vrata I and II hydro units and will last approximately 2 hours.

The maximum water levels in the coincidence of events with low provision could be defined as follows:

MWL – 32.53 + 0.1 + 0.30 = 32.93 m,

[48] Study and determination of the location of the preferred site for the construction of the new nuclear power capacity at the site of the Kozloduy NPP EAD and the neighbouring territories - review of the studies - Ref. No. REL-1000-ST-001-2, January 2013.

[49] European Stress Tests for nuclear power plants - National Report for Bulgaria, NRA, December 2011.

[50] Report on Contract No. 511/14.12.2005, task: Assessment of hydrometeorological characteristics for the design of the Belene NNP site.

where the approved additives are: local rainfall of 0.10 m and waves of 0.30 m

MWL for the Kozloduy NPP site is set at 32.93 m at the current state of the hydraulic structures on the Danube River. The scenario in which this water level occurs is in case of sudden and consistently breaking of the Zhelezni Vrata I and II hydro units by overlapping of two waves and water quantity of 10 000 m^3/s.

It follows from the above that all subsequent analyzes of the plant safety will be carried out for **MWL = 32.93m**.

The natural water levels in the technical design of Kozloduy NPP are derived empirically with data from the observations on which they are based, with provision greater than 1%. Based on extrapolation of the theoretical function of the distribution probabilities the water levels were obtained with probability for exceeding values 0.5%, 0.1% and 0.01%. The study of the maximum water levels at these low probabilities is accompanied by overflow of the protective dikes, which is likely to start upward along the river, at the Timok River, the town of Vidin, Orsoya and Tsibar. The same will happen with the Romanian dikes, as it is specified in the research from 2010[51]. The dependency of water levels for the probabilities where the level exceeds the elevation of the dike (32.00 m of the Kozloduy NPP) will differ from the water levels with larger probabilities and lower levels, precisely because of the overflow of the protection dikes which changes drastically the flood space. Regarding the natural waters in the Danube River with provision of 10^{-5} to 10^{-7} the estimated water levels are shown in **Table 3.2-31**.

TABLE 3.2-31: ESTIMATED WATER LEVELS FOR THE NATURAL WATERS IN THE DANUBE RIVER AT KM 687.

Probability for exceeding values	10^{-5}	10^{-6}	10^{-7}
Water level	32.40	32.60	32.70

On the basis of the designated water levels for the natural regime of the Danube River we can evaluate also the combination of the two events – natural extreme water levels for low probabilities (10^{-5} to 10^{-7}) and breaking of the walls of Zhelezni Vrata I and II hydro units (scenario 1). It should be noted that the combination of these two scenarios will lead to an event with very low occurrence probability. The estimated water level is shown in **Table 3.2-32**.

TABLE 3.2-32: ESTIMATED WATER LEVELS (SCENARIO 1) OF THE DANUBE RIVER AT KM 687.

Probability for exceeding values	10^{-5}	10^{-6}	10^{-7}
Water level	32.98	33.26	33.42

[51] Determination of the hydrological and hydraulic characteristics of the Danube River, related to the design, construction and operation of the Belene NPP, UACG, Part 2.2., Hydrology

The analysis of the distribution of the monthly average water levels shows that the highest monthly average water levels tend to occur in the spring months between April and June (**Figure 3.2-57**).

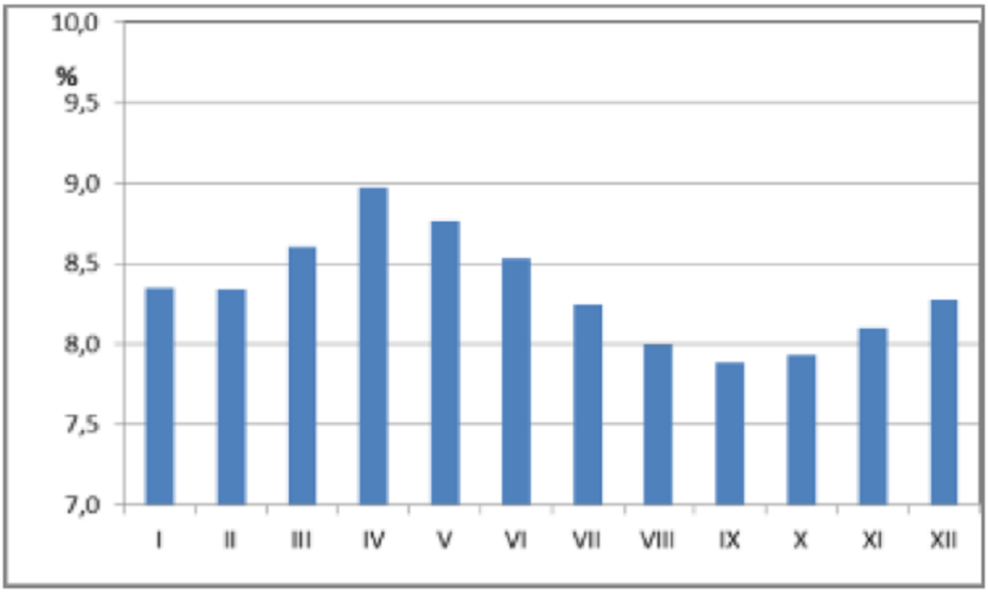


FIGURE 3.2-54: INTERNAL ANNUAL DISTRIBUTION OF THE AVERAGE MULTI ANNUM MONTHLY WATER LEVELS FOR WP BPS1 FOR THE PERIOD 1980-2011

Conclusion: **In all postulated cases involving extreme increase in the level of the Danube River, the MWL level in case of flooding below level 0.00 at the site, which confirms the identification of the plant site as not susceptible to flooding.**

3.2.1.8.6 Key curve at the WP at the Kozloduy NPP

Key curves are essential for the regime of the river in a given area. The determination thereof requires an extremely precise and volumetric measurements of the water levels, the water quantity and the condition of the river profile. The representativeness and the dynamics of the key curves along the Danube River have been the subject of numerous scientific studies. The stability of the key curves is different for the Danube River hydrometric stations and is of great importance for all studies on the indicators of the river current.

Usually the key curve over a period of one year is the same for the Danube River. The number of key curves in a cross-section of the river depends on many factors, including the stability of the bed and the banks, seasonal phenomena, etc. The number of measurements of "standing waters – water quantity" for one curve depends on the hydrological regime, the available data and technical equipment. The number of measured pairs "water standing – water quantity for the Danube River stations ranges from 8 to 20 years. The water level is measured by the method of "speed – area", and the flow speed can be measured with weighted hydrometric propeller. The hydrometric sections are benchmarked. The change of water levels for the period of measurement of rate of flow in a speed vertical must be less than 5 cm (to determine the key curves under steady conditions). The cross section is taken during the measurement of the volume of water, and also under steady conditions using an acoustic instrument. The final version of the key curve is tabulated, and the water levels are given for every centimetre of standing water. Since 1990, key curves for all paired hydrometric stations in the common Bulgarian – Romanian section of the Danube River are regularly compared by the relevant institutions of the two countries.

The standard error of the key curves of the Danube River is different in the different parts of the range of variation of water levels. At 95% confidence interval for the water quantities less than 4000 m^3/s, and for the range of water levels quantities over 8000 m^3/s, the standard error of the key curves is greater than for the average water quantities. This fact is reasonable because the number of measured quantities of water in medium water (between 4000 and 8000 m^3/s is greater than in the low and high water levels).

Key curves for the Danube River hydrometric stations and the closest stations for the tributaries are typical changing curves, and the river bed is changing (alluvial and diluvial).

Key curves for the fixed mode of motion is an integral indicator of current conditions in the lower section of the river bed. The conditions of flow motions are closely related to the river morphological processes. The normal trend of change of the natural conditions for key curves in the lower section must be positive, i.e. they need to increase, to rise. This is typical of lowland rivers such as the Danube River in the researched area. For the period 1941-1970, the dynamics of change of the key curves in the Bulgarian section of the Danube River are normal, i.e. corresponding to the natural state of the flow. For this period, key curves are relatively stable. After 1971 key curves begin to descend. It should be noted that the process of abating of the key curves for the section from Novo Selo to Svishtov stopped after 2000. Probably the process of abatement of the key curves continues for the section under Svishtov. The overall assessment of the abatement of the key curves of the Danube River for the period 1971-1994 is shown in **Table 3.2-33**.

TABLE 3.2-33: CHANGE (ABATEMENT) OF KEY CURVES FOR HYDROMETRIC STATIONS OF THE DANUBE RIVER IN THE SECTION FROM KM 865 TO KM 375 DURING THE PERIOD 1971-1994 IN CM. (PHARE PROJECT MORPHOLOGICAL CHANGES AND ABATEMENT OF THEIR NEGATIVE EFFECTS ON A SELECTED SECTION OF THE DANUBE RIVER DOWNSTREAM (ST.MODEV, 1997-2000)

Station	Low water Q < 4000 m^3/s	Medium water 4000 < Q < 8000 m^3/s	High water Q > 8000 m^3/s
Novo Selo	-60 -40	-40 -18	-18 -10
Svishtov	-50 -48	-48 -52	-52 -56
Silistra	-37 -45	-45 -36	-36 -29

The above table was prepared on the grounds of the data for key curves[52] for the Lower Danube River. They are prepared on the basis of cross sections for the hydrometric stations in alluvial sediments, as are all hydrometric sections.

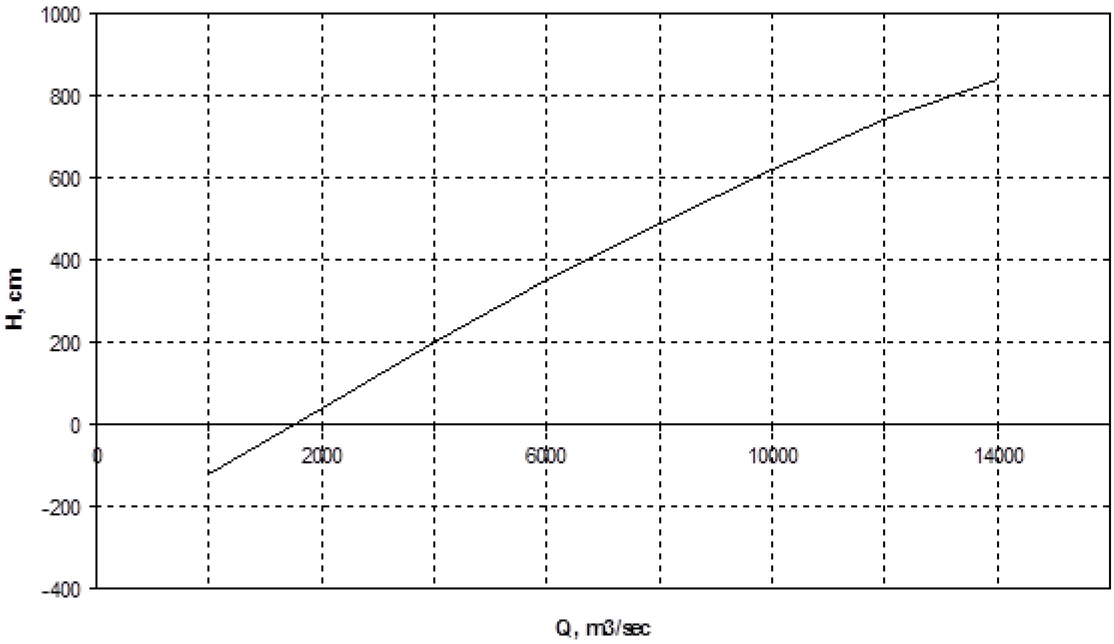


FIGURE 3.2-55: KEY CURVE OF THE DANUBE RIVER AT THE RANGE OF THE KOZLODUY NPP“ [53]

The specified documents show water levels and quantities presenting also key curves of the range of the NPP site. Hydrometric data from WR Oryahovo was used for the construction thereof for the period 1946-1986.

The following function was used: $Q = A \times (H + H_0 + H_{tr}) \times B$

Hydraulic gradient in the area of WR Oryahovo – 687 km, and the correlation between the observed absolute elevations of water levels and the respective observed water levels in WR Oryahovo were used for the transfer and construction of the key curve in the site range. The resulting key curves are shown in **Figure 3.2-55**. This Figure shows the deviations which are within the acceptable limits.

It can be seen from the figure that for costs around Q = 2 000 m^3/s in the river (close to the minimum) there is a fixed relative level H = 0 cm. At 4 000 m^3/s, it is about 200 cm, at 8 000 m^3/s it is 500 cm, reaching 1 000 cm at 16 000 m^3/s.

[52] PHARE Project Morphological Changes and abatement of their negative effects on a selected section of the Danube River Downstream (St. Modev, 1997-2000).

[53] Study and determination of the location of the preferred site for the construction of the new nuclear power capacity at the site of the Kozloduy NPP EAD and the neighbouring territories - review of the studies - Ref. No. REL-1000-ST-001-2, January 2013.

At an earlier stage in the designing of the Kozloduy NPP and especially for dimensioning and construction of the facilities of the technical water supply for Kozloduy NPP (Volume Hydrology from 1972 and Volume SOPLM from 05.1975), the maximum water levels /MWL/ were determined for the Danube River at the water intake facilities at the Kozloduy NPP at km 687.00. Typical elevations and water levels of the Danube River (km 687.00) in natural mode are shown in **Table 3.2-34.**

TABLE 3.2-34: DIMENSIONAL ELEVATIONS AND WATER QUANTITIES FOR THE DANUBE RIVER (KM 687.00) AT THE WATER INTAKE FACILITIES OF THE KOZLODUY NPP

No.	Provision [%]	Water quantity [m³/s]	Water quantity in the Danube River
1	99	1120	20.50
2	97	1290	20.70
3	Water levels with annual repetition	5790	24.77
4		5880	24.87
5		6260	25.17
6		6700	25.48
7	50	10600	27.97
8	10	13350	29.30
9	5	14500	29.70
10	2	15800	30.20
11	1	16700	30.52
12	0,5	17500	30.85
13	0,1	19300	31.47
14	0,01	21620	32.23

Volume SOPLM from May 1975 the maximum water levels are set at:

- → p= 1 % w.l. = 29.93 m
- → p= 0.1 % w.l. = 30.87 m
- → p= 0.01 % w.l. = 31.73 m

Determining MWL in the same document is performed by considering the following cases and conditions:

❶ **correction of the river at Bulgarian and partly Romanian coast:**

- → p= 1 % w.l. = 30.05 m
- → p= 0.1 % w.l. = 30.47 m
- → p= 0.01 % w.l. = 30.70 m

❷ **for increase of the dikes of the Bulgarian bank and completion of the dikes on the Romanian bank:**

- → p= 1 % w.l. = 31.35 m
- → p= 0.1 % w.l. = 32.10 m

→ p= 0.01 % w.l. = 32.50 m

Conclusion: It is obvious that even at high water with a provision of exceeding values 0.01% (repetition period 10 000 years) the level of high water will not exceed level 32.50, which means that the selected level for the plant site – 35.00, can not be reached.

3.2.1.8.7 Characteristics of the deposit flow

In a number of previous studies an analysis was performed of the data for the deposit flow. Particular attention is paid to the representativeness of the data for the deposit flow, the multi annum features of the deposit flow – floating and bottom sediments, and their distribution throughout the annual drain cycle. The changes in the deposit flow were analysed since they are the result of various technogenic impacts on the Danube River – over the area of the Kozloduy NPP. It should be noted that up to 1995 there is regular measurement of quantities of deposits few times during the year. This allows us to determine the relationship between a single deposit flow at the point from which the sample is taken and the average amount of deposit for the whole cross-section. After 1995, due to lack of dedicated funding these measurements were not performed and past results were accepted which is incorrect.

Problems of the deposit flow are represented most fully in the project under the PHARE program – Morphological Changes and abatement of their Negative Effects on a selected section of the Danube River Downstream, 1997-2000, which are summarized in **Table 3.2-35**

TABLE 3.2-35: COMMON CORRELATION COEFFICIENTS FOR PERIOD 1978-1995

Station	T.Magulare (Ro) km 597.0	Svishtov (Bg) km 554.3	Zimnich (Ro) km 553.65
1	1.000	0.824	0.856
2	0.824	1.000	0.797
3	0.856	0.797	1.000

(Ro) – according to data from Romania; (Bg) – according to data from Bulgaria

From the above table it is evident that, as it would be expected, the correlation between the Romanian time series is higher than in the Bulgarian, but in the second case this is statistically significant.

The analysis of the data in the above project shows that the deposit flow data from the Romanian stations is greater than assessed as per the measured data from the Bulgarian stations. Obviously, there are some differences in the methods for collecting information on deposit flow. Recent analyses demonstrate that the data from Svishtov correlate well with the data from Ruse and from Georgiou than with the data from Zimnich. Given the above, in this study we focus and examine the deposit flow only using the data from the Bulgarian stations. It should also be noted that the above is not 100% proof of the quality of the data of the Romanian and Bulgarian countries, but there is a need for specialized research only on the quality of data on both sides of the deposit flow of the Danube River. It should be noted that the maximum length of the time series of the deposit flow can be obtained for the period 1956-1995. In 1956 sampling began for testing the amount of floating deposits, and in 1995 it was officially discontinued. Maybe samples are taken from points close to the river bank by voluntary observers of the NIMH, but no special government funding for this activity will be available after 1995. Up to 1995 the study of deposit flows was funded by the Bulgarian energy sector.

During the period 1985-1995, the volume of water in the Danube River at Novo Selo decreased by 15.4 % while the volume of suspended sediments decreased by 76.8 %. In Svishtov this reduction is respectively 14.3 %, and 52.1 %. It is interesting to note that while the decrease in the average concentration of deposits at Novo Selo was 4.2 %, and at Silistra – 11.2 %, in Svishtov with its central position there is a decrease of about 8.5 %. Therefore the entire lower section of the Danube River has erosion processes.

TABLE 3.2-36: DISTRIBUTION OF SUSPENDED SEDIMENT ALONG THE COMMON BULGARIAN-ROMANIAN SECTION

Period-	Romanian tributaries		Bulgarian tributaries		Total tributaries		At Novo Selo	Particip. Rom. tributaries	Particip. Bulg. tributaries	Total tributaries
	m³/s	%	m³/s	%	m³/s	%	m³/s	%	%	%
1956 – 1995	350.157	80.3	85.651	19.7	435.808	100.0	-	-	-	-
1956 – 1970	438.633	76.2	137.101	23.8	575.734	100.0	1189.70	36.87	11.52	48.39
1971 – 1984	456.184	86.3	72.644	13.7	528.828	100.0	581.60	78.44	12.49	90.93
1985 – 1995	94.566	74.1	32.049	25.9	127.615	100.0	276.10	34.25	11.61	45.86
1956 – 1981	474.943	79.7	121.065	20.3	596.008	100.0	803.30	59.12	15.07	74.19
1982 – 1995	118.408	76.4	36.604	23.6	155.012	100.0	305.70	38.73	11.97	50.70

For the whole sector from Novo Selo to Silistra the contribution of the tributaries in the formation of the deposit flow of the Danube River in the period 1956 – 1970 was 48.3 % and in the period 1985-1995 it was decreased by 46 %.

The above study leads to the following serious conclusions:

- Under natural conditions (1956-1970) the tributaries of the Danube River formed 8.01 % of the total flow of the river and 2.67 % are from the Bulgarian tributaries and 5.34 % from the Romanian, while tributaries form 48 % of the deposit flow of which 37 % is from the Romanian tributaries and 11 % – from the Bulgarian;
- During the period 1971-1984, (the construction of the Zhelezni Vrata I and II) the river flows decreased slightly, while the deposit flow reduced by 51 %. For the same period the flow of water from the Romanian tributaries increased by 13 % and by was reduced by 5 % from the Bulgarian. At the same time, the inflow of debris from the Romanian tributaries is increased by 47 %, and from the Bulgarian – decreases

to 47 %. The total inflow of deposits from the inner tributaries of the section constitute 91 % of the deposit flows entering the station at Novo Selo;

- During the period 1985-1995, the deposit flow of the Danube River at Novo Selo is only 23 % of the deposit flow for the period 1956-1970.

The distribution of suspended sediments along the Danube River was investigated by Pechinov, Modev, Guergov, Raynov and other. **Table 3.2-36** shows that there are significant differences in the estimates of the amount of deposits as shown in the Bulgarian and Romanian data.

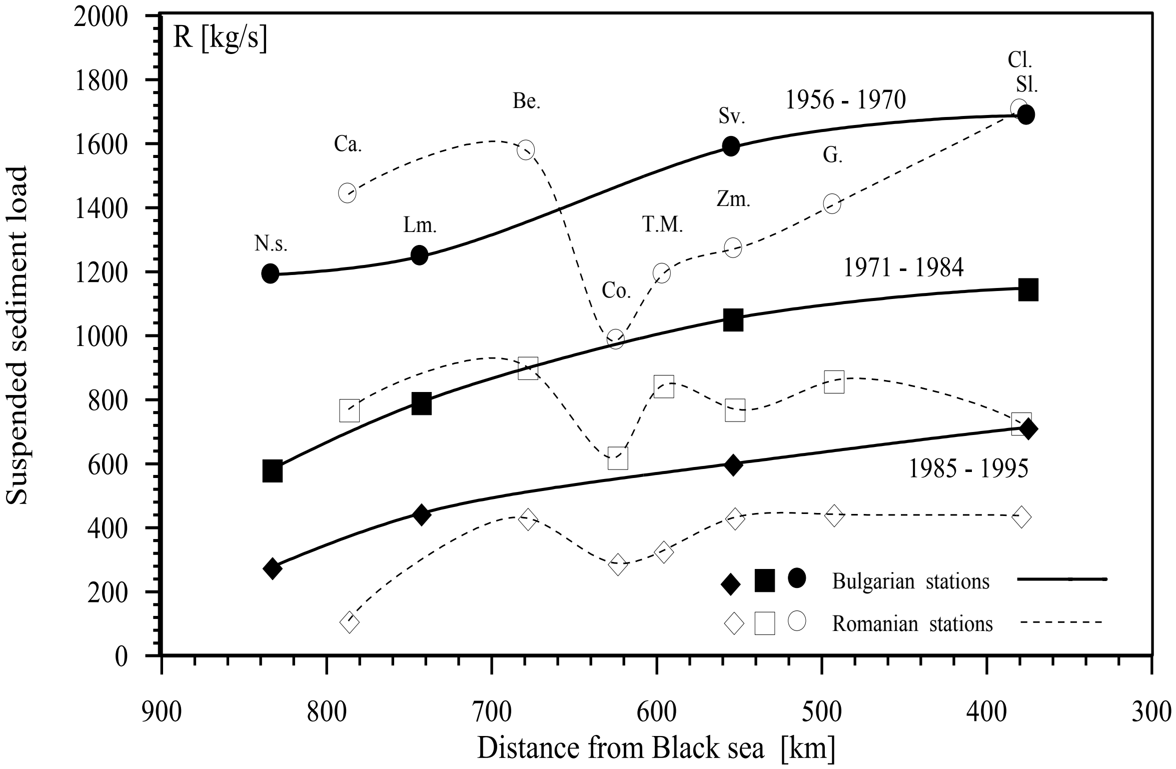


FIGURE 3.2-56: DISTRIBUTION OF THE QUANTITY OF SUSPENDED SEDIMENTS ALONG THE DANUBE RIVER.

Knowing the particle size distribution of the sediments is also essential for the calculation of the suspended flow, especially for the calculation of the river bed deformations.

Data from the measurements in the lower Danube River for the composition of suspended sediments are very few. For the Republic of Bulgaria these include mainly data from expeditionary measurements of Assoc. Prof. Dr. Eng D. Pechinov (1964-1994) as well as data published by UNESCO. This data is summarized in **Table 3.2-37**:

TABLE 3.2-37: PARTICLE SIZE OF THE SUSPENDED SEDIMENTS IN THE SECTION AT SVISHTOV.

Section	km	Date	Fractions [mm]					Average diameter
			>0.5	0.5-0.1	0.1-0.05	0.05-0.01	<0.01	[mm]
Svishtov	554	14.V.1964	-	17	26	27	20	0.08
Svishtov	554	09.VI.1965	1	20	17	32	30	0.09
Svishtov	554	29.IV.1976	-	28	7	21	44	0.10
Beket-Nikopol		21.IV.1969	-	-	15	58	27	0.03
Beket-Nikopol		17.X.1970	-	3	11	55	31	0.04
Beket-Nikopol		8.VI.1971	-	1	9	61	29	0.03
Beket-Nikopol		14.VI.1972	-	-	11	53	36	0.03
Nikopol	597	09.XI.1982	5	17	5	34	39	0.10

From the above table it is evident that the average diameter of the suspended sediments varies strongly between 0.03 – 0.10 mm. Fractions with diameter 0.02-0.15 mm are predominant. The average diameter of the suspended sediments of all measurements in the Bulgarian section of the Danube River was calculated by Pechinov in 1988 as 0.065 mm.

Conclusion: **Overall the suspended flow in the Danube River does not endanger the work of the BPS and the canals of the Kozloduy NPP. A periodic cleaning of the intake canal of the BPS is required.**

3.2.2 GROUNDWATER

The Kozloduy NPP site, the 4 proposed alternative sites and the adjacent border territories cover the following water basins, according to the Danube River water management RBMP:

- **Ground water basin, identified by code BG1G0000Qpl005** – porous water of the Quaternary – Kozloduy lowlands.
- **Ground water basin, identified by code BG1G0000Qpl023** – porous water of the Quaternary – between the Lom and Iskar Rivers.
- **Ground water basin, identified by code BG1G00000N2034 –** porous water of the Neogene – Lom and Pleven depression.

In the delineation of the groundwater water basins the criteria was taken into account that was applied in the Dutch approach for Strengthening of the capacity and enhancement of the national groundwater monitoring system of Bulgaria towards implementation of the Water Framework Directive 2000/60/EC, which was carried out by a team from the Hydrogeology section at the Geological Institute of the Bulgarian Academy of Sciences, on the basis of a contract with the Dutch Company ARCADIS EUROCONSULT BV. Identification was performed by the EEA in cooperation with the Basin Directorate. We used geological map (GIS vector, M 1:100, 000), hydrogeological maps (GIS, M 1:500 000 scalar, M 1:200 000 for individual water rich areas of the country – M 1:25 000).

The characterization of water basins is a requirement of the Water Framework Directive 2000/60/EC, based on expert accepted criteria at national level for the assessment of the load and the impact (IMPRESS review). These are taken from the criteria developed by the ICPDR, and are adapted to the national conditions. For the evaluation we used the Manual for Implementing the Water Framework Directive, prepared under the Twinning Project BG 03/IB-EN-02.

The assessment of the protective effect of the covering layers of groundwater bodies is performed on the basis of an expert assessment of the characteristics of the geological units. The analysis is based on the rate of detection of the ground water body on the terrain and the loads of human activity on the excavated parts of the bodies. Three separate FTP classes have been – with favourable, intermediate and adverse effect for the covering layers.

The three bodies falling within the Kozloduy NPP territory are identified as areas water protection zones from which water is extracted for human consumption with an average daily flow rate of 10 m^3/d or used to supply water to more than 50 people in accordance with art. 7, paragraph 1 of Directive 2000/60/EC and art. 119 of the Water Act.

3.2.2.1 GROUNDWATER BASINS

3.2.2.1.1 Groundwater basin, identified by code BG1G0000Qpl005 – porous water from the Quaternary – the Kozloduy lowlands.

This groundwater body is located in the E-NE part of the Kozloduy NPP site and the border areas. It also includes the non-flood terrace of the Danube River – with Pleistocene age and the floodplain – with Holocene age. Both terraces form a common Quaternary aquifer in lithological structure involving quaternary alluvial deposits, especially in gravel-sandy sedimentary rocks from the Paleo bed of the Danube River.

The Kozloduy lowland encompasses the banks of the Danube River from km 685 to km 699. Having length of 14 km and width of 1 to 3.5 km – its total area totals 31 km^2. The average altitude of the lowlands (flood plain) is 27.7 m. The first non-flood terrace has relative height 5-7 m and is preserved in the western part, close to the town of Kozloduy and in the middle of the lowlands. In the eastern part (under the village of Harlets) monitoring is taking place for two non-flood terraces with relative height of 20-25 m and 40-45 m. Geostructurally the lowlands fall in the middle of the Lom – Pleven depression.

The alluvial deposits of the Danube River and the Neogene sediments laying below have impact on the hydrogeological characteristics of the lowland. The flooded river terrace has a two-layer structure with a total thickness of 15-16 m. The lower gravel-sand layer has an average thickness of 7 m. At the base of the terrace, in the west part, there are clay layers (Brusartsi Formation), and in the central and eastern parts these are missing, so that the terrace is positioned on the sands of the Archar Formation, forming a common aquifer. The collectors of porous groundwater are gravels, sands, clays and sandy clays, covered by sandy clays and clays. Groundwater is non-pressure type.

The following characteristics are identified for the water body: average thickness of GWB is 13 m, average water conductivity 1155 m^2/d, average filtration coefficient of 89 m/d, average groundwater flow module 4 l/s.km^2, natural resources 160 l/s, size of the flooding area 39 km^2. The direction and rate of exchange with the Danube River is direct. According to the performed assessment for the chemical and quantitative status, the GWB is defined as being at risk. There is established pollution of Fe and Cl resulting from human activity influence on the chemical status of the GWB. According to the RBMP, the protective effect of the coverage layers is distributed as follows 10 % – average and 90 % – poor.

Loess materials serve as a top of the Quaternary aquifer in the non-flood terrace (sandy loess, clay loess and loess-like clay), and for the flood plain – powder sandy clays.

The main equipment of Kozloduy NPP is on the non-flood terrace of the Danube River. The average elevation of the terrain for units 1 ÷ 4 is 35.00 m, and for units 5 and 6 it is 36.50 m. In lithostratigraphic terms there are two layers, top to bottom in the non-flood terrace:

- ✓ The first (top) layer consists of loess materials (sandy loess, clay loess and loess-like clay). It has a lower water permeability. In the western and southern part it is dominated by sandy loess and in the central parts loess is developed with its three lithological variations. Its thickness varies from 14-15 m to 11-13 m height, and respectively levels from 25-23 to 24-22 m;
- ✓ The second (lower) layer consists of gravel-gravey-sandy alluvial sediments with widespread Quaternary aquifers. Its thickness varies from 1-2 m to 10-11 m, an average of 6-7 m and respectively levels 17-10 m.

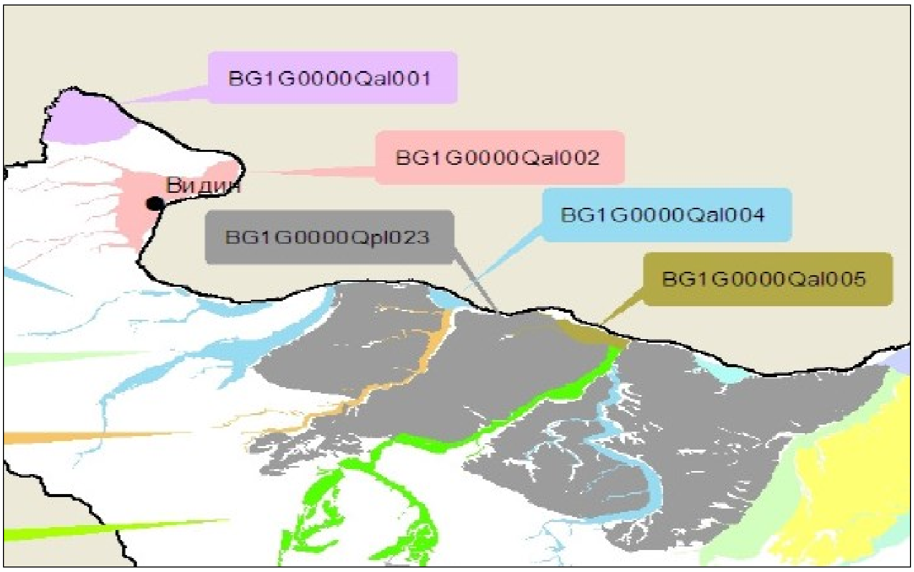


FIGURE 3.2-57: GROUNDWATER WATER BASINS – QUATERNARY LAYER, LOCATED ON THE TERRITORY OF THE KOZLODUY NPP, ACCORDING TO THE DANUBE REGION FOR WATER MANAGEMENT OF RBMP

Survey works in 1967-1970, and in 1978-1980, related with the construction of the EP-1 and EP-2, no groundwater was not identified in loess materials. Boreholes were made in dry conditions by hand drills this is how it was found that the occurrence and the level of groundwater from the Quaternary aquifer varies from 9.60 to 10.50 m, respectively for levels 26 to 27 and between 10.60 – 12.50 m, corresponding to levels 24.50-22.50.

This indicates that the water level of the groundwater occurs a little above the water saturated gravels and sands in the loess materials so that due to its hydraulic character the aquifer is a semi-pressure aquifer. The difference between the depths of the spreading of the water saturated rocks and the occurrence of the water level, indirectly establishes the magnitude of capillary rise in the loess materials, which varies between 1.20 – 1.60 m.

To determine the filtration characteristics of the Quaternary aquifer, filtration works were carried out on test plots with water supply and observation boreholes. The results of these tests are as follows:

- ✓ for the region of units 1 ÷ 4 the filtration coefficient changes from 45 m/d to 100 m/d, average K = 70 m/d, and respectively, the coefficient of conductivity T = 500 m^2/d;
- ✓ for the region of units 5 and 6, the filtration coefficient changes from 45 to 135 m/d, average K = 100 m/d, and respectively T = 700 m^2/d.

The increase of values of filtration indicators from east to west is due to a change in the grain size of gravel-sand sediments, their better washability, flooding with groundwater from the west from the flood plain in case of high water levels of the Danube River and from sandy loess that in the western part represents the top of the aquifer. The water exchange coefficient of the Quaternary aquifer is from 0.004 to 0.007, and the coefficient of gravitational water exchange of the aquifer rocks – from 0.15 to 0.2. The average values for the filtration coefficient of the individual lithological variations are shown in **Table 3.2-38.**

TABLE 3.2-38: SUMMARISED DATA FOR THE FILTRATION COEFFICIENT OF THE LITHOLOGICAL VARIETIES, FORMING THE TERRAIN OF THE NPP (STUDY BY ENERGOPROJECT, 1967-1980)

Lithological varieties	Filtration coefficient, m/d		
	From	To	Average
Gravel-sand sediments	45	170	90
Sand with various grain size	5	20	10
Sand – fine grain	2	10	5
Loess like sand	3	5	4
Sandy loess	1	2.5	1.5
Clayey loess	0.3	0.4	0.20
Loess like clay	0.1	0.2	0.15
Pliocene sands	0.5	2	0.50

Regime monitoring and the map of hydroizohipses prepared during the studies and indicate direction of the flooding of the flood plain from the west, south-west to the east northeast. To the west there are the higher filtration indicators of the aquifer. The hydraulic gradient in the vicinity of the site is from 0.006 to 0.01.

The Quaternary aquifer receives flooding from several places:

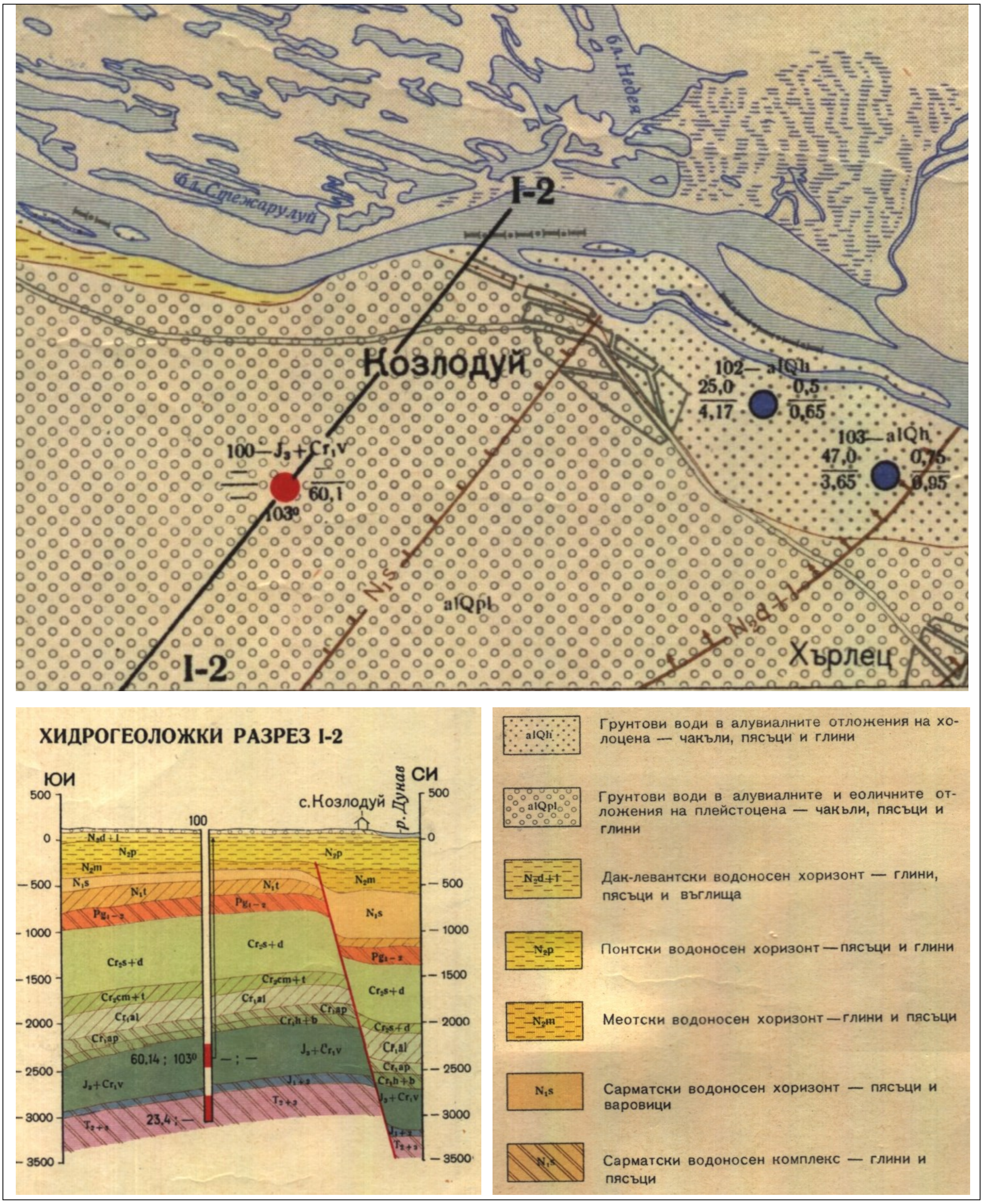
- ✓ from the south slope of the sub-loess gravel;
- ✓ from the west of the flood plain at high water levels on the Danube River;
- ✓ from the area of infiltration during rainfall;
- ✓ from the depth and from the aquifers – Brusartsi Formation sands;
- ✓ in the places in direct contact with the gravel aquifer.

Drainage of the aquifer is implemented as follows:

- ✓ drainage to the flood plain and to the drainage canals therein;
- ✓ drainage into the Danube River at low water levels of the river.

The key factors affecting the groundwater regime of the Quaternary aquifer of the Kozloduy lowland are the Danube River and the hydro-technical and irrigation facilities built into it. Near the river (500 m) the impact is most significant. Change in the water level of the groundwater follows the changes of the level of the river. By moving away from the river (up to 2 km) its influence gradually decreases. The degree of change of the layer pressure in the bed is that of the river level, but with a much smaller amplitude and much more smoothly. The increase of the groundwater levels in the vicinity of the Kozloduy NPP is mainly due to the leakage of process water from the power plant.

The bed of the Quaternary aquifer (BG1G0000Qpl005) is made of grey and grey-green clays of the Brusartsi Formation (Pliocene), but in some places under the gravel there are fine grain sands from the same formation that spread in the form of lenses and thin layers and then the waterbed is imperfect. These areas provide the flooding of the Quaternary aquifer from below the overlaying aquifers. It was found that the substrate surface is uneven. This groundwater body is identified by code BG1G00000N2034 – porous water in the Neogene – Lom-Pleven depression.



Left: Hydrogeological cross section I-2

Right: (from the top): Grunt water in alluvial sediments of the Holocene – gravel, sands and clays

Grunt water in alluvial and aeolic sediments of the Pliocene – gravel, sands and clays

Dak-levant aquifer – gravel, sands and coal

Pontian aquifer – sands and clays

Meotian aquifer – clays and sands

Sarmatian aquifer – sands and limes

Sarmatian aquifer complex – clays and sands

FIGURE 3.2-58: FRAGMENT OF THE HYDROLOGICAL MAP AND THE HYDROGEOLOGICAL PROFILE IN M 1:200 000 (IV. STANEV, 1967), INCLUDING THE TERRITORY OF THE KOZLODUY NPP

3.2.2.1.2 Groundwater basin, identified by code BG1G0000Qpl023 – porous water from the Quaternary – between the Lom and Iskar Rivers

The Kozloduy NPP site is entirely within on this water basin which covers an area of 2890 km^2. This is the first aquifer from the surface. The collectors for the porous type of groundwater are the various grain size gravels with sand-clay filler, in places with layers of sands, covered by loess deposits. Groundwater is non-pressure.

The following characteristics are identified for the water body: average thickness of GWB is 25 m, average water conductivity 13 m^2/d, average filtration coefficient of 2 m/d, average groundwater flow module 1.1 l/s.km^2, size of the flooding area 2888 km^2, natural resources 2310 l/s. The direction and rate of exchange with the surface water is identified as difficult. According to the performed assessment for the chemical and quantitative status, the GWB is defined as not being at risk. According to the RBMP, the protective effect of the coverage layers is distributed as follows 90 % – favourable and 10 % – medium.

3.2.2.1.3 Groundwater basin, identified by code BG1G00000N2034 – porous water from the Neogene – Lom and Pleven depression

The Kozloduy NPP site is entirely within on this water basin which is under the Quaternary aquifer. It covers an area of 3065 km^2. It includes upper and lower layer, as follows:

In the upper layer the collectors of the fresh non-pressure porous groundwater are the grey-green clays, sandy clays and clayey sands alternating with low-power coal lenses covered by sandy clay and loess. The following characteristics are identified for the top layer: average thickness of GWB is 70 m, average water conductivity 140 m^2/d, average filtration coefficient of 2 m/d, average groundwater flow module 0.8 l/s.km^2, size of the flooding area 618 km^2. The direction and rate of exchange with the surface water is identified as difficult. According to the performed assessment for the chemical and quantitative status, the GWB is defined as being at risk regarding its chemical condition and as not at risk regarding its quantitative condition. There has been established contamination by NO_3, Mn and others due to agricultural activities. According to the RBMP, the protective effect of the coverage layers is distributed as follows 10 % – medium and 90 % – poor.

In the bottom layer clays are at the top (waterbed) and after that follow various grain size sands (aquifer) with small-scale clay strips. It is pressure by nature. The following characteristics are identified for the lower layer: average thickness is 100 m, average water conductivity 2500 m^2/d, average filtration coefficient of 25 m/d, natural resources 1730 l/s. There is no establishment of volume of surface water flows. According to the performed assessment for the chemical and quantitative status, the GWB is defined as not being at risk regarding its chemical condition and quantitative condition. According to the RBMP, the protective effect of the coverage layers is distributed as follows 95 % – favourable and 5 % – medium.

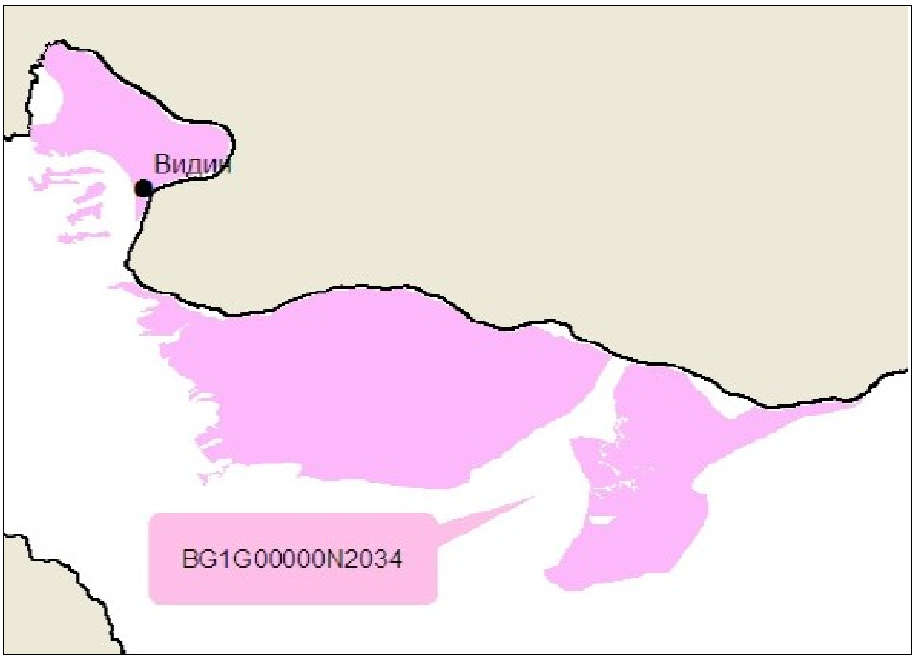


FIGURE 3.2-59: GROUNDWATER BASINS – NEOGENE LAYER, ON THE TERRITORY OF THE KOZLODUY NPP, ACCORDING TO THE RBMP OF THE DANUBE REGION FOR WATER MANAGEMENT

3.2.2.2 USE OF GROUNDWATER

3.2.2.2.1 For drinking-household water supply

Protection zones of drinking water for groundwater bodies are determined on the basis of permits for the catchment of drinking-household water and sanitary protection established around water catchment facilities in compliance with the European legislation transposed in the Water Act and Regulation No. 3/16.10.2000 for the terms and conditions for research, design, validation, and operation of sanitary protection zones around facilities for drinking-household water supply and sources of mineral waters used for therapeutic, prophylactic, drinking and hygiene needs.

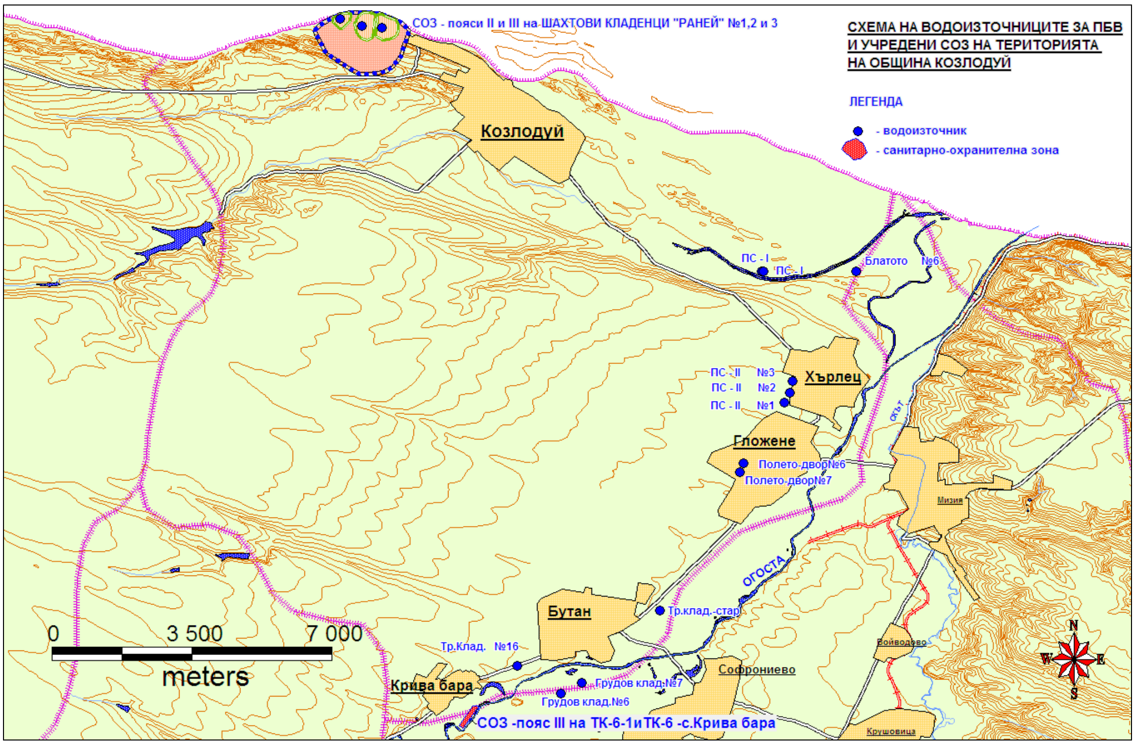
Water from the GWT BG1G0000Qpl005 – porous water in the Quaternary – the Kozloduy lowlands is characterized by total beta activity and content of natural uranium which is under the values in accordance with the requirements of Regulation No. 9/16.03.2001 on the quality of water for drinking-household purposes and specific activity of the tested radionuclides (^{40}K, ^{137}Cs, ^{54}Mn, ^{109}Cd, ^{226}Ra, ^{232}Th, ^{214}Pb, ^{214}Bi) is below the maximum limits according to the Regulation on basic standards for radiation protection, 2012.

According to the information presented by the Basin Directorate for water management of the Danube River Region – Pleven by letter ref. No. ЗДОИ-380/11.02.2013 on the territory of the water body BG1G0000Qpl005- porous waters in the Quaternary – the Kozloduy lowlands is controlled by a monitoring point – SHK R2 WS Kozloduy, which was appointed for the principal monitoring of physicochemical indicators for group I and II and for specific pollutants for group I metals and metalloids and group II of organic substances.

The results of the analysis of the monitoring showed that all monitored indicators are within the norm, according to the quality standards specified by Regulation No. 1 of 10 October 2007 for the study, use and protection of groundwater in force from 30.10.2007, promulgated in State Gazette No. 87 of 30 October 2007, amended in State Gazette No. 2 of 8 January 2010, amended in State Gazette No. 15 of 21 February 2012.

The long years of tests of drinking water, conducted by the Kozloduy NPP within the program for environmental monitoring, showed that the values for total beta activity were significantly lower than the maximum admissible values according to the requirements of Regulation No. 9/16.03.2001 on the quality of water for drinking-household purposes, and the content of technogenic ^{90}Sr and ^{137}Cs is many times lower than the norm specified in the Regulation on basic radiation protection standards, 2004.

The location of the water intake facilities and the established sanitary protection zones in the municipality of Kozloduy are shown in **Figure 3.2-60**. This shows that the NPP site and the four potential sites for the NNU are outside of the established sanitary zones.



Key: water source, sanitary zone

FIGURE 3.2-60: SCHEME FOR THE WATER CATCHMENT FACILITIES FOR DRINKING-HOUSEHOLD WATER SUPPLY AND THE ESTABLISHED SANITARY ZONES ON THE TERRITORY OF THE KOZLODUY MUNICIPALITY

Water supply for drinking-household purposes is done via the drinking water pipeline for the Kozloduy NPP, which is provided from two underground water sources /shaft wells, Raney type/ located approximately 11 km from the NPP located in the Danube River lowlands, on the west side of the town of Kozloduy /Kozloduy port, **Figure 3.2-60**/.

From the shaft wells via horizontal lines the water enters the two-chamber tank /each chamber is 2000 m^3/, where it is distributed for water supply for the town of Kozloduy and for the NPP. Chlorinating station is provided for the disinfection of the drinking water.

From the tanks for the town of Kozloduy, by gravity, the water reaches the pump station in a steel pipeline with Ø 530, with length of 11 km. Through the pumping station the water is pumped up to tanks at the level of the plant – 93.0 m, from where by gravity it goes to the consumers of the Kozloduy NPP. The external piping providing drinking water for the power plant is made of steel with Ø 500 mm.

The estimated calculations show that for an average monthly consumption of drinking water by consumers in the NPP the actual quantity of drinking water is about 35 ÷ 40 l/s.

3.2.2.2.2 For technical water supply of the NPP

The groundwater extraction shall be according to the water use permits No. 11530128/30.05.2008, No. 11590203/30.05.2008, and No. 11530128/30.05.2008. The water catchment of groundwater shall be as follows:

- ✓ Water Use Permit No. 11530127/30.05.2008, for six shaft wells – ShPS 1 ÷ 6 regulates the water extraction for backup (emergency) service water supply of Units 5 and 6 heat pools of Kozloduy NPP. During normal operation, the water losses in the heat pools of the Production Units 5 and 6 are recovered by CPS 3 and 4. In order to improve the level of safety of the system for emergency service water that provides water for the heat pools in cases where this cannot be done by CPS. The emergency maintenance water supply is designed for water flow of 280 l/s, which is provided by, and consists of 6 nos. shaft pump stations (ShPS). ShPS are located in the terrace of the Danube River about 25 to 30 m, south of the foot of the state dike. These are equipped with 2 nos. of submersible pumps.
- ✓ Water Use Permit No. 11530128/30.05.2008 from a well, Raney-5 type. Provides technical water – for technological purposes (lubrication of the bearings of shore pumps) and for the fire extinguishing system in BPS -1, -2 and -3. The well has a diameter of 4 m and is located about 1200 m to the southeast of the BPS site. The design flow of the pump station is 116 l/s, distributed as follows:
    - for technological needs – 46 l/s; two pumps are mounted, each with a flow of 50 l/s (one operating and one on stand-by);
    - fire extinguishing system – 70 l/s; two pumps are mounted, each with a flow of 140 l/s.
- ✓ Water Use Permit No. 11590203/30.05.2008, from the Valyata shaft well providing hygiene-household water supply of Units 1 to 4 of the Kozloduy NPP.

The stated water masses via the licenses greatly exceed the used water quantities and there are sufficient water quantities available for industrial use for the future IP.

3.2.2.3 Monitoring of groundwater

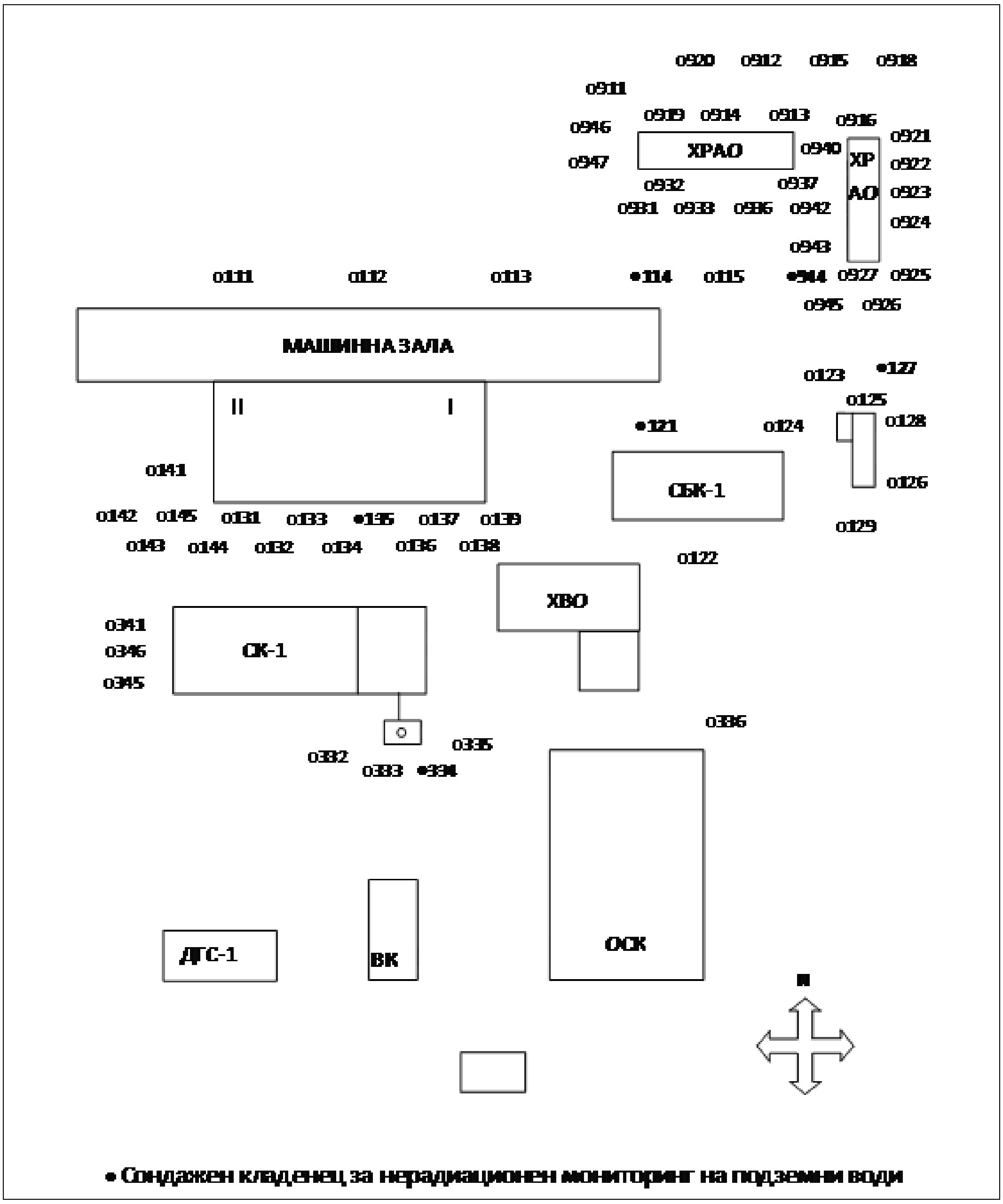
In pursuance of the recommendations of the EIAR from 1999 and the requirements of the EIA Decision No. 28-8/2001 internal non-radiation monitoring (INM) shall be carried out in the Kozloduy NPP.

The territory of the industrial site of the Kozloduy NPP has 181 monitoring wells (piezometers). Of these, 76 are located in the EP-1, 52 within the EP-2 and 53 in the regions of SFS, SRAW and the Lime Plant.

Since the commissioning of the facility for radioactive waste processing RAWPP, in 2001 the study of 26 new piezometers was started.

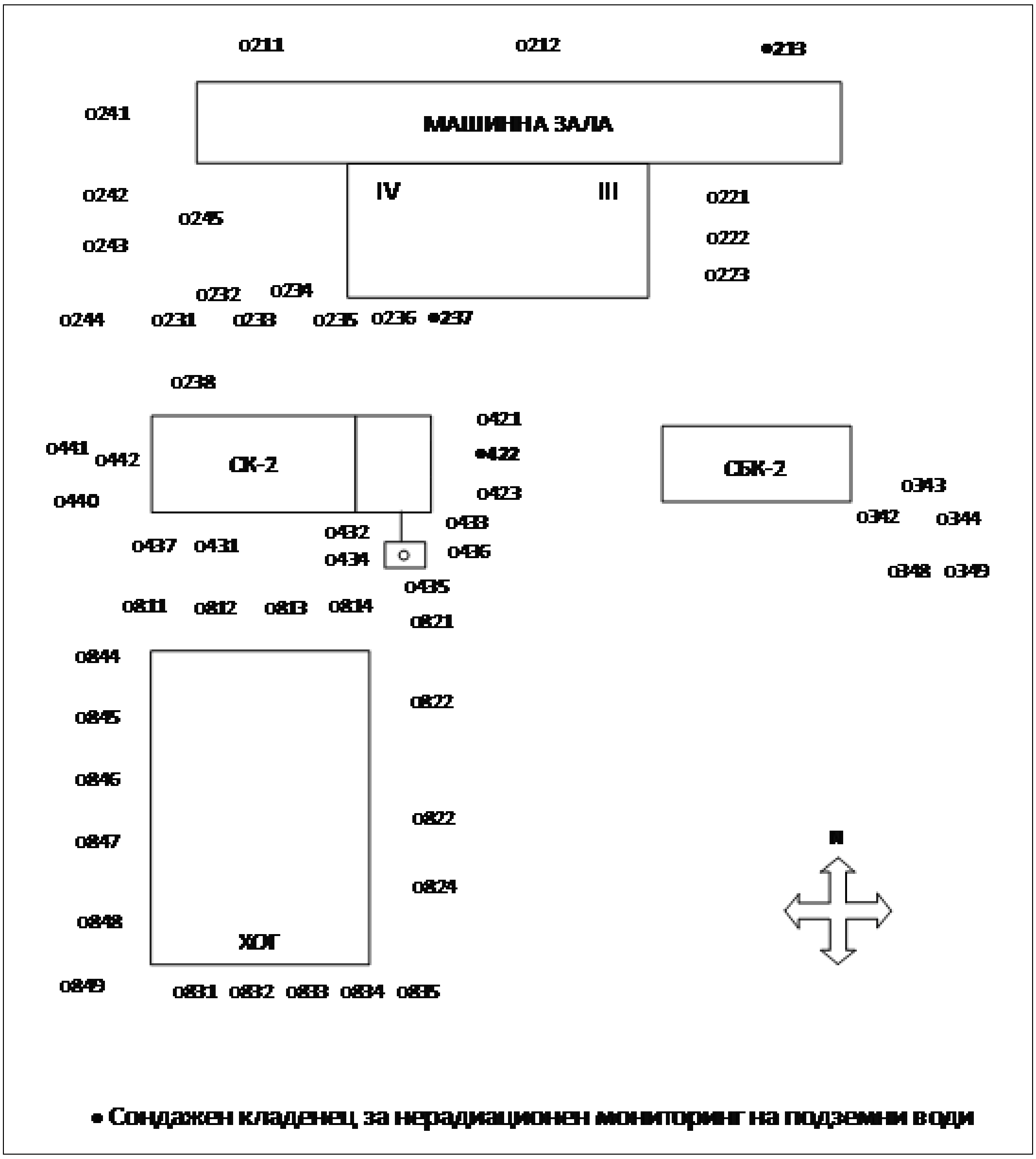
3.2.2.3.1 Monitoring network

The locations of the monitoring stations, as supplied by the NPP, are presented in the following figures.



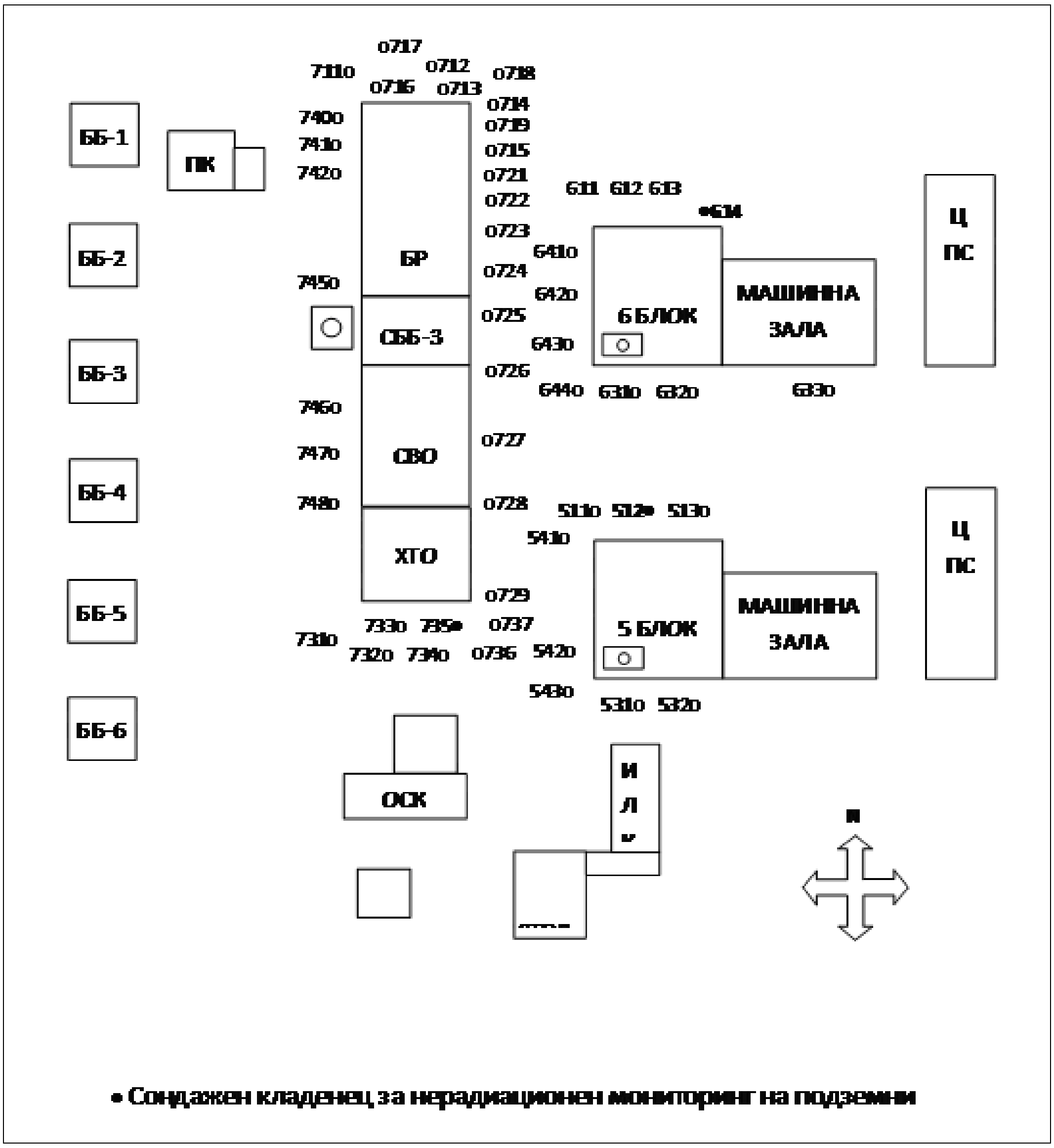
SRAW
Machine hall
SBK -1
CWT
CC
Borehole well for non-radiation monitoring of groundwater

FIGURE 3.2-61: SCHEME FOR LAYOUT OF THE BOREHOLE WELLS ON THE TERRITORY OF UNITS 1 AND 2



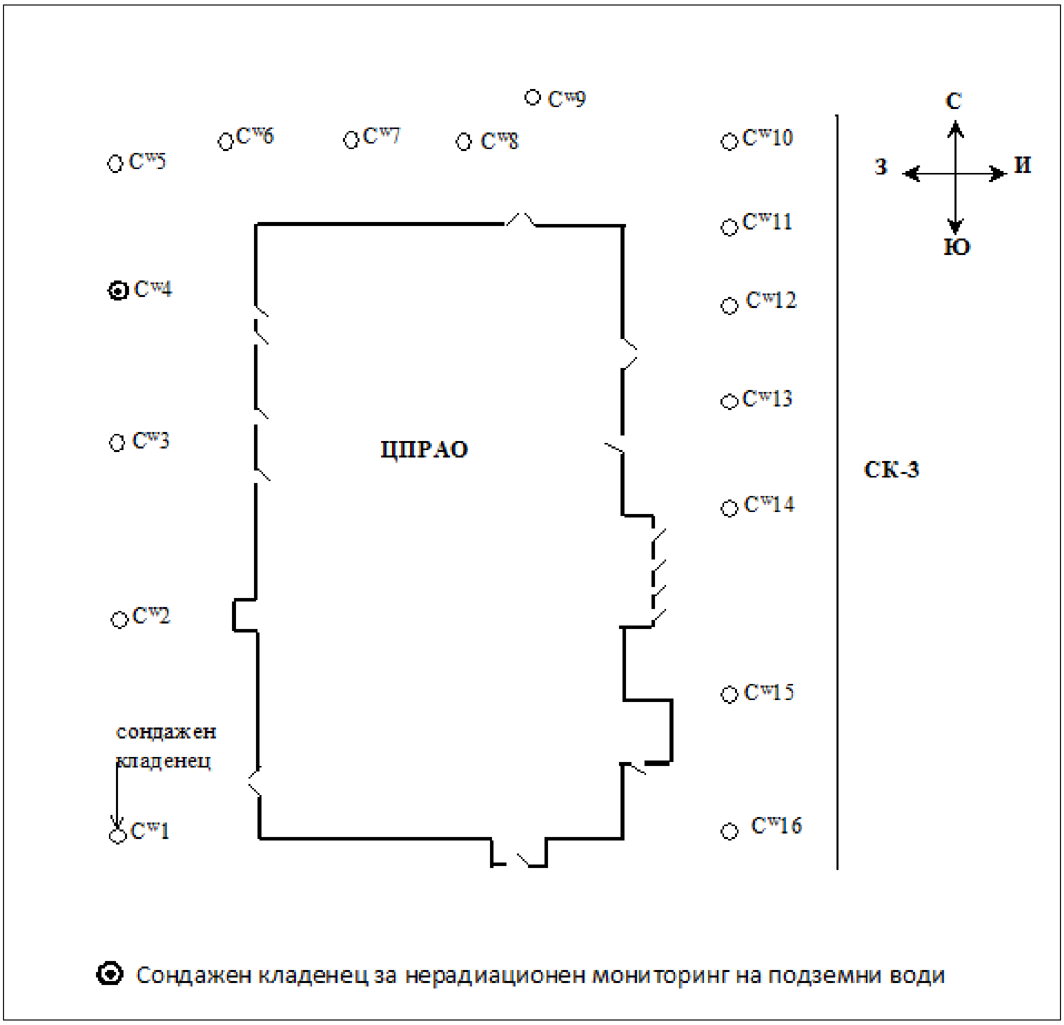
Machine hall
SBK -1
CC
SFS
Borehole well for non-radiation monitoring of groundwater

FIGURE 3.2-62: SCHEME FOR LAYOUT OF THE BOREHOLE WELLS ON THE TERRITORY OF UNITS 3 AND 4



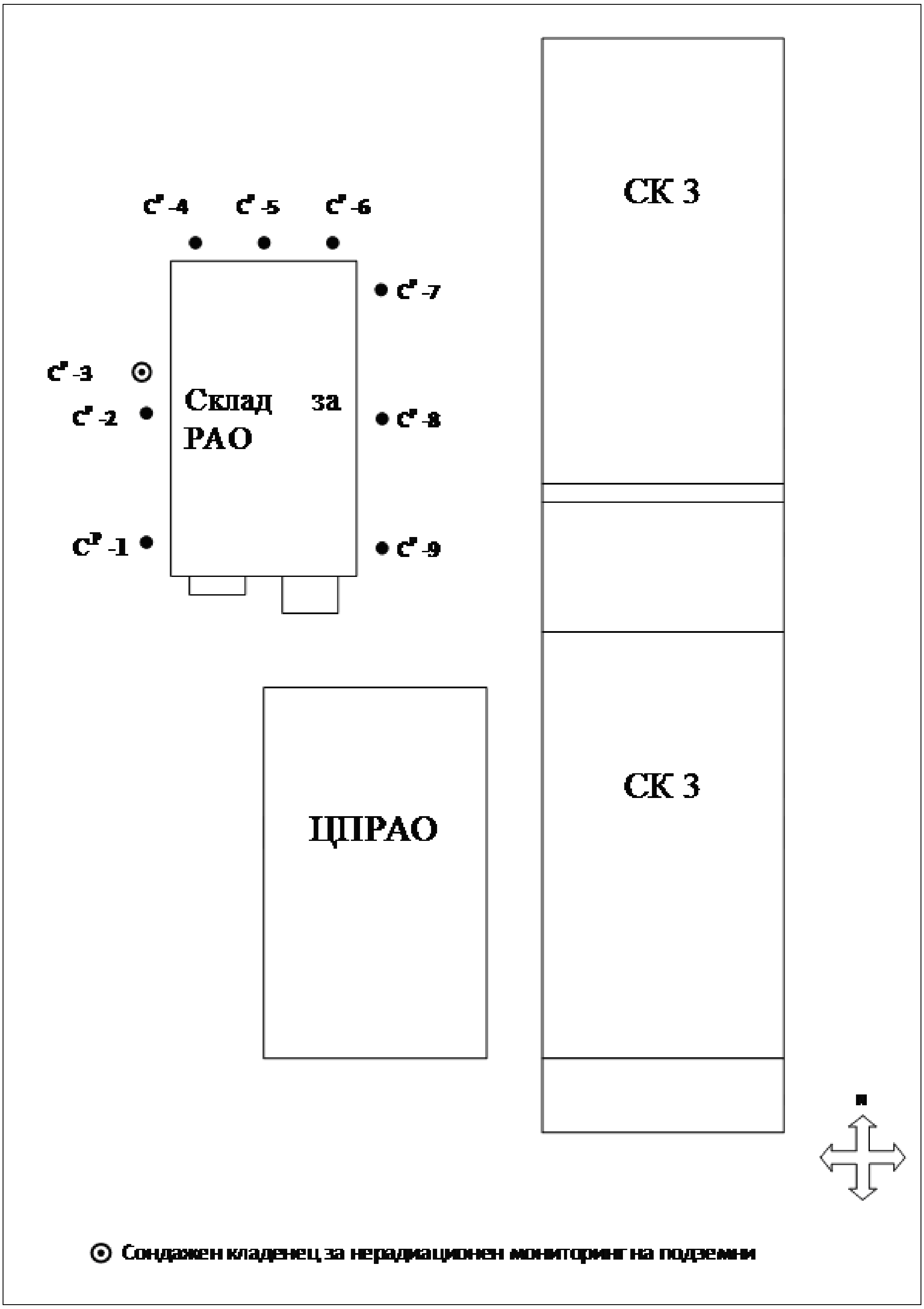
Machine hall
BU-1
SBK -1
SFS
Borehole well for non-radiation monitoring of groundwater

FIGURE 3.2-63: SCHEME FOR LAYOUT OF THE BOREHOLE WELLS ON THE TERRITORY OF UNITS 5 AND 6



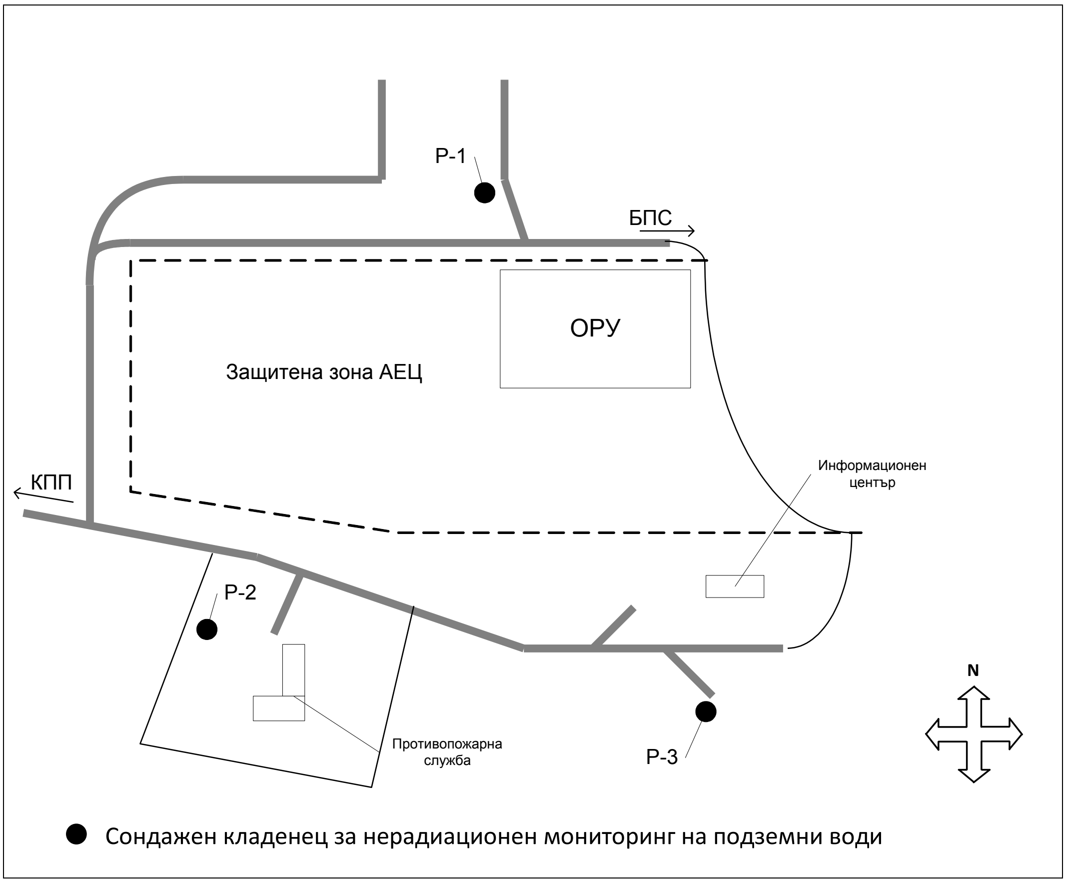
RAWTF
Borehole well
Сондажен кладенец за нерадиационен мониторинг на подземни води – Borehole well for non-radiation monitoring of groundwater

FIGURE 3.2-64: SCHEME FOR LAYOUT OF THE BOREHOLE WELLS ON THE TERRITORY OF THE RAWTF



CC 3
SRAW
RAWTF
Borehole well for non-radiation monitoring of groundwater

FIGURE 3.2-65: SCHEME FOR LAYOUT OF THE BOREHOLE WELLS ON THE RAWTF SITE



R1
BPS
ODD
NPP Protected zone
Information centre
CBCP
Fire fighting service
Borehole well for non-radiation monitoring of groundwater

FIGURE 3.2-66: SCHEME FOR LAYOUT OF THE BOREHOLE WELLS ON OUTSIDE OF THE NPP PROTECTION ZONE

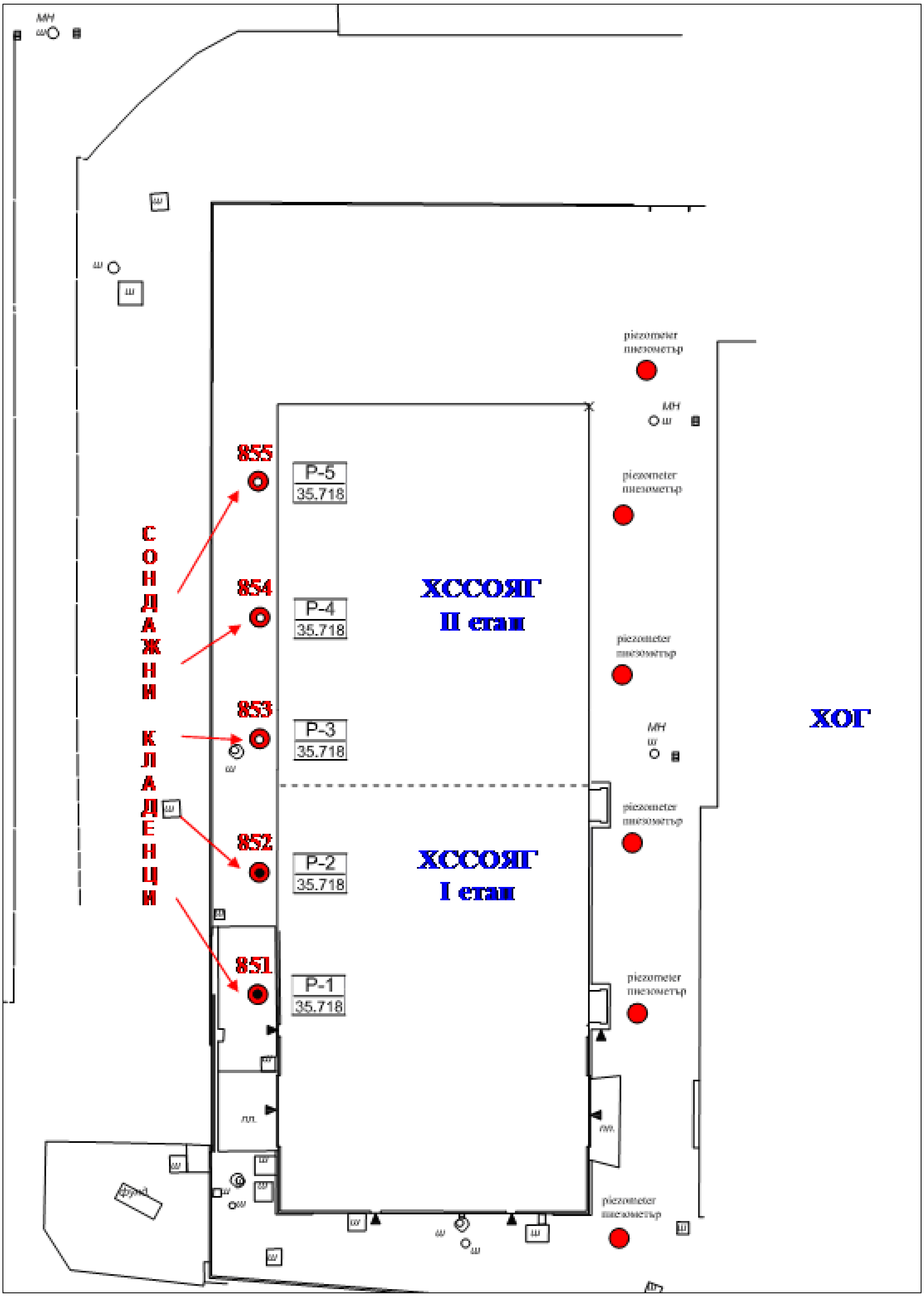


FIGURE 3.2-67: LAYOUT OF THE BOREHOLE WELLS ON THE TERRITORY OF EP-1 /DDSSNF SITE/

Water monitoring is carried out to an agreed review of their status, including periodic measurements, observations and assessments. Monitoring data are the basis for control of production processes and activities to prevent/limit the negative impact on the water.

3.2.2.3.1.1 Non radiation monitoring

Non-radiation monitoring includes all measurements and laboratory analysis of major environmental components of ground, surface and waste water included in the environment permit conditions. It is divided in two parts – a mandatory non-radiation monitoring and internal company control.

The mandatory internal non-radiation monitoring for Kozloduy NPP covers all required measurements and analyzes resulting from statutory requirements and the conditions of the Company's issued permits for water extraction and use of water bodies including:

- ✓ Measuring the amount of water used from the Danube River and the concentration of contaminants therein;
- ✓ Measuring wastewater quantity and concentration of pollutants therein which has certain individual emission limits shown in the permits issued to the Employer under the Water Act;
- ✓ Measuring the amount of extracted groundwater;
- ✓ Monitoring of water levels and chemical status of groundwater bodies used for the extraction of water.

The internal company control covers additional analyzes of waters which are performed by laboratories and includes testing of:

- ✓ use the waters of the Danube River;
- ✓ wastewater;
- ✓ wastewater from external organizations (EOs) discharged under contract to the sewers of the Kozloduy NPP;
- ✓ groundwater at industrial sites, incl. the territory of which there are buildings and facilities of SP CE and SP RAW DP RAW.

Performed and monitoring of groundwater and wastewater from DNBPO under the Program for self-monitoring of DNBPO, identification No. УК.УОС.ПМ.011 and radiation environment monitoring, which is carried out under the Programme for radiation monitoring of the environment for the operation of Kozloduy NPP, identification No. УБ.МОС.ПМ.262.

Table 3.2-39. Volume and periods for testing the groundwater in the region of the Kozloduy NPP

Borehole wells (piezometers) in the region of the NPP

No.	Location
114	– North of MZ – 1, 2 units;
122	– SWO – 1÷4 units;
127	– neutralisation pits for SWO – 1÷4 units;
135	– to the transportation corridor of PO – 1, 2 units;
213	– North of MZ 3 – 4 units;
237	– to the transportation corridor of PO – 3, 4 units;
334	– Spec. block -1;
442	– Spec. block -2;
512	– to the reactor hall of unit 5;
614	– to the reactor hall of unit 6;
735	– SWO – 5, 6 units;
944	– before DNBPO, site of SRAW
C^P-3	– neutralisation pits for SWO – 5, 6 units, tank for oils and wastewater shaft– unit 5, RAW storage;
C^W-4	– petroleum oil hall, HRAW;
P – 1	– north of CCD;
P – 2	– Fire fighting yard;
P –3	– south of the Information centre

	Size	Period
Dissolved substances	mg/l	3 m
Total β-activity	Bq/l	3 m
Electrical conductivity	$\mu S/cm^{-1}$	2 y
Amonium 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
Permangane oxidation	mgO_2/l	3 m
Total hardness	mgeqv/l	2 y
Fluorides	mg/l	2 y
Cyanides	mg/l	2 y
Borium	mg/l	2 y

Key: ***2 y*** *–analyse once every 2 years;* ***3 m*** *– analyse once every 3 months*

3.2.2.3.1.2 Summarised results of the non-radiation monitoring

Summary of physico-chemical studies of groundwater in 2010:

- ✓ Water from the CC fully complies with the quality standards in 2010: No. 114, No. 121, No. 127, No. 135, No. 213, No. 237, No. 334, No. 735, No. 944, No. P-3 and P No. -3.

- ✓ Individual exceedances of the standard of quality in some measurements were recorded for waters of CC No. 421, No. 512, No. 614, No. P-1 and P-2 No..
- ✓ In CC No. 512 there are registered exceedance of the corresponding values of the standard for quality, pH in the II-nd quarter (9.81 in standard ≥ 6.5 and ≤ 9.5).
- ✓ In CC No. P-2 there are recorded exceedances of the values of quality standards:
  - content of nitrates in I-st, III-nd and IV-th quarter (68.2 mg/dm^3, 50.9 mg/dm^3 and 65.2 mg/dm^3 for standard 50 mg/dm^3);
  - content of sulphates in I-st quarter (267 mg/dm^3, with standard 250 mg/dm^3).
- ✓ There are exceedences in the remaining wells regarding the nitrates and mangane indicators:

For the nitrates indicator

- ✓ CC No. 422 – 55.6 mg/dm^3 for the II quarter; 57.5 mg/dm^3 for the III quarter; 54.3 mg/dm^3 for the IV quarter for standard 50 mg/dm^3;

For the mangane indicator:

- ✓ CC No. 614 – 81.24 µg/dm^3 for the III quarter, for standard 50 µg/dm^3;
- ✓ CC No. P-1 – 570.54 µg/dm^3 for the III quarter, for standard 50 µg/dm^3;

Summary of physico-chemical studies of groundwater in 2011:

- ✓ Water from the CC fully complies with the quality standards in 2011: No. 114, No. 127, No. 213, No. 334, No. 422, No. 614, No. 735, No. 944, No. Wed-3, No. P-1 and No. P-3.
- ✓ Individual exceedances of the standard of quality in some measurements were recorded at the waters of CC No. 121, No. 135, No. 237, No. 512, No. CW-4 and No. P-2.
- ✓ In CC No. 512 Exceedance of the corresponding values of the standard for quality, pH in III-rd quarter (9.80 for standard ≥ 6.5 and ≤ 9.5).
- ✓ In CC No. P-2 were recorded exceedances of the values of quality standards:
  - – content of nitrates for the III quarter (70.04 mg/dm^3 for standard 50 mg/dm^3);
  - – content of sulphates for the III quarter (362.62 mg/dm^3, for standard 250 mg/dm^3).
- ✓ exceedances in other wells in terms of indicators, nitrates and fluorides:

For the nitrates indicator

- ✓ - CC No. 135 – 109.23 mg/dm^3 for the III quarter, for standard 50 mg/dm^3;
- ✓ - CC No. 237 – 60.19 mg/dm^3 for the III quarter, for standard 50 mg/dm^3;

For the fluorides indicator;

- ✓ - CC No. 121 – 2.46 mg/dm^3 for the III quarter, for standard 1.5 mg/dm^3;
- ✓ - CC No. 135 – 2.9 mg/dm^3 for the III quarter, for standard 1.5 mg/dm^3;
- ✓ - CC No. Cw-4 – 2.01 mg/dm^3 for the III quarter, for standard 1.5 mg/dm^3;

With regard to groundwater at the site and in the area of Kozloduy NPP the requirements of the quality standard set out in the Regulation on the study, use and protection of groundwater do not comply with:

- ✓ Water CC No. P-2, located in the courtyard of the fire service – in terms of indicators, nitrates and sulphates
- ✓ Water CC No. 135, located near the centre of Reactor Units 1 and 2 and the chemical purification of the EP-1 with respect to the indicator for nitrates and fluorides
- ✓ Water CC No. 512, located near the reactor hall unit 5, has active alkaline reaction (> 9), some of the values exceed the limit of standard quality (≤ 9.5);
- ✓ Water CC No. 237, located near the centre of Reactor of Units 3 and 4 – in terms of indicators, nitrates .

For the first time in 2011 there was an exceedance of the standard quality indicator for fluorides for CC No. 121 (Chemical hall in EP-1) CC No. 135 (located in the reactor hall of Units 1 and 2 chemical water purification and the EP-1) and AB No. CW-4 (located in the Petroleum-oil sector in the EP-2 and SRAW processing).

3.2.2.3.2 Radiation monitoring

European requirements on the application of art. 36 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 d. This recommendation is essential for standardization and unification of practices applied in the field of radiological monitoring of EU member states. Concepts are defined and the general requirements of the types of monitoring, network monitoring and sampling (dense and dilute), the frequency of monitoring, the volume of monitoring requirements for sampling and analysis of the main objects of controlled environment. Are also regulated by the volume of the sub- sample information management and communication of monitoring data.

The internal radiological environmental monitoring is regulated by long-term program of Kozloduy NPP for radiation monitoring of the environment. The program is based on the legal requirements in the field – Art. 130 of the Regulation to ensure the safety of nuclear power plants, promulgated in the State Gazette issue No. 66 of 30.07.2004, Art. 118 of the Regulation on radiation protection during activities with sources of ionizing radiation, promulgated in issue No. 74 of 24.08.2004, Art. 14, paragraph 1, Section 3 of the Regulation on the conditions and procedure for the determination of areas with special status around nuclear facilities and sites with sources of ionizing radiation, promulgated in the State Gazette issue No. 69 of 06.08.2004, as well as international best practices and operational experience of the PM Department. The program is coordinated with the Ministry of Environment and Water /MEW/, the Ministry of Health /MH/ and the Agency for Nuclear Regulatory Agency /NRA/and is in compliance with the international recommendations in the field, art. 35 of the EURATOM Treaty and Recommendation 2000/473/EURATOM. In order to provide independent control programs radiation monitoring programmes are implemented by the control authorities EEA/MEW and NCRRP/MH.

To locate and assess the potential impact of the Kozloduy NPP on the environment and the population, around the plant there are 2 separate control zones with different radii: Protective Measures Zone – PMZ /2 km/ and Urgent Protective Measures Zone (UPMZ) /30 km/. The industrial site itself is under monitoring. For comparison purposes, sampling and measurements are carried out in the benchmark points up to 100 km around the NPP, where there is no expected impact from the operation of the plant. Laboratory and automated control of the components of the environment is performed as well.

For the purpose of radiation monitoring of groundwater at the site and in the area of the nuclear power there is a network of borehole wells. 17 of them were selected for purposes of CHM – 14 nos. in the protected area of the Kozloduy NPP and 3 nos. outside the protected area. Their location is as follows:

- ✓ CC 114 – Turbine Hall of Units 1 and 2;
- ✓ CC 121 – Chemical plant in EP-1;
- ✓ CC 127 – neutralizing pit and nitrogen oxygen station in EP-1;
- ✓ CC 135 – Hall of Reactor Units 1 and 2 and chemical water purification of the EP-1;
- ✓ CC 213 – Turbine Hall at 3 and 4;
- ✓ CC 237 – Reactor hall 3 and 4;
- ✓ CC 334 – Auxiliary 1;
- ✓ CC 422 – Auxiliary 2;
- ✓ CC 512 – Reactor hall unit 5;
- ✓ CC 614 – Reactor Hall 6;
- ✓ CC 735 – Chemical plant in EP-2;
- ✓ CC 944 – Before DNBPO site storage of radioactive waste;
- ✓ CC Wed-3 – neutralizing pit in the EP-2 and warehouse waste;
- ✓ CC CW-4 – Oil-oil sector in the EP-2 and factory for processing of waste;
- ✓ CC P-1 – North of outdoor switchgear (outside zone);
- ✓ CC P-2 – In the yard of the fire fighting (outside zone);
- ✓ CC P-3 – South of the Information Centre (outside zone).

Test programs for the radioactivity of groundwater at the industrial site of Kozloduy NPP are carried out for sampling of 115 borehole wells. Of these, 27 are within the EP-1, 29 within the EP-2, 26 are in the region of RAWPP and the SRAW 25 in the regions of SFS HRAO, the Lime plant and the temporary storage of solid waste in the open and 5 at the landfill.

In August 2004, started sampling and analysis of the 3 new benchmark wells located on the inlet and outlet of the aquifer near the industrial site.

Water samples from boreholes were analysed four times a year for total beta activity and tritium content.

3.2.2.3.2.1 Summarised results of the radiation monitoring

Practice shows that the results of radiological monitoring have values significantly lower than those established by the regulations. Therefore, most often it is practical to compare the current results to those obtained from previous years of operation before the commissioning of the nuclear power plant in operation. This approach allows you to record and analyze even the smallest changes in the trends of radiation. Measurements done in the area of Kozloduy NPP were held in the period 1972 – 1974, from NCRRP (then NIRRH).

A summary of these results was made in a publication by order of the Bulgarian Trade Union Confederation in 1993.

Available data on the radioactivity of water from the environment of Kozloduy NPP in the pre-commissioning period 1972-1974 shows the following contents: Cesium -137 – 10.0 ± 6.0 mBq/l; Strontium -90 – 7.0 ± 6.0 mBq/l; total beta activity 420 ± 170 mBq/l.

In the performance of modern monitoring program, particular attention is paid to the drinking water in the area of NPP. The drinking water for Kozloduy, the village of Harlets, the Kozloduy NPP and the town of Oryahovo was investigated monthly for total beta activity and tritium. Twice during the year there are tests for ^{90}Sr and ^{137}Cs in the water supplying wells of Kozloduy NPP, II-nd pumping station of the NPP and the village of Harlets and four times a year in the water supply network of the town of Oryahovo. In 2011 there are analysed 60 samples of drinking water and the number of the analyses is 144 – respectively: 12 gamma- spectrometric, radiometric 60 for total beta activity, 60 for liquid scintillation for tritium and 12 radiochemical separation of strontium.

The results for total beta activity in drinking water in 2011 are in the range 0.024 ÷ 0.088 Bq/l, an average of 0.051 Bq/l. The tritium activity in all samples analysed in 2011 ranged <3.9 ÷ 8.3 Bq/l, average 5.7 Bq/l. The values are much lower than the permissible limits for drinking water: 2 Bq/l total beta activity and 100 Bq/l of tritium Regulation No. 9/16.03.2001, the results are similar and comparable to those of previous years. For 2011, the activity of ^{137}Cs in all samples analysed below MAC (<0.5 ÷ <1.1 mBq/l). Activity of 90Sr in drinking water in 2011 varied in the range <0.8 ÷ 2.3 mBq/l.

The results are similar to those of the previous years and about 1000 times lower than the laws

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

For the purposes of the EIAR from Kozloduy NPP data is presented for the period 2006-2012 as summarized for the Kozloduy NPP, village of Harlets and PS-2 of radiological monitoring of drinking water.

TABLE 3.2-40: SUMMARISED DATA FOR DRINKING WATER FOR THE PERIOD 2006-2012

Drinking water of:	Total β activity, Bq/l	Activity Tritium, Bq/l	Activity gamma, Bq/l	
			^{134}Cs	^{137}Cs
- NPP -Kozloduy -Harlets - II pump station	0.019-0.17 av.- 0.054	2.0-8.3 av.-4.7	0.0004-0.0015 av.-0.0009	0.0004-0.0014 av.-0.0009

The data shows that the radioactivity of drinking water in the area of Kozloduy NPP is lower than the limit values (total β-minute activity -1 Bq/l, tritium - 100 Bq/l) as per Regulation No. 9/16.03. 2001.

In 2011, a total of 692 samples were analysed from 115 wells of the industrial site. A total of 1308 analysis, respectively: 616 for liquid scintillation for tritium, 616 radiometric for total beta activity and 76 gamma spectrometry for radionuclide composition of the water.

Of the 115 wells tested for tritium in 2011, for 54 the tritium activity is not exceeded at any time during the year MAC (up to 7.9 Bq/l). Water in 38 wells contained at least once a year tritium within MAC ÷ 100 Bq/l, and the water in 23 wells at least once a year has exceeded 100 Bq/l.

The highest content of tritium in water from wells drilled in 2011 was measured as follows:

- on the territory of EP-1, boreholes 341 (422 Bq/l);
- on the territory of EP-2, boreholes 711 (12 861 Bq/l).

Of 9 wells with increased activity of tritium over 1000 Bq/l, 5 are located in the area of CC - 3, 5 and 6, and 3 wells are around SRAW hall and one SRAW. The maximum concentrations of tritium were measured on the east side of the SBB.

At the end of 1994 a change to the route was made where the discharge water is disposed in CC -3, a possible reason for leakage and groundwater pollution in the area.

Despite periodic pumping of water from these wells, however, there is no continuous decrease the content of tritium in groundwater. Periodically there are recorded anomalies in the radiation status.

115 wells were used to measure the total beta activity in 2011; in 110 the total beta activity was not higher than 0.75 Bq/l even once during the year. 0.75 Bq/l is the limit value for surface waters, as per Regulation No. 7/1986. Groundwater generally has a higher salt content than surface water, respectively, higher natural radioactivity. Water in 4 wells at least once during the year was tested for total beta activity in the range of 0.75 ÷ 1.5 B q/l, and in 1 borehole at least once during the year there was total beta activity greater than 1.5 Bq/l.

In 2011, the highest values for total beta activity in drilling were as follows:

- on the territory of EP-1, borehole 341 (0.796 Bq/l);
- on the territory of SFS, borehole 844 (1.48 Bq/l);

- on the territory of EP-2, borehole 728 (0.78 Bq/l);
- on the territory of SRAW, borehole 948 (1.43 Bq/l), 951 (3.02 Bq/l);
- on the territory of HRAW, borehole 002 (0.667 Bq/l).

According to the Program for radiation monitoring of the environment, water from wells with a total beta activity greater than 1.5 Bq/l was tested with gamma spectrometry for radionuclide composition.

Technological activity is recorded only in wells No. 131 and 145. Similarly, in previous years, in 2011 the activity of ^{60}Co was measured only in well No. 131 and 145. Traces of activation products (54Mn) were not detected. Negligible activity of ^{137}Cs is found in well 725.

Increased radioactivity of tritium in piezometers around the complex processing of RAW No. 010, 012 and 013 (RAWPP) and 022 (SRAO) due to past contamination and infiltration of water from the side of the AB-3. This cannot be used to assess the impact of facilities on SP RAW – Kozloduy on the groundwater in the area. Total beta activity of the wells has background levels.

Overall, with the exception of well No. 951 (2.56 Bq/l and 3.02 Bq/l), all measured values of total beta activity are lower than the rate for groundwater (2 Bq/l, Regulation No. 1 of 15.11.1999 norms for purposes of radiation protection and safety for the liquidation of the uranium industry in Bulgarian).

Radioactivity in the remaining wells of the site and any reference wells is very low (below and around MAC), indicating that there was no effect on the operation of nuclear power on the aquifer in the area.

CONCLUSION: The impact on groundwater is only local in certain sections of the site. The results in 2011 were similar to those of previous years.

Overall radiological characteristics of the aquifer at the entrance and exit of the site is unaffected by the operation of Kozloduy NPP.

For the purposes of the EIAR from Kozloduy NPP summary data is presented for the period 2006-2012 from the radiological groundwater monitoring at the NPP.

TABLE 3.2-41: SUMMARISED DATA FOR THE GROUNDWATER FOR THE PERIOD 2006-2012.

Drinking water	Total β activity, Bq/l	Activity Tritium, Bq/l	Activity gamma, Bq/l	
			^{60}Co	^{137}Cs
Storage for non-radioactive waste 7 nod.	0.051-0.40 Av.- 0.10	2.8-159 Av.-18.2	0.086-0.33 Av.-0.20	0.11-0.34 Av.-0.21
Benchmark boreholes -3 nos.	0.025-0.36 Av.- 0.12	2.1-7.6 Av.-4.9	0.084-0.43 Av.-0.16	0.10-0.39 Av.-0.17

3.2.2.3.3 Internal monitoring of the extracted groundwater

Mandatory internal monitoring of extracted groundwater shall be performed under the conditions of the water use permits (No. 11530127/30.05.2008, No. 11530128/30.05.2008, and No. 11590203/30.05.2008), and includes measurement of extracted quantities, monitoring water levels and the chemical status of groundwater bodies used for the extraction of water.

- ✓ Water levels and quantities produced by SC Valyata, measured by Sector CP/Administrator ODL.
- ✓ Water levels and quantities produced by SC Raney 5 measured from Workshop BPS.
- ✓ Water levels and quantities derived by ShPS 1 ÷ 6 are measured by Sector ETA/EP-2.

On measured water levels and discharges Sector CP/Administrator ODL Workshop BPS and Unit ETA/EP-2 there are prepared quarterly reports that shown the control quality by the 10th day of the month following the report quarter.

Sampling and testing of water from SC Valyata, SC Raney-5 and ShPS 1 ÷ 6 in order to determine the chemical status of groundwater bodies is carried out by accredited laboratories according to the information **Table 3.2-39**. The organization and control of the volume of the quantity and concentration of the chemical indicators are as follows:

TABLE 3.2-42: CHEMICAL STATUS OF UNDERGROUND WATER BODIES

No.	Indicator	Period								Laboratory
		Sc Valyata	SC Raney -5	SHPS1	SHPS2	SHPS3	SHPS4	SHPS5	SHPS6	
1.	Active reaction	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	Sec. IH LIK Dep K
2.	Electrical conductivity	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	Ext. laboratory
3.	Conc. of diss. O_2	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	Ext. laboratory
4.	Amonium ion	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	Ext. laboratory
5.	Nitrates	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	Ext. laboratory
6.	Chlorides	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	Ext. laboratory
7.	Sulphates	1y.	1y.	1y.	1y.	1y.	1y.	1y.	1y.	Ext. laboratory
8.	Total hardness	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
9.	Nitrites	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
10.	Phosphates	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
11.	Fluorides	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
12.	Cyanides	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
13.	Mercury	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
14.	Cadmium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
15.	Copper	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
16.	Nickel	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
17.	Lead	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
18.	Selenium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
19.	Chrome	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K

No.	Indicator	Period								Laboratory
		Sc Valyata	SC Raney -5	SHPS1	SHPS2	SHPS3	SHPS4	SHPS5	SHPS6	
20.	Aluminium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
21.	Iron	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
22.	Calcium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
23.	Magnesium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
24.	Mangane	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
25.	Zink	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
26.	Natrium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
27.	Borium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
28.	Anthimonium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
29.	Arsenicum	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Sec. IK LIK Dep K
30.	Natural uranium	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
31.	Benzo(b+k)fluoranthene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
32.	Benzo(a)pyrene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
33.	Indeno(1,2,3-cd)pyrene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
34.	Benzo(ghi)perylene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
35.	α – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
36.	HCB	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
37.	β – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
38.	γ – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
39.	δ – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
40.	ε – HCH	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
41.	Heptachlor	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
42.	Aldrin	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
43.	op' DDE	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
44.	pp' DDE	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
45.	Dieldrin	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
46.	op' DDD	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
47.	Endrin	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
48.	op' DDT	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
49.	pp' DDD	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
50.	pp' DDT	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
51.	Methoxychlor	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
52.	Benzene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
53.	1,2 – Dichloroethane	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
54.	Trichloroethylene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
55.	Tetrachloroethylene	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
56.	Atrazine	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
57.	Simazine	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory
58.	Propazine	3y.	3y.	3y.	3y.	3y.	3y.	3y.	3y.	Ext. laboratory

Note: *Taking and testing water samples from external laboratories (EL) is performed on the basis of signed contract.*

All samples are single and are selected by the staff of the testing laboratory in the presence of a representative of the ES department.

Additional internal control is carried out by chemical laboratories of the NPP, for the purpose to complement the mandatory control in months when the required analyses are not provided as per the water use permits and permits for use of water bodies for discharge of wastewater.

For the purpose of internal control of the boreholes (piezometers) drilled in the industrial site of Kozloduy NPP and for purposes of radiation monitoring are carried out periodic internal tests on non-radiation performance. Number of boreholes is as follows:

Table 3.2-43: Borehole wells

No.	Borehole well	Location
1.	No. 114	Machine hall for 1 and 2 units
2.	No. 121	Chemical hall in EP-1
3.	No. 127	Neutralisation pit in ACS in EP-1
4.	No. 135	Reactor hall in 1 and 2 units in SFS in EP-1
5.	No. 213	Machine hall for 3 and 4 units
6.	No. 237	Reactor hall in 3 и 4 units
7.	No. 334	Spec. block 1 and oil hall in EP-1
8.	No. 422	Spec. block 2 and SFS
9.	No. 512	Reactor hall 5 units
10.	No. 614	Reactor hall 6 units
11.	No. 735	Chemical hall in EP-2
12.	No. 944	Site for storage of RAW (before DNBAO)
13.	No. 027 (Cp-3)	Neutralisation pit in EP-2 and storage for RAW
14.	No. 004 (Cw-4)	NMS in EP-2 and RAW treatment hall
15.	No. 001 (P-1)	North of CCD (outside 33)
16.	No. 002 (P-2)	In the yard of the fire department (outside 33)
17.	No. 003 (P-3)	South of the Information centre (outside 33)

The locations of the borehole wells are shown on **Figure 3.2-61** to **Figure 3.2-67**.

3.2.2.3.4 Internal monitoring of groundwater in the depot region

For the purposes of CHM groundwater near the landfill 5 wells were drilled along its entire length, but because of permanent damage, CC No. 3 is removed from the monitoring program during the III-rd quarter of 2007 (**Figure 3.2-68**).

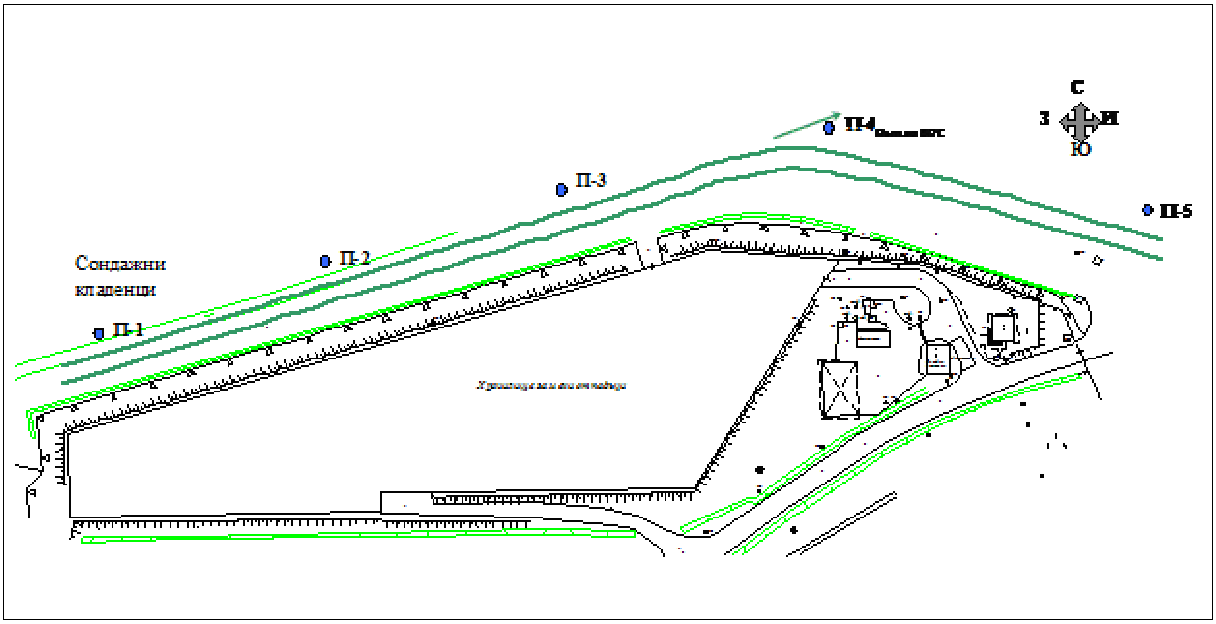


FIGURE 3.2-68: LAYOUT OF THE BOREHOLE WELLS AROUND THE DEPOT FOR HOUSEHOLD, CONSTRUCTION AND INDUSTRIAL WASTE OF THE KOZLODUY NPP

To ensure comparability of results, sampling from well No. 944 is carried out under the non-radiation control program and the Programme for internal monitoring of a landfill for non-radioactive and industrial waste (УК.УОС.ПМ.011).

Twice a year all wells are controlled for absence of contamination on the PM.

Control results are formed in protocols of the PM department presented to the Quality Control Department by the 10th day of the next 6 month period.

Before sampling is carried out measurement of water levels and extraction boreholes is performed. Water levels are measured before extraction. Boreholes are used up to three times the amount of actual drilling, no later than three days prior to sampling.

The organization and control of the volume of chemical indicators are as follows:

TABLE 3.2-44: CONTROL OF CHEMICAL INDICATORS

No.	Indicator	Period	Laboratory
1.	Active reaction (pH)	6m.	Sec IHLIK/Dep K
2.	Electrical conductivity	6m.	Sec IHFHK/Dep K
3.	Total hardness	6m.	Sec IHFHK/Dep K
4.	Permanagane oxidisation	6m.	Sec IHFHK/Dep K
5.	Ammonium ion	6m.	Sec IHFHK/Dep K
6.	Nitrates	6m.	Sec IHFHK/Dep K
7.	Nitrites	6m.	Sec IHFHK/Dep K
8.	Sulphates	6m.	Sec IHFHK/Dep K
9.	Chlorides	6m.	Sec IHFHK/Dep K
10.	Dissolved substances	6m.	Sec IHFHK/Dep K
11.	Phosphates	6m.	Sec IHFHK/Dep K
12.	Fluorides	6m.	Sec IHFHK/Dep K

No.	Indicator	Period	Laboratory
13.	Cyanide	6m.	Sec IHFHK/Dep K
14.	Borium	1y.	Sec IHLIK/Dep K
15.	Iron	1y.	Sec IHLIK/Dep K
16.	Mangane	1y.	Sec IHLIK/Dep K
17.	Lead	1y.	Sec IHLIK/Dep K
18.	Mercury	1y.	Sec IHLIK/Dep K
19.	Cadmium	1y.	Sec IHLIK/Dep K
20.	Copper	1y.	Sec IHLIK/Dep K
21.	Nickel	1y.	Sec IHLIK/Dep K
22.	Selenium	1y.	Sec IHLIK/Dep K
23.	Chromium	1y.	Sec IHLIK/Dep K
24.	Aluminium	1y.	Sec IHLIK/Dep K
25.	Calcium	1y.	Sec IHLIK/Dep K
26.	Magnesium	1y.	Sec IHLIK/Dep K
27.	Zinc	1y.	Sec IHLIK/Dep K
28.	Sodium	1y.	Sec IHLIK/Dep K
29.	Anthimonium	1y.	Sec IHLIK/Dep K
30.	Arsenicum	1y.	Sec IHLIK/Dep K

3.2.2.3.5 Documentation and processing of data from the groundwater monitoring

Measured quantities of the used surface water and groundwater, and wastewater from the Kozloduy NPP are recorded by the responsible persons and by their measurement units in the quarterly reports to be submitted to the Quality Control Department (Section RSL).

The reported annual quantities of wastewater from WO discharged under contract to the sewers of Kozloduy NPP, are recorded on the RSL in inspection reports.

The results of the sampling and testing of surface, ground and waste water are obtained by the laboratories in the protocols presented in the Quality Department (Section RSL).

The results of the extraction boreholes and measurement of water levels are recorded in protocols.

Based on reports of measured quantities the RSL Department prepares the following documents:

- ✓ quarterly summaries of the measured water levels and discharges obtained through SC Valyata, SC Raney 5, ShPS 1 ÷ 6;
- ✓ Annual Report for quantities of surface and waste waters discharged.

Quarterly summary reports are sent to DRWMBD – Pleven, by the 15th day of the month following the reporting quarter.

The annual reports of used and discharged water quantities are registered in CA and sent to DRWMBD – Pleven, by January 31 of the next year.

Based on the records of the sampling and testing of waste and groundwater department RSL prepares and sends the following references:

TABLE 3.2-45: PREPARED REPORTS

No.	Description	Period	Deadline	Addressee
1	Report on the CHM for water, performed by accredited laboratory	3 m.	By the 10th of the next month	RIEW – Vratsa P Directorate
2	Report on the CHM for water, performed by accredited laboratory	1y.	31 March of the next reporting year	DRWMBD – Pleven
3	Report on the results of the internal company tests for surface and groundwater	1 m.	By the 7th of the next month	P Directorate
4	Report on the results of the CHM for the extracted groundwater, performed by the accredited laboratory	1 y.	45 days before the end of the year	DRWMBD – Pleven, P Directorate
5	Report on the results of the internal company tests of groundwater of the Kozloduy NPP site	4 m.	By the 10th of the next month	P Directorate

Annually, by March 31 Section RSL prepare an annual report on the results from their non-radiation water monitoring during the operation of Kozloduy NPP. The report shall be registered in the Central Archives and sent to DRWMBD – Pleven and RIEW – Vratsa.