REPORT
on the results of radiation and environmental monitoring in the area of the Belarusian Nuclear Power Plant

year 2023

CONTENTS

INTRODUCTION

The Report for 2023 on the results of radiation and environmental monitoring in the control area of Belarusian NPP State Enterprise (hereinafter – the Belarusian NPP, enterprise) was developed within the framework of implementation of the Post-Design Analysis Program of the Belarusian NPP (agreed by the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus on December 23, 2014) to fulfill the obligations of the Republic of Belarus under the Convention on Environmental Impact Assessment in a Transboundary Context (Article 7). The monitoring was carried out by specialized Belarusian organizations.

CHAPTER 1
General description of the Belarusian NPP

The Belarusian NPP is located in Ostrovets District, Grodno Region, Republic of Belarus, 18 km north-east of the town of Ostrovets (Fig. 1.1).

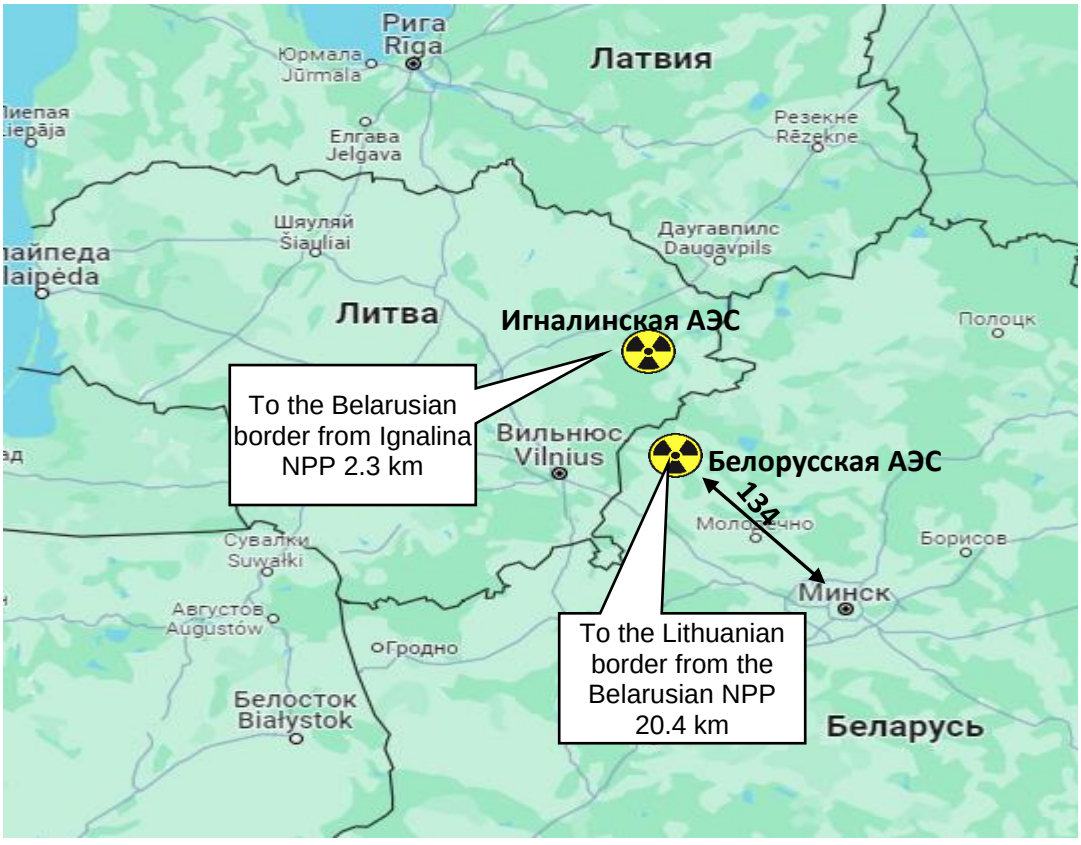


Figure 1.1 - Location map of the Belarusian NPP

The neighboring countries are the Republic of Lithuania (distance to the border - 20.4 km), the Republic of Latvia (distance to the border - 106 km), the Republic of Poland (distance to the border - 194 km), the Russian Federation (distance to the border - 200 km), Ukraine (distance to the border - 315 km).

The distance from the Belarusian NPP site to Minsk, the capital of the Republic of Belarus, is 134 km.

The Belarusian NPP consisting of two power units with total electric capacity up to 2400 MW with VVER-1200 reactors is constructed according to the Russian project "NPP-2006" of generation 3+ near the town of Ostrovets (Grodno region). The design of the Belarusian NPP meets the most modern, so-called "post-Fukushima" standards of reliability and safety, achieved by the introduction of new "passive safety systems" that are able to function without operator intervention in case of full plant blackout.

The actual layout of the NPP power unit with VVER-1200 is presented in Fig.1.2.

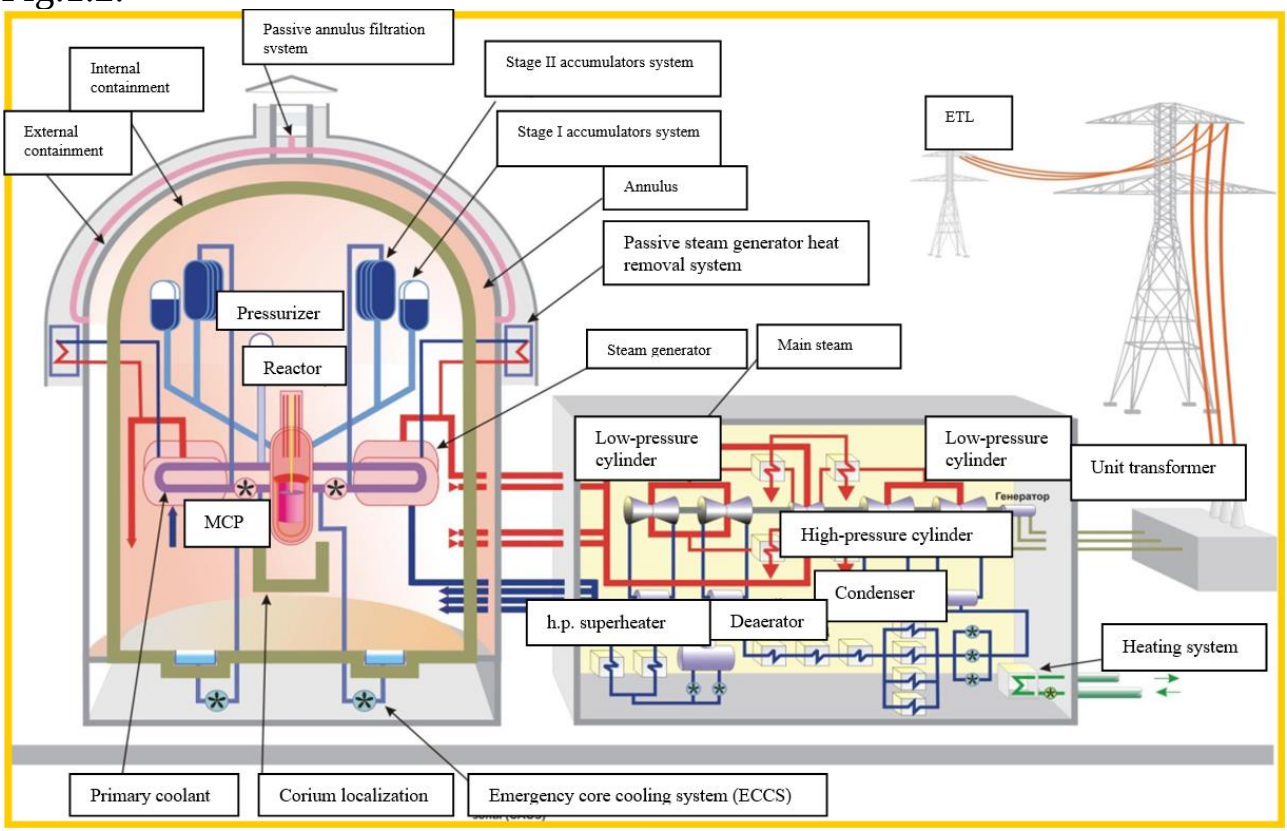


Figure 1.2. – Actual layout of the NPP power unit with VVER-1200

Key purpose technical and economic features:
installed rated power of the power unit – 1200 MW (e);
number of power units - 2;
service life of the power unit - 60 years;
net efficiency factor - 33.7%;

power consumption for plant internal needs - not more than 7.15% of the rated capacity.

The safety assurance in the Belarusian NPP project is based on the defense-in-depth principle - application of a system of barriers to the spread of ionizing radiation and radioactive substances into the environment.

The system of barriers includes:

- fuel matrix preventing fission products release under the fuel cladding;
- fuel cladding preventing fission products from entering the coolant of the main circulation circuit;
- main circulation circuit preventing fission products release under the protective hermetic cladding;
- a system of protective hermetic containments preventing fission products release into the environment.

The safety of the Belarusian NPP project has been repeatedly confirmed by experts of the International Atomic Energy Agency (hereinafter - IAEA) and the World Association of Nuclear Operators (hereinafter - WANO). The experience of Belarus in the implementation of the nuclear power plant project has been duly appreciated by the international nuclear community.

The site of the Belarusian NPP occupies an area of about 1 km^2.

According to the project, the territory of the Belarusian NPP site coincides with the boundary of the sanitary protection zone (hereinafter - SPZ), the observation zone (hereinafter - OZ) is a circle with a radius of 12.9 km.

The Belarusian NPP uses a recycling system of technical water supply with cooling towers and splash pools.

The site of water intake facilities of technical water for make-up of the technical water supply system is located 7 km to the north of the Belarusian NPP site on the Viliya River near the settlement of Malye Sviryanki. The site of the II lifting facilities is located 0.25 km to the north of Matskely settlement.

Water intake facilities of the household and drinking water supply system are located 6 km south-east of the Belarusian NPP in the vicinity of the villages Gaigoli and Popishki. The water intake facilities include 4 sites of water intake facilities and a site of the household drinking water treatment plant.

CHAPTER 2
Main activity of the Belarusian NPP

The second scheduled preventive maintenance (hereinafter - SPM) was carried out at power unit No. 1 of the Belarusian NPP from October 6 to December 16, 2023. Within the framework of the SPM, the following activities were performed: partial reloading of nuclear fuel with fuel element tightness control of all 163 fuel assemblies, maintenance of the main equipment and safety systems of the Belarusian NPP, as well as the scheduled work on metal operational inspection and technical inspection of equipment and pipelines.

In 2023, commissioning of power unit No. 2 of the Belarusian NPP was completed: all planned work at stage B "Physical Startup of the Reactor", stage C "Power Startup" and stage D "Pilot Operation" was successfully completed.

On November 1, 2023, power unit No. 2 of the Belarusian NPP was put into commercial operation.

A total of 22.539 billion kWh of electric power was generated by the power units of the Belarusian NPP from the moment of switching on to the grid till January 01, 2024. The equivalent of substituted natural gas from electric power generation since the first synchronization of turbine generators of power units No. 1, 2 of the Belarusian NPP with the energy system of the Republic of Belarus is 6 billion m^3.

Figure 2.1 - Belarusian Nuclear Power Plant

In order to improve the system of nuclear and radiation safety during commissioning and subsequent operation of the Belarusian NPP, to obtain external expert support from foreign specialists, the Belarusian NPP actively cooperates with international organizations such as IAEA, WANO, European Group of Nuclear Safety Regulators and others.

Interaction with the WANO NPP Moscow Center (hereinafter referred to as WANO NPP - MC) is carried out based on the annual WANO NPP – MC action plan as well as the Working Schedule of interaction between WANO NPP - MC and Belarusian NPP State Enterprise (hereinafter referred to as the Working Schedule) approved bilaterally by the Heads.

As part of the Working Schedule for 2023, 9 activities were carried out on the topics of the personnel policy and training, emergency readiness, exchange of NPP management experience and safety culture.

In 2023 the Belarusian NPP underwent the categorization procedure (determination of the level of interaction and support of the Belarusian NPP by WANO AES - MC) for the first time.

Interaction on monitoring the state of NPP operation is carried out on a permanent basis.

During 2023, the implementation of the IAEA technical assistance project for 2020-2023 "Enchasing the Operational Safety of the Nuclear Power Plant during Commissioning and Operation" (BYE2008) continued.

Based on the package of documents submitted by the Ministry of Energy of the Republic of Belarus to the Ministry of Economy of the Republic of Belarus, the term of implementation of the IAEA project " Enchasing the Operational Safety of the Nuclear Power Plant during Commissioning and Operation" (BYE2008) was extended until December 31, 2024.

CHAPTER 3
Integrated Management System Policy and Radiation Safety Policy of the Belarusian NPP and their implementation

In 2020, the Integrated Management System Policy (hereinafter referred to as IMS) was implemented at Belarusian NPP. The Environmental Management System is a part of the IMS.

In 2021, the Integrated Management System Policy of the State Enterprise "Belarusian NPP" (hereinafter referred to as the IMS Policy) was reissued at Belarusian NPP. The management of Belarusian NPP undertook obligations to implement the IMS Policy, including in terms of environmental protection

through prevention, mitigation and minimization of possible adverse environmental impacts associated with the activities of the enterprise.

In 2023, the Policy in the field of IMS of the State Enterprise "Belarusian NPP" was updated. The updated document establishes the following objectives in terms of environmental management:

production of electric and thermal energy while ensuring safety, including environmental safety, as the top priority of its activities;

rational use of natural resources.

The realization of these objectives is achieved by complying with applicable requirements and other accepted obligations in the field of environmental protection.

All employees are familiarized with the IMS Policy during the introductory briefing on environmental protection.

Implementation of the IMS Policy in 2023 by Belarusian NPP was ensured by:

compliance with the requirements of the legislation of the Republic of Belarus in the field of environmental protection and rational use of natural resources;

demonstration by managers of all levels the leadership for safety purposes;

implementation of internal forms of activity control;

environmental protection through prevention, mitigation and minimization of possible adverse environmental impacts associated with the enterprise's activities.

The radiation safety policy at Belarusian NPP was implemented on April 22, 2019, and updated on April 25, 2022.

Performing the functions of an operating organization in accordance with the regulatory legal acts of the Republic of Belarus in the field of atomic energy use, the State Enterprise Belarusian NPP declares that ensuring radiation safety is one of the priorities of activities in the field of atomic energy use.

The objective of radiation safety policy: to ensure protection of present and future generations of people from the harmful effects of ionizing radiation.

Realization of the goal is achieved by:

carrying out activities on the use of atomic energy in accordance with the provisions in the field of radiation safety reflected in international contracts, agreements and conventions ratified by the Republic of Belarus, national legislation of the Republic of Belarus, local legal acts of the enterprise, as well as IAEA recommendations;

determination of functional responsibilities of the enterprise personnel and representatives of third-party organizations on radiation safety and their responsibility for compliance with the established radiation safety requirements;

determination and implementation of a set of organizational and technical measures aimed at improving radiation safety.

The State Enterprise "Belarusian NPP", realizing the policy in the field of radiation safety, follows the following three main principles:

prohibition of all types of activities on the use of ionizing radiation sources, in which the benefit received does not exceed the risk of possible harm caused by exposure additional to the natural radiation level;

ensuring that the basic radiation dose limits are not exceeded;

maintaining radiation doses and the number of exposed persons when using ionizing radiation sources at the lowest possible and achievable level, taking into account economic and social factors.

The management of the enterprise assumes the following obligations:

creation of necessary organizational and structural conditions for effective functioning of radiation safety management process, allocation of appropriate financial, technical, personnel and other resources;

training and professional development of the enterprise personnel in the field of radiation safety;

informing this Policy to all concerned parties;

consideration and support of any employee initiatives aimed at maintaining and improving radiation safety.

CHAPTER 4
Environmental management and quality management system

The IMS created and functioning at Belarusian NPP is a set of interrelated documented and managed processes aimed at achieving target indicators realized in compliance with the established requirements.

Such safety aspects as nuclear safety, radiation safety, industrial safety, fire safety, technical safety, physical nuclear safety, environmental safety, occupational safety by means of allocation of relevant processes, as well as such elements as quality assurance, human and organizational factors, socio-economic aspects are implemented in the IMS of Belarusian NPP. The highest priority of the enterprise's activity is to ensure safety. By now, within the framework of the IMS of Belarusian NPP the following systems have been implemented, operated and kept up-to-date, and certified in the National System of Confirmation of Conformity of the Republic of Belarus:

- quality management system for production of electric and thermal energy, performance of functions of customer, developer, rendering engineering services when carrying out activities in the field of construction of facilities of 1-4 complexity classes for compliance with the requirements of STB ISO 9001-2015

"Quality Management Systems. Requirements" (certificate of conformity № BY/112 05.01. 003.01.00510 dated 02.12.2022, valid until 01.12.2025);

- health and safety management system for professional activities of electric and thermal energy production for compliance with the requirements of STB ISO 45001-2020 "Health and safety management systems for professional activities. Requirements and guidelines for application" (certificate of conformity No. BY/112 05.04. 003.01.00051 dated 28.04.2021, validity period till 28.04.2024);

- environmental management system of electric and thermal energy production for compliance with the requirements of STB ISO 14001-2017 "Environmental management systems. Requirements and Guidelines for Application" (certificate of conformity No. BY/112 05.10. 003.01.00052 dated 28.04.2021, validity period till 28.04.2024).

Within the framework of the IMS in force at Belarusian NPP:

- the IMS Policy was adopted, which establishes the obligations of top management to maintain and improve the IMS, and IMS objectives;

- the IMS Coordination Council was established and is functioning; its main tasks are coordination of the enterprise's work within the framework of the IMS, maintenance and continuous improvement of the IMS, control over the implementation of decisions made at the meetings of the Coordination Council;

- by the order of the State Enterprise "Belarusian NPP" No. 209 of March 29, 2022, the authorized representatives on IMS to ensure functioning of IMS within the structural subdivisions of the enterprise were appointed;

- IMS documents were developed in various areas of the enterprise's activities (policies, guidelines, enterprise standards, regulations, process data sheets, quality assurance programs (general quality assurance program (GQAP (O), during operation of power units of Belarusian NPP GQAP (E), during handling of nuclear materials (nuclear fuel) QAP (NM (NF)), during handling of operational radioactive waste QAP (RAW), during handling of ionizing radiation sources QAP (IRS)), etc.);

- development of programs for quality assurance of the General Contractor's activity during implementation of the project "Belarusian NPP" GQAP (O1), during design GQAP (P), during construction and installation works GQAP (C), during commissioning of power units of Belarusian NPP GQAP (VE) was ensured;

- current documents are being updated and new documents are being developed;

- IMS processes are defined;

- process owners and their responsibilities are defined;

- process risks are analyzed and assessed, risk registers and risk management programs for IMS processes are developed and periodically updated;

- internal audits of IMS are conducted, including inspections of compliance with the requirements of quality assurance programs, with appropriate documents (programs, reports, corrective action plans);

- external audits of suppliers' management systems are conducted, including verification of compliance with the requirements of quality assurance programs, with execution of relevant documents (programs, plans, reports, corrective action plans);

- monitoring of existing IMS processes and activities of structural subdivisions is carried out with the established periodicity;

- management analysis is performed;

- measures to improve the IMS are defined on a regular basis.


CONFORMITY CERTIFICATE

Registered in the Register under No. BY/112 05.10. 003.01 00946

Registration date 13 December 2023
Expiry date 12 December 2026

Republic Unitary Enterprise
"Belarusian Nuclear Power Plant"

Nuclear power plant building site,
Ostrovets, Grodno region,
231201, Republic of Belarus

Registration Number in the Unified State Register of Legal Entities and Individual Entrepreneurs 190919639

This Certificate of Conformity certifies that the Environmental Management System for production of electric and thermal energy conforms to the requirements of STB ISO 14001-2017 (ISO 14001:2015, IDT)

Additional information:
Issued to replace No. BY/112 05.10. 003.01 00052, registration date 28.04.2021.
First registration date 28.04.2021.

Deputy Director
for Conformity Assessment

In 2023 the independent body on certification of management systems, the Republican Unitary Enterprise "Belarusian State Institute of Metrology" (RUE "BelSIM") re-certified the environmental management system for compliance with the requirements of the standard STB ISO 14001-2017.

As a result, a positive assessment of the functioning of the environmental management system was obtained.

The certificate of conformity was issued No. BY/112 05.10. 003.01 00946 dated 13.12.2023.

In its environmental protection activities to ensure environmental safety, the enterprise is guided by the following basic principles:

ensuring compliance of production activities with legislative, including international requirements in the field of environmental protection;

obligatory assessment of the impact of planned activities on the environment through identification and assessment of environmental aspects of activities,

identification of high environmental risks of the results of the enterprise's activities and development of measures aimed at preventing or reducing the harmful impact of environmental aspects on the environment and management of high environmental risks;

minimizing the negative environmental impact of the nuclear plant;

transparency and availability of environmental information.

In 2023, in order to ensure high environmental performance, the environmental protection department of the enterprise implemented the following measures:

1) the organization standard STO 1.1.1.006.0057-2023 "Management of environmental aspects, risks and opportunities" was developed

2) the risk register of the process PP IMS 04-OOOC for 2023 was updated, the risk management program for the process "Environmental Safety Management" for 2023 was developed;

3) a new IMS process passport "Environmental Safety Management" dated 26.12.2023 No. 0.0345. OOOC.PP-23 was developed. Based on the results of the process performance analysis for previous years, the risks were revised and performance indicators for 2024 were updated.

4) assessment of the ecological condition of soils and substantiation of the regulations for local monitoring of soils in the area of the Belarusian NPP location were carried out.

Chapter 5
Main documents regulating the environmental protection activities of Belarusian NPP and activities in the field of ensuring the functioning of radiation and ecological monitoring of the environment

1. "Convention on Environmental Impact Assessment in a Transboundary Context" (concluded in Espoo 25.02.1991).

2. Law of the Republic of Belarus No. 208-Z of 10.10.2022 "On Regulation of Safety in the Use of Atomic Energy".

3. Law of the Republic of Belarus dd. 26.11.1992 No. 1982-XII "On Environmental Protection".

4. Law of the Republic of Belarus dd. 18.06.2019 No. 198-3 "On radiation safety".

5. Law of the Republic of Belarus No. 2- Z dd. 16.12.2008 "On the Protection of Atmospheric Air".

6. Law of the Republic of Belarus No. 271- Z dd. 20.07.2007 "On Waste Management".

7. Code of the Republic of Belarus No. 406- Z dd, 14.07.2008 "Subsoil Code of the Republic of Belarus".

8. Code of the Republic of Belarus No. 149- Z dd. 30.04.2014 "Water Code of the Republic of Belarus".

9. Code of the Republic of Belarus No. 425- Z dd. 23.07.2008 "Land Code of the Republic of Belarus".

10. Resolution of the Council of Ministers of the Republic of Belarus No. 949 dd. 14.07.2003 "On the National System of Environmental Monitoring in the Republic of Belarus".

11. Resolution of the Council of Ministers of the Republic of Belarus No. 482 of 28.04.2004 "On carrying out certain types of environmental monitoring and use of their data".12. Resolution of the Council of Ministers of the Republic of Belarus No. 576 dd. 17.05.2004 "On radiation monitoring and use of its data".

13. Resolution of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus No. 52 dd. 11.10.2013 "On carrying out industrial observations in the field of environmental protection, rational use of natural resources".

14. STB ISO 9001-2015 "Quality Management Systems. Requirements".

15. STB ISO 14001-2017 "Environmental Management Systems. Requirements and guidelines for application".

16. GOST ISO/IEC 17025-2019. "General requirements for the competence of testing and calibration laboratories".

17. Norms and rules for ensuring nuclear and radiation safety "General provisions for ensuring the safety of nuclear power plants", approved by Resolution of the Ministry of Emergency Situations of the Republic of Belarus No. 15 dd 13.04.2020.

18. Norms and Rules for Nuclear and Radiation Safety "Safety of Nuclear Power Plants in the Sanitary protection zone and Observation zone. Requirements for organization and provision of radiation monitoring", approved by the Resolution of the Ministry of Emergency Situations of the Republic of Belarus dd. 30.06.2016 No. 29.

Other regulatory legal acts of the Republic of Belarus in the field of environmental protection.

CHAPTER 6
System of ensuring technical competence and independence of laboratory control according to GOST ISO/IEC17025-2019

1. A production laboratory (hereinafter referred to as "LP of SSS") has been established at Belarusian NPP in the shop of supporting systems (hereinafter referred to as "SSS"), which meets the criteria of the National Accreditation System of the Republic of Belarus and is accredited for compliance with the requirements of GOST ISO/IEC 17025-2019 "General Requirements for the Competence of Testing and Calibration Laboratories" (accreditation certificate No. BY/112 2.4928 dated 19.05.2017).

LP SSS is accredited to analyze drinking water quality by the following indicators: sampling (GOST 31862-2012), iron (GOST 4011-72 p. 2), odor (GOST 3351-74 p. 2), taste (GOST 3351-74, p. 3), color (GOST 31868-2012, method B), turbidity (GOST 3351-74, p. 5), hydrogen index (STB ISO 10523-2009), total hardness (GOST 31954-2012, method A), dry residue (GOST 18164-72, item 3.1), permanganate oxidizability (STB ISO 8467-2009), total microbial number (MUK RB 11-10-1-2002, item 8.1), thermotolerant coliform bacteria (MUK RB 11-10-1-2002, item. 8.2), total coliform bacteria (MUK RB 11-10-1-2002, p. 8.2), spores of sulfite-reducing clostridia (MUK RB 11-10-1-2002, p. 8.4), synthetic surfactants (FR.1 .31.2014.17189 (PND F 14.1:2:4.158-2000 (M01-06-2013)), petroleum products (FR.1.31.2012.13169 (PND F 14.1:2:4.128-98 (M 01-05-2012))).

LP SSS is also accredited to analyze the quality of surface water and wastewater for the following indicators: sampling (GOST 31861-2012, STB 17.13.05-29-2014/ISO 5667-10:1992, STB ISO 5667-6-2021), mass concentration of hydroxyethylidene diphosphonic acid zincdinatrium salt (MVI.MN 6332-2021), suspended solids (MVI.MN 4362-2012), water mineralization (MVI.MN 4218-2012), phosphorus total

(GOST 18309-2014, method G), total iron (STB 17.13.05-45-2016), hydrogen index (STB ISO 10523-2009), chemical oxygen consumption (FR.1.31.2012.12706 (PND F 14.1:2:4.190-2003)), phosphate ion (GOST 18309-2014, method B), ammonium ion

(STB 17.13.05-09-2009/ISO 7150-1:1984), nitrite-ion

(STB 17.13.05-38-2015), nitrate-ion (STB 17.13.05-43-2015), chloride-ion (STB 17.13.05-39-2015), sulfate-ion (STB 17.13.05-42-2015), synthetic surfactants (FR.1.31.2014.17189 (PND F 14.1:2:4.158-2000 (M01-06-2013))), petroleum products (FR.1 .31.2012.13169 (PND F 14.1:2:4.128-98 (M 01-05-2012)), temperature (MVI.MN 5350-2015), mass concentration of hydroxyethylidene diphosphonic acid zincdinatrium salt (AMI.MN 0015-2021).

Accreditation certificate validity period: until 19.05.2027.

2. The design documentation of the Belarusian NPP as part of the radiation monitoring system provides for radiation monitoring of the environment in the SPZ and OZ with the help of the automated radiation monitoring system (hereinafter -ARMS) and the environmental radiation monitoring laboratory (hereinafter - ERML) of the radiation safety division (accredited in the National Accreditation System of the Republic of Belarus for compliance with the requirements of GOST ISO/IEC 17025-2019 "General Requirements for the Competence of Testing and Calibration Laboratories", accreditation certificates No. BY/112 2.5262 of 22.01.2021 and No. BY/112 1.1824 of 10.09.2021.

ARMS is designed for continuous monitoring of radiation situation in the SPZ and OZ of Belarusian NPP. The software and hardware complex of the

ARMS includes: 10 radiation monitoring stations (9 of which are located in the territory of the OZ and 1 - in the control point outside the OZ (Svir settlement)); automated meteorological station (Vornyany settlement); 2 mobile radiometric laboratories; main central monitoring station at the site of the Belarusian NPP and reserve central monitoring station in Ostrovets.

ERML is designed for periodic laboratory control of radionuclide content in environmental objects (atmospheric air, atmospheric fallout, precipitation, soil, groundwater, surface water, bottom sediments, aquatic and terrestrial vegetation) in the SPZ and OZ of the Belarusian NPP, as well as in agricultural products and locally produced foodstuffs (vegetables, fruits, milk, meat, fish).

CHAPTER 7
Industrial environmental monitoring

On the basis of Article 94 of the Law of the Republic of Belarus "On Environmental Protection" and in accordance with the Resolution of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus dated dated 11.10.2013 № 52, the following local regulatory documents and monitoring plans - schedules for the organization of production monitoring in the field of environmental protection have been developed:

- standard of organization STO 1.1.1.006.0009-2022 "Basic Rules for Ensuring Environmental Protection at the Nuclear Power Plant";
- instruction on implementation of production monitoring in the field of environmental protection and rational use of natural resources at the Belarusian NPP;
- instruction on production waste handling at Belarusian NPP;
- radiation control regulations of the Belarusian NPP;
- program of radiation monitoring of the environment in the sanitary protection area and control area of Belarusian NPP;
- instructions for control of radioactive emissions and discharges of radioactive substances at Belarusian NPP;
- plan-schedule of observations within the framework of local monitoring;
- plan-schedule of observations of pollutant emissions into the atmospheric air from stationary sources;
- map-scheme of location of sources of pollutant emissions into the atmospheric air within the framework of local monitoring;
- map-scheme of location of observation wells within the framework of local groundwater monitoring;

- map-scheme of location of pollutant emission sources and emission sources at the production sites of the natural resource user.

The main tasks of industrial environmental observations at Belarusian NPP are:

- control over fulfillment and compliance with the requirements of the legislation of the Republic of Belarus in the field of environmental protection;
- rational use of natural resources;
- control over the state of the environment in the area affected by the results of economic activities of the Belarusian NPP;
- accounting of the nomenclature and quantity of pollutants entering the environment from economic and other activities;
- timely and reliable submission of information on the state and pollution of the environment to the state environmental control authorities, including emergency pollution from economic and other activities of the Belarusian NPP;
- participation in development of projects and implementation of state (republican, branch, local and other) programs and measures on rational use of natural resources and environmental protection aimed at prevention and elimination of environmental pollution;
- control over the operation of environmental protection equipment and facilities;
- organization and development of the system of education, upbringing in the field of environmental protection and formation of ecological culture, as well as training and retraining of specialists in the field of environmental protection.

Based on the results of industrial environmental observations, acts of industrial environmental observations or prescriptive acts (in case of observations) are drawn up.

The objects of industrial environmental observations are:

- construction site of the Belarusian NPP, including engineering networks (technical water supply, power supply, etc.);
- facilities of the production base, which are in gratuitous use of the general contractor JSC ACE;
- production base facilities used by the state enterprise "Belarusian NPP";
- housing facilities used by the State Enterprise "Belarusian NPP";
- sources of water supply (underground water intake in the Losha River basin; surface water intake from the Viliya River) and water disposal (surface water object of the Viliya River; technological water object of the Losha River basin - evaporation pond from the territory of military unit 7434);
- sources of production and consumption wastes generation: workshops, sections, technological processes and particular technological stages;
- emissions of pollutants into the air by stationary and mobile sources;

- wastewater discharges into water objects, including sewerage systems and wastewater disposal networks, wastewater treatment systems;
- surface waters in the area where wastewater discharge sources are located;
- groundwater in the area of location of identified or potential sources of their pollution;
- lands (including soils) in the area of location of identified or potential sources of their pollution;
- objects of flora.

Analytical (laboratory) control in the field of environmental protection with the involvement of accredited testing laboratories is organized and carried out at the State Enterprise "Belarusian NPP".

In accordance with the Resolution of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus No. 5 dated 11.01.2017, the State Enterprise "Belarusian NPP" from 22.07.2020 is included in the list of legal entities carrying out local monitoring. The objects of local monitoring are:

- emissions of pollutants into the atmospheric air from technological and other equipment, technological processes, machines, mechanisms (4 sources of boiler unit emissions);
- wastewater discharged into surface water objects and surface water in the area where the sources of wastewater discharges are located (the place of wastewater discharge into the Viliya River, reference and control stations on the Viliya River);
- groundwater at the locations of identified or potential sources of pollution (3 observation wells on the territory of the enterprise);
- soils (sub-soils) in the locations of identified or potential sources of their pollution (16 sampling sites on the territory of the enterprise).

CHAPTER 8
Environmental impact

1. Protection of atmospheric air

In 2023 the inventory of pollutant emissions into the atmospheric air from the facilities of the State Enterprise "Belarusian NPP" located at all production sites of the enterprise was completed. The total volume of pollutant emissions established in the Act of Inventory of pollutant emissions into the atmospheric air (hereinafter referred to as the Inventory Act) is 90.683 tons per year. The total actual volume of pollutant emissions from all facilities in 2023 was 19.3475 tons, which is 21.34% of the total established volume.

According to the Inventory Act, the number of operating sources of pollutant emissions located at all production sites of the enterprise is 130, including: organized - 106, unorganized - 24.

The main sources forming the gross emission of pollutants from the enterprise facilities are presented in Table 8.1.

Table 8.1 - Key sources of pollutant emissions at the state enterprise “Belarusian NPP”

№	Source of pollutant emissions	Emission value established by the Inventory Act, t/year	Actual emission volume for 2023, tons/year
1	Sewage treatment plant complex (STP)	8,503	8,503
2	Boiler house of the military camp for NPP protection (BMGK).	0,698	0,313
3	Free access zone workshops	2,92	1,75
4	Diesel generator units (DGU)	25,14	5,69
5	Startup reserve boiler station (SRS)	51,409	0,114

The contribution of the main sources of pollutant emissions to the gross emissions of the enterprise in 2023 is shown in Figure 8.1.

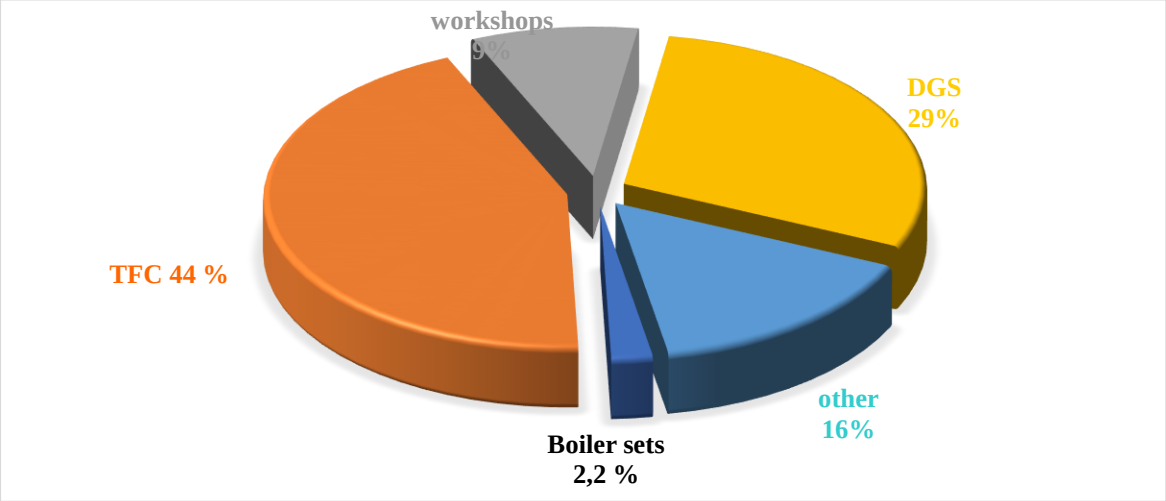


Figure 8.1 –Gross emissions from key sources of pollutant emissions at the Belarusian NPP in 2023, %.

For 64 emission sources the norms of permissible emissions are established in the permit.

According to the new permit for emissions of pollutants into the atmospheric air No. 04/12.0098 dated 19.05.2023, the norm of permissible emissions is 62.955197 tons/year.

The actual gross emission of pollutants into the atmospheric air from standardized stationary emission sources under the permit in 2023 amounted to 10.57 tons, which was 16.8% of the established standardized value.

Dynamics of pollutant emissions in tons from boiler units of the enterprise in comparison with previous years is presented in Figure 8.2.

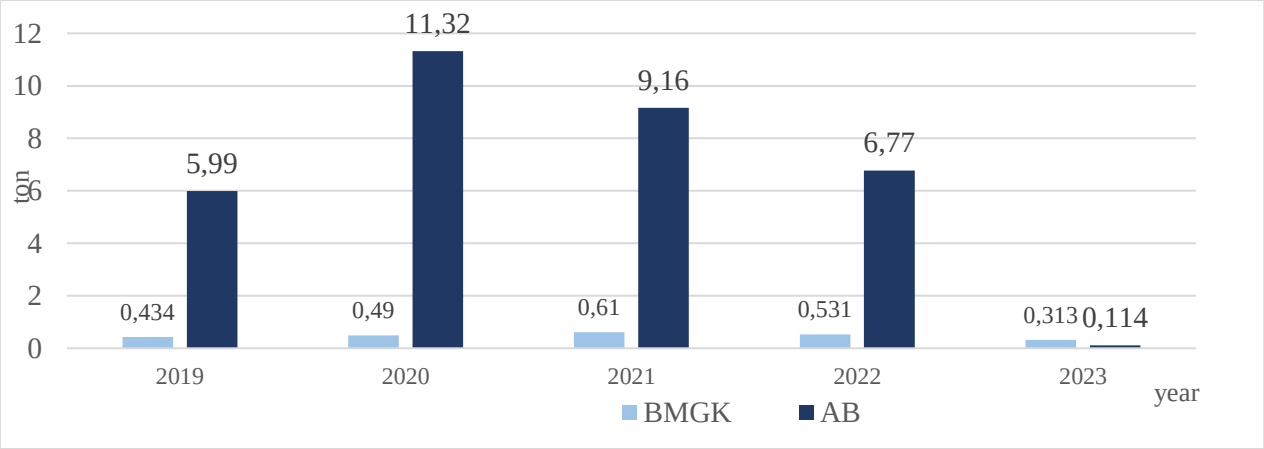


Figure 8.2 – Evolution of pollutant emissions from the Belarusian NPP boiler sets, ton/year.

The reduction of emissions from the auxiliary boiler (hereinafter AB) in 2023 compared to the previous year was due to the operation of Power Unit No. 1 and commissioning of Power Unit No. 2.

The AB operated only in accordance with the approved Schedule of Tests, Trials and Equipment Transitions.

The company's emissions contain pollutants of 1 - 4 hazard classes, with hazard class 1 substances accounting for 0.00146 tons, hazard class 2 substances - 3.15 tons, hazard class 3 substances - 0.8 tons, and hazard class 4 and no hazard class substances - 15.396 tons. The contribution of pollutant emissions grouped by hazard class to the total actual emissions for 2023 is presented in Figure 8.3.

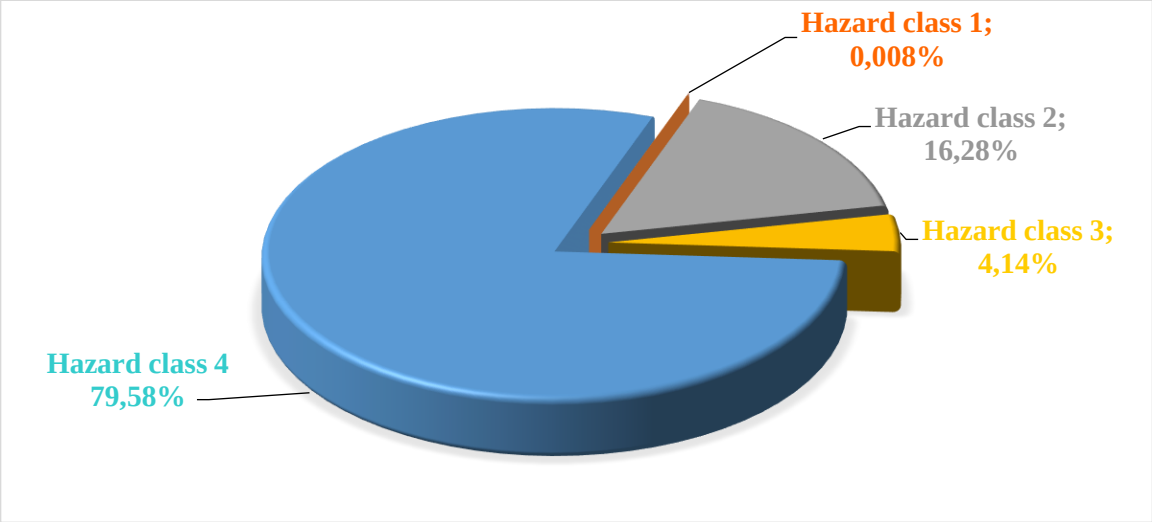


Figure 8.3 – Composition of air pollutant emissions in 2023, %.

In 2023, analytical (laboratory) control of pollutant emissions from the objects of impact, gas regulator station ("GRS") and BMGK was carried out. During the reporting period 5 measurements of pollutant emissions were carried out for 10 pollutants and protocols of environmental measurements were drawn up.

No exceedances of permissible emission standards were detected for any pollutant.

2. Production waste handling

In accordance with the Law of the Republic of Belarus dated 20.07.2007 No. 271-3 "On Waste Handling" the state enterprise "Belarusian NPP" carries out separate collection of generated production waste.

In 2023 the inventory of production waste was carried out, the Instruction on production waste handling at Belarusian NPP was developed, in accordance with which production waste is handled.

In 2023, 384.5 tons of production waste were generated at the state enterprise "Belarusian NPP" (in 2022 - 125 tons). As of the end of 2023 there are 107.12 tons of waste in temporary storage, mercury-containing waste - 98 units.

Distribution of waste in tons by hazard class for the reporting year is presented in Figure 8.4.

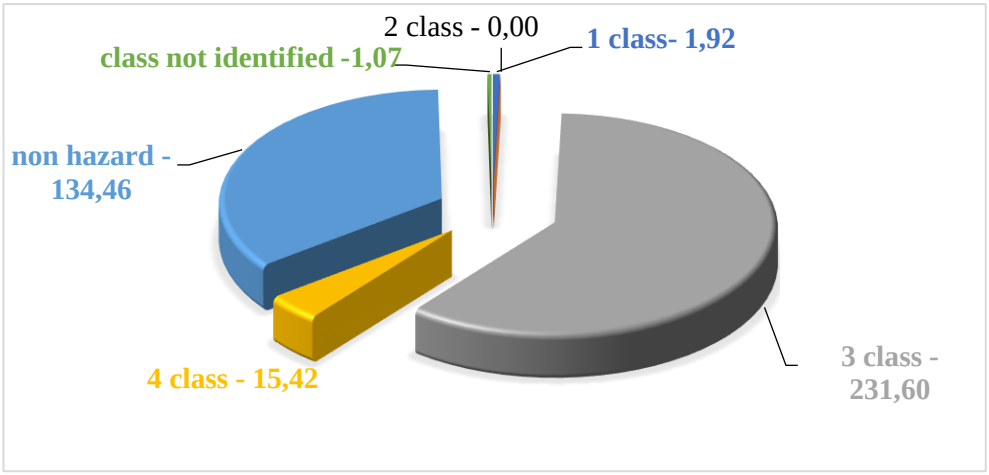


Figure 8.4 – Waste generation in 2023 according to Hazard Class, ton.

In the reporting year, production wastes were transferred to facilities for use and disposal in accordance with permits and agreements, as well as moved to temporary storage sites. The share of secondary material resources from the total volume of waste amounted to 6.4% (22.4% in 2022). The increase in the share of waste transferred for disposal was due to the commissioning of power unit No. 2 of the Belarusian NPP and the implementation of relevant production processes. In connection with the exhaustion of the resource of lamps of lighting devices the amount of waste transferred for neutralization (used mercury lamps, used fluorescent tubes, used compact fluorescent lamps (energy-saving)) increased: in 2023 - 1117 pcs. (in 2020 and 2021 - 0 pcs., in 2022 - 1460 pcs.). The dynamics of waste generation in tons compared to previous years is shown in Figure 8.5.

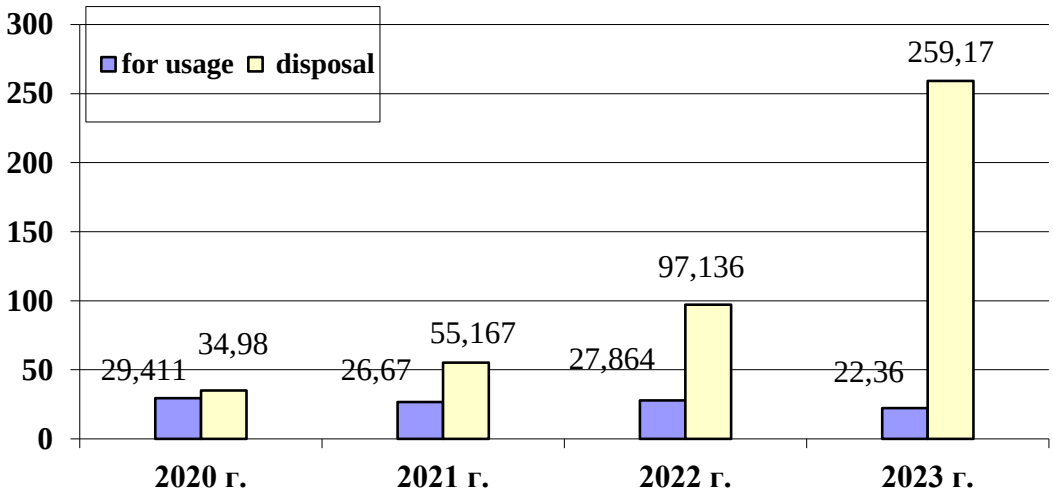


Figure 8.5 - Dynamics of production waste transfer to use and disposal facilities, tons.

During the operation of the Belarusian NPP in 2023, radioactive waste (after preliminary sorting before reprocessing) was generated in the following quantities:

at power unit No. 1:

very low-level waste and solid waste of the controlled access zone - 102.6155 m^3;

very low-level solid radioactive waste - 22,364 m^3;

low-level solid radioactive waste - 10,026 m^3;

medium-active solid radioactive waste - 4.357 m^3;

high-level solid radioactive waste - 0.667 m^3;

at power unit No. 2:

very low-level waste and solid waste of the controlled access zone - 22.2075 m^3;

very low-level solid radioactive waste - 3.6432 m^3;

low-level solid radioactive waste - 0.88165 m^3;

moderately active solid radioactive waste - 0.175 m^3.

After reprocessing and containerization, solid radioactive waste was placed in the solid radioactive waste storage facility in the amount of 284 packages (metal barrels with the volume of 0.2 m^3 each) filled with very low-level waste and solid waste of the controlled access zone (177 barrels - power unit No. 1, 24 barrels - power unit No. 2), very low level solid radioactive waste (44 barrels - power unit No. 1, 8 barrels - power unit No. 2), low level solid radioactive waste (16 barrels - power unit No. 1), medium level solid radioactive waste (15 barrels - power unit No. 1), as well as 6 capsules (0.05 m^3 each) filled with high level solid radioactive waste with a total volume of 57.1 m^3.

3. Use and protection of water resources

Water consumption and water disposal at Belarusian NPP was carried out in accordance with the limits set in the permit for special water use No. 04.12.0397 dated 17.06.2022 and did not exceed the design and established values.

The volumes of water consumption and water discharge for 2023 compared to previous years are given in Table 8.2.

Table 8.2 – Water consumption and water disposal volume at the state enterprise “Belarusian NPP” in 2023 year.

Indicator	Limits established in the permit for special water use, thousand m^3/year	Amount, thousand m^3			
		2020	2021	2022	2023
1. The volume of produced (received) water, total	70 682,2	5 527,4	29 567,8	29 537,8	49 686,5
2. Water used for household needs, total	34 392,0	160,8	15 382,2	22 509,8	3 590,4
3. Water used for transferred to other organisations	36 253,7	5 366,7	14 185,6	6 930,3	139,1
4. Volume of wastewater discharged into a surface water body	31 781,3	4 155,2	19 176,6	21 998,0	26 408,2
Name of indicator	Water use limits established in accordance with the special water use permit, thousand m^3/year	Value, thousand m^3			
		2020 г.	2021 г.	2022 г.	2023 г.
1. volume of withdrawn (extracted) and received water, in total	70 682,2	5 527,4	29 567,8	29 537,8	49 686,5
2. The volume of water used for own needs, total	34 392,0	160,8	15 382,2	22 509,8	3 590,4
3. Volume of water transferred to other organizations	36 253,7	5 366,7	14 185,6	6 930,3	139,1
4. Volume of wastewater discharged into surface water objects	31 781,3	4 155,2	19 176,6	21 998,0	26 408,2

Local monitoring is carried out at 3 observation points (wastewater discharge site in the Viliya River, background and control sites on the Viliya River).

Analytical quality control of drinking water and wastewater is carried out by LP SSS. In addition, third-party accredited laboratories are involved on a contractual basis to perform the full scope of production observations.

In the period from January to December 2023, 25 studies of wastewater and surface water samples taken at 3 observation points of local monitoring with 98 protocols of measurements in the field of environmental protection were carried out.

According to the results of observations for the reporting period, no exceedances were detected.

4. Groundwater protection

In 2021 the list of observation points of local environmental monitoring includes 3 observation wells on the territory of Belarusian NPP.

Groundwater monitoring at the locations of identified or potential sources of its pollution includes 3 types of works: observations of groundwater level dynamics; observations of groundwater temperature; observations of groundwater chemical composition dynamics. Chemical analysis included determination of BOD5, mineralization, pH, temperature, COD_{cr}, total iron, potassium, sodium, sulfate ion, chloride ion.

In April 2023, according to the agreement with "BelGidrotekhproekt" Limited Liability Company, the study of groundwater samples from 3 observation wells was carried out with registration of the protocol of measurements in the field of environmental protection.

According to the results of observations for the reporting period, no exceedances were detected.

5. Plant world

In 2023, the record sheets for the limited-use landscaped areas of the company's sites were updated.

6. Carrying out integrated environmental monitoring

In 2023, comprehensive environmental monitoring was carried out in the OZ and SPZ of Belarusian NPP.

The forces and resources of specialized accredited organizations of the Republic of Belarus were involved in the work on the basis of agreements.

According to the monitoring programs of Belarusian NPP, the following types of monitoring were carried out in 2023:

- observations of groundwater regime;
- monitoring of meteorological processes, phenomena and factors, including, inter alia, meteorological and microclimate observations;
- aerological monitoring;
- observations of surface water regime;
- seismological monitoring;
- geodetic monitoring of modern movements of the earth's crust;
- monitoring of pollution of the surface layer of the atmosphere, terrestrial and aquatic ecosystems, water objects, condition of aquatic biological resources;
- radiation monitoring.

6.1 Observations of groundwater regime

In 2023, observations of groundwater regime included three types of works: observations of groundwater level dynamics; observations of groundwater temperature; observations of groundwater chemical composition

dynamics and its possible contamination. Chemical analysis included determination of physical properties of water, mineralization, water hardness, free and aggressive CO_2, O_2 oxidizability, ions Cl^-, SO_4^{2-}, HCO^{3-}, Ca^{2+}, Mg^{2+}, Na^+, K^+, Fe_{gen}, pH, BOD_5, COP_{Cr}.

Observations were carried out at equipped observation wells (piezometric observation well network consists of 26 well clusters) (Figs. 8.6, 8.7).

Figure 8.6 - Piezometric well cluster

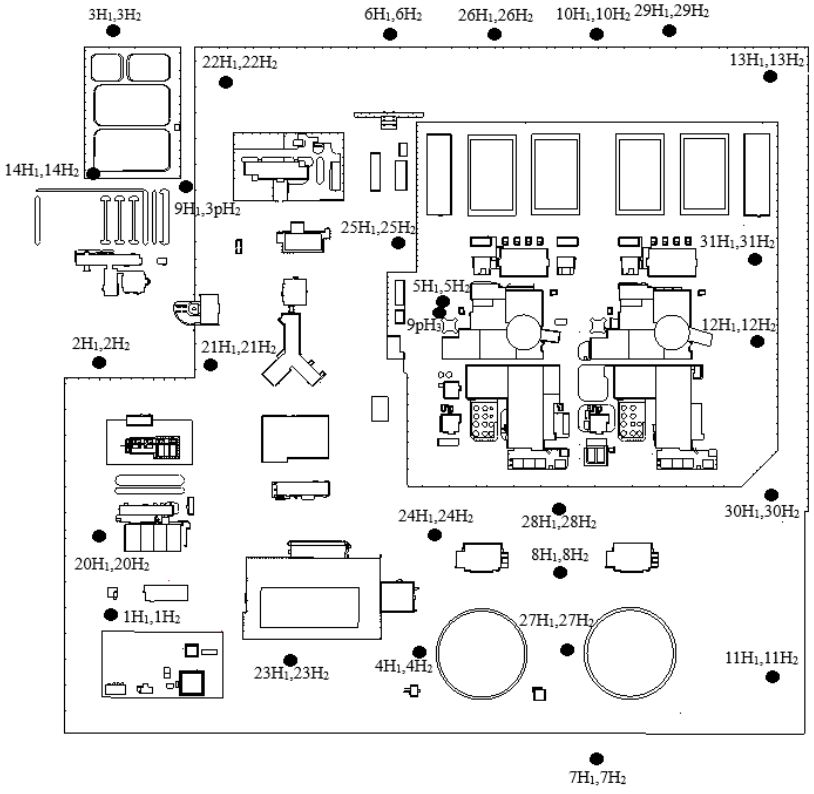


Figure 8.7 – Piezometric well clusters map

According to the results of groundwater monitoring in 2023, the full scope of work to determine the groundwater regime was performed.

The site of Belarusian NPP location was and remains in the zone of groundwater transit and inflow. During the periods of maximum and minimum levels the direction of groundwater flow is the same. The groundwater level regime of the groundwater observation wells on the territory of the Belarusian NPP location generally correlates with the fluctuations of daily precipitation recorded by the meteorological station (hereinafter referred to as MS) Markuny, which can be seen in Figure 8.8, and in general remains stable throughout the year (the average amplitude of fluctuations during the year does not exceed 1.3 m). Water levels in the observation wells located in the Szohsky finite-marine H2 aquifer fluctuated between 155.93 and 164.94 m of the Baltic Height System (hereafter referred to as BS) with an average value of 160.80 m BS. The amplitude of water level fluctuations in these piezometers during the 2023 varied from 0.44 to 6.49 m with a mean at 1.26 m. The water level in the only observation well installed in the Szohsky finite-marine aquifer H3 fluctuated insignificantly during 2023 - within the absolute values of 150.39 to 150.99 m BS with the average value at the level of 150.66 m BS, the amplitude of fluctuations amounted to 0.27 m. The obtained dynamics of the groundwater level indicates the absence of "hydrogeological windows" on the site and adjacent to it territory, through which intensive groundwater feeding due to infiltration of atmospheric precipitation and ingress of harmful chemicals into groundwater is possible. In general, the groundwater level remains stable.

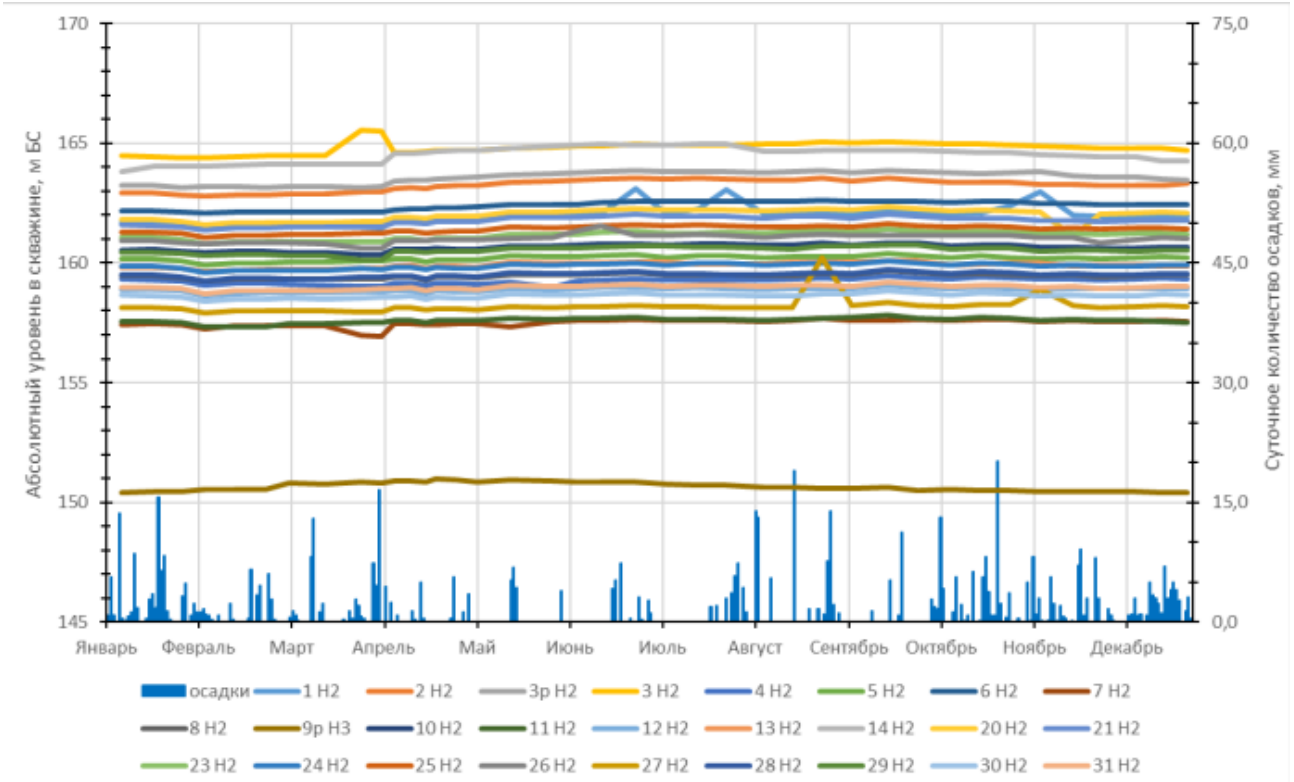


Figure 8.8 - Graph of the dependence of the level of groundwater on the amount of precipitation in 2023
(The graph is provided for illustrative purposes only)

The temperature regime of groundwater of the observation wells on the territory of Belarusian NPP in general correlates with climatic factors (average daily atmospheric air temperature), which can be seen in Figure 8.9. Thus, the groundwater temperature increased from May to November, as in the previous observation periods. Groundwater temperature in observation wells located in the Szohsky finite-marine aquifer ranged from 7.8 to 11.0°C with an average value of 8.8°C. The regular increase in the warm period and decrease in the cold period indicates that there is no recharge by heated water from water-bearing utilities. According to the classification OST 41-05-263-86 ground waters of observation wells on the territory of the Belarusian NPP are characterized as cold all the year round (the temperature does not exceed the range of 4 - 20 °C). In general, the temperature regime of groundwater remains stable.

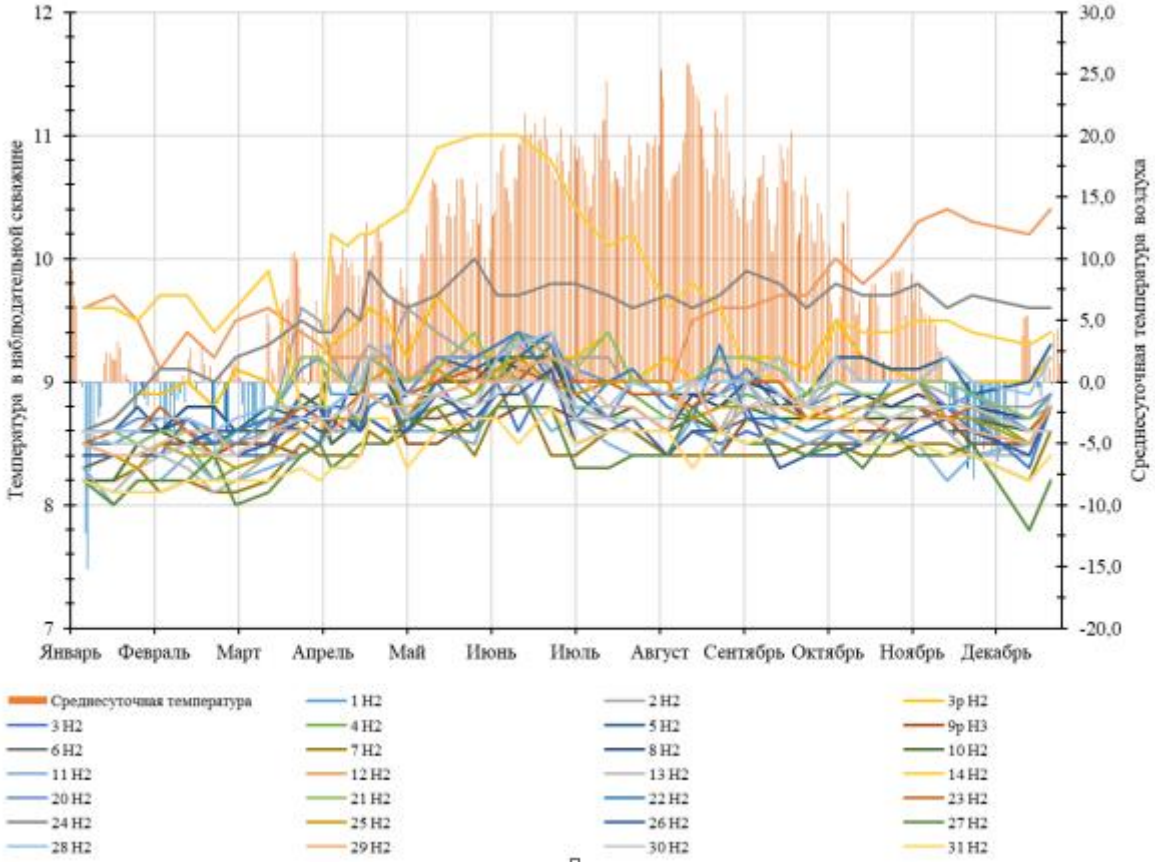


Figure 8.9 – Graph of dependence of groundwater temperature on air temperature in 2023

The waters of observation wells are characterized by hydrogen index from neutral (7.44 pH) to alkaline (9.20 pH), by mineralization all fresh (less than 1 g/dm^3), by hardness - from very soft (1.19°J) to hard (7.13°J), which coincides with the values obtained in 2022. The content of aggressive and free carbon dioxide in the collected groundwater samples did not exceed 8.8 mg/l, in most of the samples the values of these indicators were not detected at all. Oxidizability of the collected samples during the year fluctuated within the range of 0.32 - 5.36 mgO_2/dm^3, averaging 1.17 mgO_2/dm^3 for the year. BOD and COD values ranged from 0.5 - 24.00 (5.88) and 1.09 - 47.7 (12.71), respectively. The anionic composition of groundwater samples was dominated by hydrocarbonates. The fluctuations in the values of the content of the determined anions during 2023 were: hydrocarbonates 39.70 - 341.60 mg/dm^3; chlorides 2.80 - 84.20 mg/dm^3; sulfates less than 2.0 - 67.50 mg/dm3; carbonates 0.20 - 12.0 mg/dm3. Calcium and magnesium cations predominate in the cation composition of groundwater samples. Fluctuations in the values of the content of determined cations during 2023 amounted to: calcium 8.50 - 98.10 mg/dm^3; magnesium 7.40 - 35.60 mg/dm^3; sodium 2.80 -51.00 mg/dm3; potassium 0.67 - 5.00 mg/dm^3; iron 0.28 - 23.98 mg/dm^3.

Waters of all wells in average for 2023 are characterized as hydrocarbonate magnesium-calcium.

In general, during the observation period the chemical composition of groundwater is relatively stable. Surface contamination of groundwater caused by the technological cycle of the Belarusian NPP was not observed.

6.2 Monitoring of meteorological processes, phenomena and factors

In 2023, 8 long-term observations of meteorological parameters were carried out at MS "Markuny", as well as a set of special observations: gradient observations of air temperature and humidity, wind speed at 0.5 and 2 m heights; observations of ice and frost phenomena, measurements of soil temperature at depth, and observations of evaporation from the water surface (Figs. 8.10, 8.11).

Figure 8.10 - Markuny meteorological station

In 2023, the average air temperature according to MS Markuny was 13.4°C and the average soil temperature was 14.2°C. The coldest month in 2023 was February with an average monthly air temperature of minus 1.2°C, the hottest month was August with an average temperature of 19.8°C. The absolute maximum air temperature of 32.6°C was recorded in August, the absolute minimum was observed in January and made minus 17.6°C.

The average value of relative humidity for the year is 81%. Average monthly values of relative humidity varied from 68 % in March to 89% in December. The lowest value of relative air humidity was recorded in May and equaled 20%. The highest number of days with relative humidity above 80% at

15 hours was observed in December and amounted to 31 days. The daily variation of relative humidity in all months tends to decrease in the daytime hours with minimum values at 15 hours local time. From March to September relative air humidity and saturation deficit have a pronounced daily variation, while in other months it is smoother.

Water vapor partial pressure follows the course of monthly mean air temperature and increases from winter to summer, reaching maximum monthly mean values in August (17.8 mb, respectively) and decreasing again by the end of the year to values of 0.1 mb for water vapor partial pressure.

During 2023, the mean daily pressure at MS Markuny varied from 987.5 hPa to 1003.3 hPa and averaged 999.1 hPa. The highest atmospheric pressure at the time was recorded on September 25 and comprised 1016.5 hPa, the lowest - 956.3 hPa on December 23.

Figure 8.11 - Measuring tools at the Markuny meteorological station

A total of 254 days with precipitation were observed during the reporting period. During the year, 646 mm of precipitation fell, most of it in January, August, October, December, when monthly precipitation totals exceeded 80 mm. The maximum daily layer of precipitation was observed on October 26 and amounted to 20.2 mm. During the year, winds of northwesterly and westerly directions prevailed. The least frequency of occurrence was observed in the east rhumb winds (Fig. 8.12).

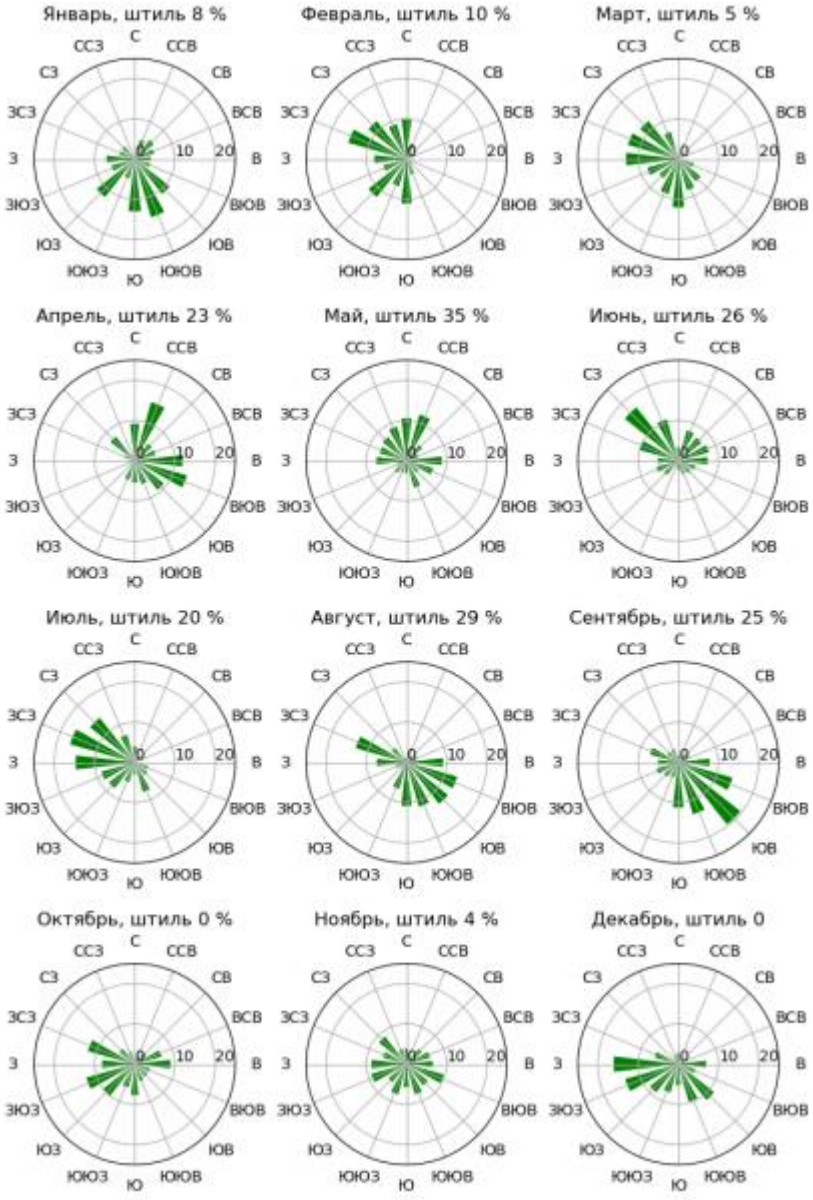


Figure 8.12 – Wind roses according to MS Markuny
for January - December 2023

The average annual wind speed for 2023 was 3.0 m/s, with the highest average monthly values in December (4.3 m/s).

Winds with speeds of 2-3 m/s during the year amounted to 50 %, cases of calm and winds with speeds of 1 m/s were most often observed in the summer months, totaling 21 % for the year. Winds above 4 m/s accounted for 18% of the total frequency of occurrence. Winds above 6 m/s were recorded in winter, but their frequency of occurrence was about 10%. The highest frequency of weak winds prevailed from April to September.

The maximum wind speed in the gust between the dates was highest in August (30.08) and October (07.08.10) and reached 24 and 23 m/s, respectively. Slightly lower maximum gust was recorded in March and amounted to 20 m/s.

In February, July and December, the wind gusts reached 18 m/s, and in January 17 m/s. Next in decreasing order of wind gusts strength are May and September 6 m/s. In April, June, September and November, wind gusts did not exceed 14-15 m/s.

The available values of meteorological characteristics for the period 2015-2023 are still insufficient for conclusions about climatic conditions in the study area, and we can only speak about the update of extreme values of meteorological characteristics.

6.3 Observations of microclimate

In 2023, microclimatic observations were continued in the area of the Belarusian NPP. Microclimate observations were carried out at 10 points on two transects. One transect Czech Republic - Bobrovniki is oriented from east to west, the other one Michalishki - Czech Republic is oriented from north to south (Fig. 8.13). At each transect, observations were made at 5 points twice a day at 6 and 18 hours.

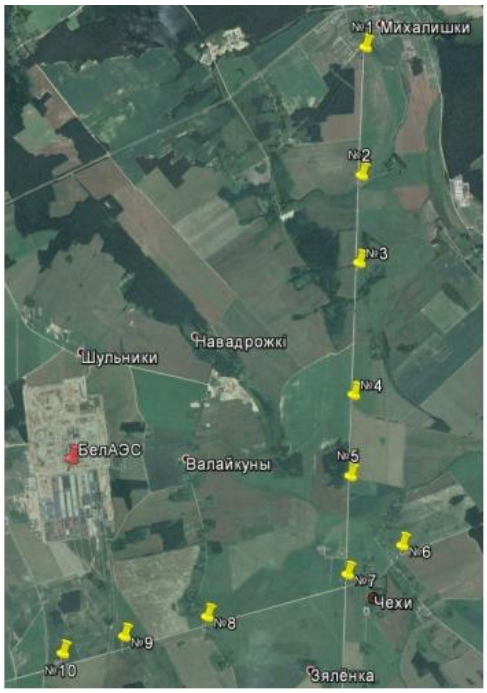


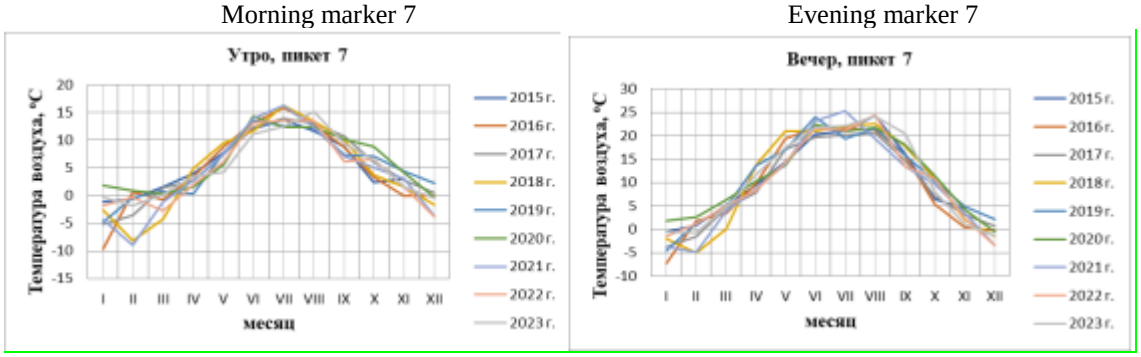
Figure 8.13 – Map of microclimate monitoring points

According to the monitoring results, the combined graphs of air temperature variations showed that the values of air temperature at the pickets and MS Markuny, MS Lyntupy, MS Oshmyany are practically the same (the difference between the values on average does not exceed 0.6 °C).

Combined graphs of air temperature variations at the pickets showed: for the observation period from 2015 to 2023, the lowest air temperature values were registered in 2016 in January minus 9.6 °C (morning) and minus 7.4 °C (evening); the highest air temperature values were registered in July evening in 2021 (25.5 °C) and in July morning in 2018 and 2021 (16.5 °C). The winter of

2019 - 2020 can be classified as anomalously warm, as the air temperature has positive values (above 0.0 °C) (8.14).

Morning marker 7 Evening marker 7



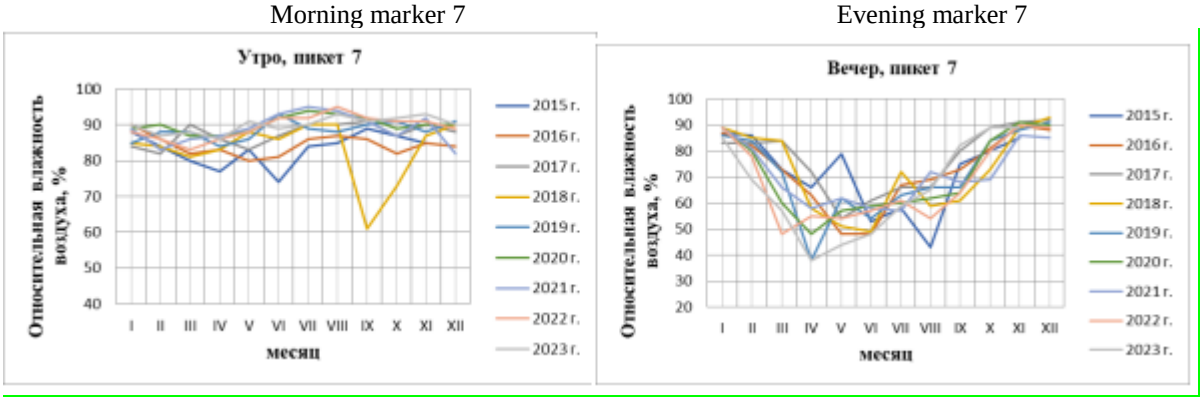
Month Month

Figure 8.14 – Combined air temperature graphs at marker 7 during the observation cycle of 2015-2023.

The combined graphs of the relative air humidity variations showed that predominantly the relative air humidity values at the meteorological stations were higher than at the pickets. The lowest relative humidity values were in the evening in May (at the pickets at MS Oshmiany 38 - 39 %, at MS Markuny - 39 %, and at MS Lyntupy - 40 %).

Combined graphs of the course of relative humidity at the pickets for the observation period from 2015 through 2023 showed that the driest month in the morning (with the lowest relative humidity) was September 2018 (relative humidity 60%). The driest month in the evening for the entire observation period was April 2019 (relative humidity 38 %). Correspondingly, the most humid month in the morning was July 2022 (95 %) and in the evening was November 2020 (93 %). The highest annual average relative humidity in the morning time was observed in 2020 (91 %), and the lowest annual average relative humidity in the evening observation time was in 2022 and in 2023 (68 %) (Figure 8.15).

Morning marker 7 Evening marker 7



Month Month

Figure 8.15 – Combined relative humidity graphs at the marker 7 during the observation cycle of 2015-2023 years.

The combined graphs of wind speed variations showed that at MS

Oshmiany the wind speed values both in the morning and in the evening are higher compared to other observation points. In spite of the fact that wind speed values at the meteorological stations and pickets fluctuate among themselves during the entire observation period, the dynamics of these fluctuations is similar. Generally, the wind speed at the pickets is lower than at the meteorological stations.

The combined graphs of wind speed progression at the pickets showed: for the observation period from 2015 to 2023, the highest wind speed values were observed in the morning in February 2022 (3.4 m/s) and in the evening in March 2019 (4.3 m/s) (Figure 8.16).

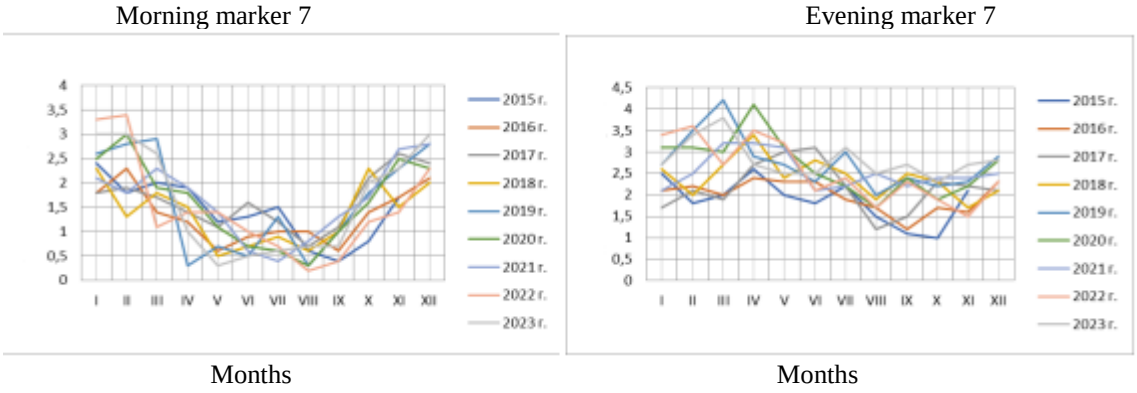


Figure 8.16 – Combined wind speed graphs at the marker 7 during the observation cycle of 2015-2023 years

For the eight-year observation period the results of the main microclimatic parameters (air temperature, wind speed, relative air humidity), which are the criteria determining the microclimate changes, were obtained. However, it should be noted that the available observation database is still insufficient for statistical processing and assessment of microclimate changes in the area of Belarusian NPP location. Observations of microclimatic parameters will be continued.

Thus, even after full commissioning of the Belarusian NPP and its reaching full capacity, no external microclimatic errors are observed in the territory of its location, natural-climatic features of the territory correspond to the annual seasonality, microclimatic indicators change regularly and predictably. Data for 2023 show that the operation of the cooling towers has no significant impact on the environment.

6.4 Aerological monitoring

In 2023, studies on the aerological monitoring of the state of the atmospheric boundary layer (hereinafter - ABL) were carried out at the Markuny MS. Observations were carried out using the SODAR/RASS measuring complex (Fig. 8.17).

Figure 8.17- SODAR measuring complex

The results of observations for 2023 showed that the vertical temperature gradients and temperature inversions indicate the presence of retention layers in the ABL and provide a qualitative characterization of the conditions of dispersion of impurities. On average per year, the vertical temperature gradient is positive and varies for the 0-300, 0-600, and 0-900 m layers within the range of 0.28-1.88°C/100 m. Among different types of inversions, elevated inversions predominate. The total frequency of occurrence of unfavorable stability classes (E and F) in general for the year under study was not more than 15.2 %.

According to the obtained calculated data, the most unfavorable conditions of dispersion of impurities in ABL, which can affect the environment and the population at all stages of the NPP life cycle, are realized in autumn months. However, even in autumn, the recurrence of stability classes E and F is insignificant.

Average wind speeds are moderate and in general for the study period winds of south-west direction prevail (Fig. 8.18).

С	ССВ	СВ	ВСВ	В	ВЮВ	ЮВ	ЮЮВ	Ю	ЮЮЗ	ЮЗ	ЗЮЗ	З	ЗСЗ	СЗ	ССЗ
N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW

Figure 8.18 – Average wind roses in 2021

Thus, in general, a relative interannual stability of the main mean annual characteristics of the atmospheric dispersion is noted during the period 2015-2023.

6.5 Observations of surface water regime

In 2023, an annual series of observations of level, runoff, ice, thermal regimes of surface waters and turbidity of water in the rivers Viliya, Stracha, Gozovka and Polpe was carried out. According to the results of observations of surface water regime in 2023, no extreme, abnormal and dangerous hydrological phenomena were detected in the area of Belarusian NPP location and water intake of the Viliya River (Fig. 8.19).

Figure 8.19 - Water gauge station

Based on the results of observations of the level regime in 2023, it was found that the water level of the river Viliya near Malye Sviryanki settlement varied from 1.90 m BS (27.07.2023) to 3.95 m BS (05.04.2023). The average value of water level for 2023 was 2.52 m BS (Figure 8.20).

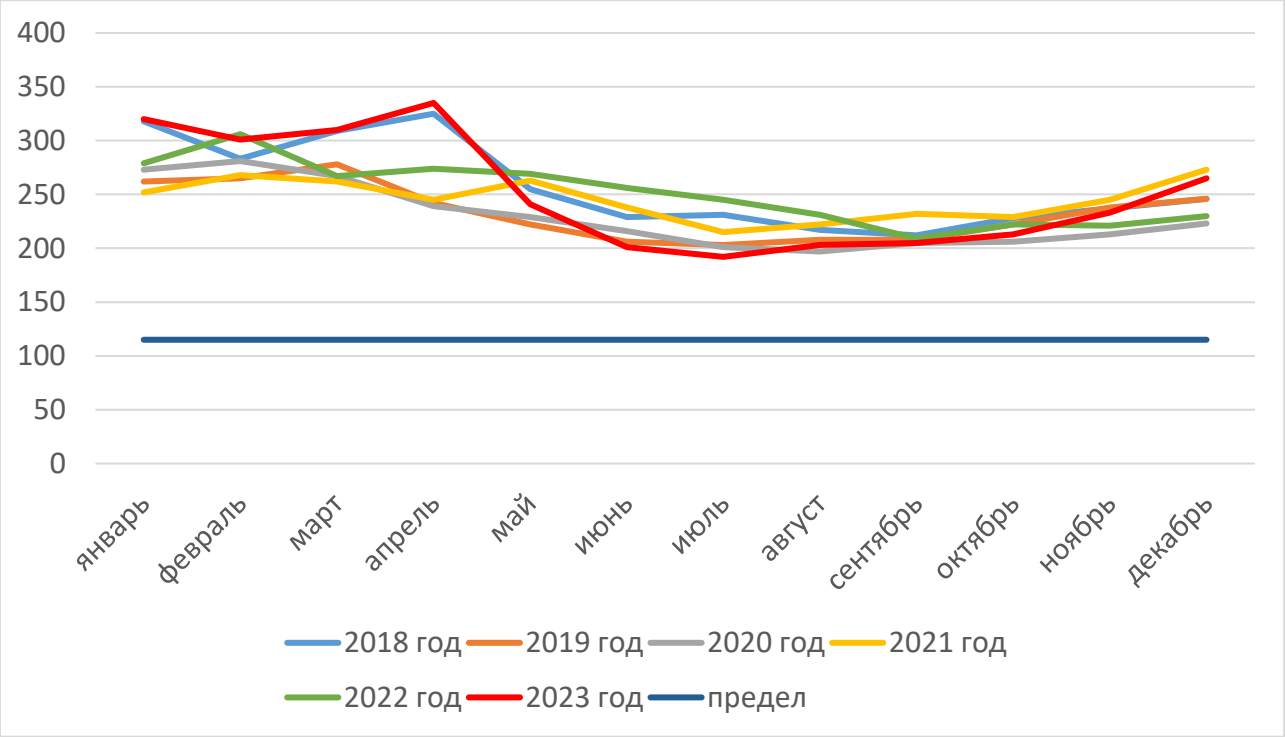


Figure 8.20 – Water level measurement at the water gauge station of the Viliya river (settlement Malye Sviryanki) in 2018-2023, mBS

It should be noted that the maximum and minimum values of the level of the Viliya River measured in 2023 did not exceed the limits of the design parameters adopted as the design basis.

In general, the level regime on the examined rivers in 2023 was characterized by small amplitude during the year, being within the measurement range of previous years of observations.

Based on the results of observations of the temperature regime in 2023, it was found that the water temperature of the Viliya River near Malye Sviryanki settlement varied from 0.1 °C (01-03.2023) to 25 °C (19.08.2023). The average value of water temperature for 2023 was 9.6 °C (Fig. 8.21).

It should be noted that the maximum values of water temperature of the river Viliya measured in 2023 did not exceed the limits of the design parameters adopted as the design basis.

In general, the temperature regime on the studied rivers in 2023 was within the measurement range of previous years of observations.

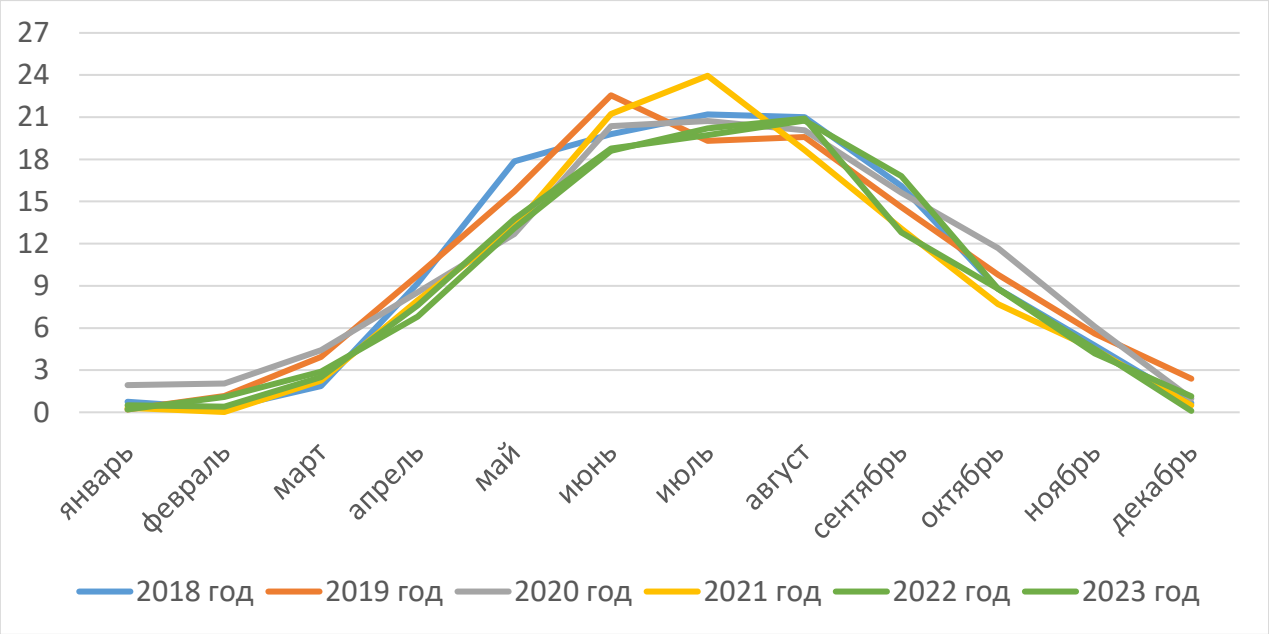


Figure 8.21 – Water temperature measurements at the water gauge station of the Viliya river (settlement Malye Sviryanki) in 2018-2023, °C

Based on the results of observations of the flow regime in 2023, it was revealed that the water discharge of the river Viliya near Malye Sviryanki settlement varied from 28.5 m3/s (14-17.07.2023) to 195 m3/s (5.04.2023). The average value of water discharge for 2022 was 65.0 m3 /s (Fig. 8.22).

Fluctuation of water discharge values is related to natural enviromental processes (beginning of spring flood, meteorological phenomena).

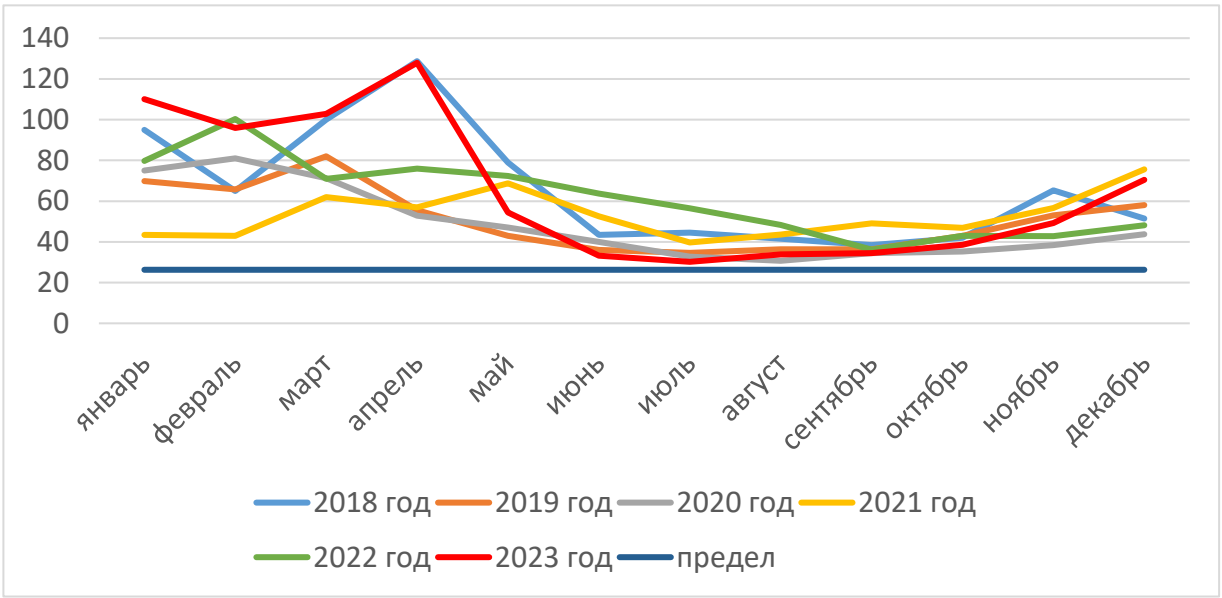


Figure 8.22 – Water consumption measurements at the water gauge station of the Viliya river (settlement Malye Sviryanki) in 2018-2023, m3/s

In winter 2022 - 2023, unstable ice phenomena appeared in late November - early December, with slush ice drift and overbank ice on the Viliya River. In general, winter 2023 - 2024 is also characterized by the absence of stable ice phenomena at all hydrological stations due to the absence of prolonged negative air temperatures.

According to the results of observations of currents in 2023 it was revealed that the flow velocity of the river Viliya near the settlement Malye Sviryanki varied from 0.55 m/s (05.08.2023, 05.09.2023) to 0.97 m/s (05.04.2022). The average value of the river flow velocity for 2022 was 0.67 m/s.

In 2023, during all phases of the hydrological regime, water samples were taken at four water gauging stations (Viliya River, Stracha River, Gozovka River, Polpe River) to determine the chemical composition of the water with the following indicators: physical properties of water, suspended solids, hardness, gases dissolved in water, pH, content of major ions, nutrients, Si, Fe, biochemical oxygen demand (5 days), petroleum products, synthetic surfactants, phenols, heavy metals, pesticides.

According to the results of the analysis, river waters are classified as slightly alkaline (according to Nikanorov A.M. classification), the value of hydrogen index (pH) ranged from 7.58 to 8.89.

The oxygen regime remained favorable for sustainable functioning of watercourse ecosystems. Dissolved oxygen content corresponded to the established quality standards and varied from 7.22 mgO_2/dm^3 to 14.1 mgO_2/dm^3.

The content of easily oxidizable organic substances (BOD5 indicator)5 - by the amount of oxygen consumed during biochemical oxidation of substances over a period of time (5 days) did not exceed the quality standards established for watercourses. The content of hard-to-oxidize organic substances (by COD), main nutrients (nitrogen and phosphorus compounds) corresponded to quality standards in water of all studied watercourses.

6.6 Seismological monitoring

Monitoring of seismic parameters of the area where the Belarusian NPP site is located is carried out using a temporary local observation network (7 observation points of the local seismic network: "Vadatishki", "Gradovshchizna", "Boyary", "Selishche", " Vorobyi", "Gornaya Kaimina" and "Litvyany"). This local network functions in a round-the-clock mode with continuous registration of signals from natural and artificial sources of seismic oscillations and provides registration of seismic events in a wide range of epicentral distances and energies (Fig.8.23).

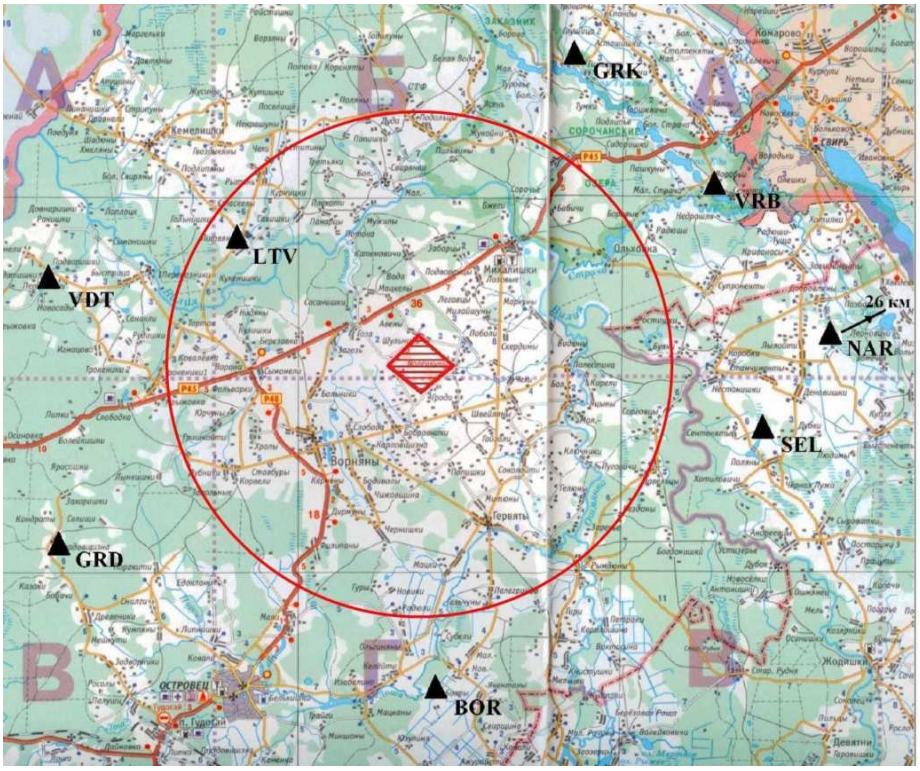


Figure 8.23 - Layout of seismic stations in the vicinity of the Belarusian NPP

Symbols: ▲ - seismic stations: Boyary – BOR; Gradovshchizna – GRD; Vadatishki – VDT; Selishche – SEL; Vorobi – VRB; Gornaya Kaimina – GRK; Livtiany – LTV; Naroch – NAR. ▭ - contour of the Belarusian NPP site.

Distant, regional and near earthquakes, as well as technogenic seismic events (explosions) were informatively registered during the reporting period according to the materials of records processing. Regional (local) earthquakes in the near zone up to 30 km from the NPP site were not registered by the local observation network during the reporting period.

Catalog of distant earthquakes with magnitude $M \geq 6.0$ for annual cycle of observations contains information about 249 earthquakes. Catalog of regional earthquakes for annual cycle contains data on 173 earthquakes. Catalog of close earthquakes (R = 30 - 300 km) for the annual cycle of observations contains information about 53 earthquakes. The catalog of man-made seismic events for the annual cycle includes 225 explosions.

In 2023 all close earthquakes were registered in the southern part of the territory of Belarus (Soligorsk mining district), with epicentral distance from 200 to 300 km from the site of Belarusian NPP. Epicenters of earthquakes are confined to the Pripyat non-linear seismogenic overzone of possible earthquake sources (hereinafter - PES), which is the most extensive and active geodynamic structure within Belarus. This overzone includes a number of zones, which in turn are subdivided into subzones. The North Pripyat seismogenic zone (Luban, Berezinskaya and Gomelskaya subzones), the Central Pripyat seismogenic zone and the South Pripyat seismogenic zone (Slovechnenskaya and Turovskaya subzones). The main factor for singling out the PES Pripyatskaya overzone was

its confinement to the Pripyat-Dneprovsky-Donetsk paleorift paleotectonic province. Similar structures have increased seismicity on other ancient platforms. Strong earthquakes usually occur in the marginal parts of the structures, while weaker earthquakes occur in the central part of the depression.

Weaker ones - in the central part of the depression. They are mainly associated with longitudinal faults, fragments of which are active at the newest stage of tectonic development. Concentration of centers of close earthquakes (in 300 km zone from the site of Belarusian NPP location) is observed in the north-western part of Pripyatskaya superzone. Epicenters of close earthquakes are located in the Central-Pripyat seismogenic zone and two seismogenic subzones Lubanskaya and Berezinskaya. Seismotectonic potential of the Central-Pripyat seismogenic zone (Mmax = 3.5; h = 5 km; I = 4 - 5 degree). Seismotectonic potential of two seismogenic subzones: Lubanskaya (Mmax = 4.0; h = 5 km; I = 5 - 6 points) and Berezinskaya (Mmax = 4.5; h = 10 km; I = 6 - 7 degree). Magnitude range of registered close earthquakes in 2023 was M = 1.0 - 2.8, which does not exceed the seismotectonic potential of PES zones, in which their epicenters are located.

The following values of parameters were obtained for the earthquakes that had the greatest seismic impact on the NPP site for the annual cycle of 2023. The maximum value of acceleration and the highest value of intensity were obtained from the distant earthquake which occurred in Turkey on 06.02.2023 with magnitude 6.9 and maximum peak acceleration 0.1895 cm/sec2 (1.89-10-4 g) with calculated value of 1.8 degree. The maximum value of acceleration and the highest value of intensity were obtained from the distant earthquake which has happened in Morocco on 08.09.2023 with magnitude 6.6 and maximum peak acceleration 0.0181 cm/sec2 (0.18-10-4 g) with calculated value of 0.4 degree (Fig. 8.24).

Figure 8.24 – Map of epicenters of distant earthquakes with M ≥ 6.0, registered for the annual cycle of observations in 2023

The maximum value of acceleration and the highest value of magnitude is obtained from the regional earthquake which has happened in Romania on 14.02.2023 with magnitude 5.7 and maximum peak acceleration 0.0779 cm/sec2 (0.78-10-4 g) with calculated value of 0.9 degree. The maximum value of acceleration and the highest value of magnitude is obtained from the regional earthquake which has happened in Slovakia on 09.10.2023 with magnitude 5.0 and maximum peak acceleration 0.0354 cm/sec2 (0.78-10-4 g) with a calculated value of 0.5 degree (Fig. 8.25).

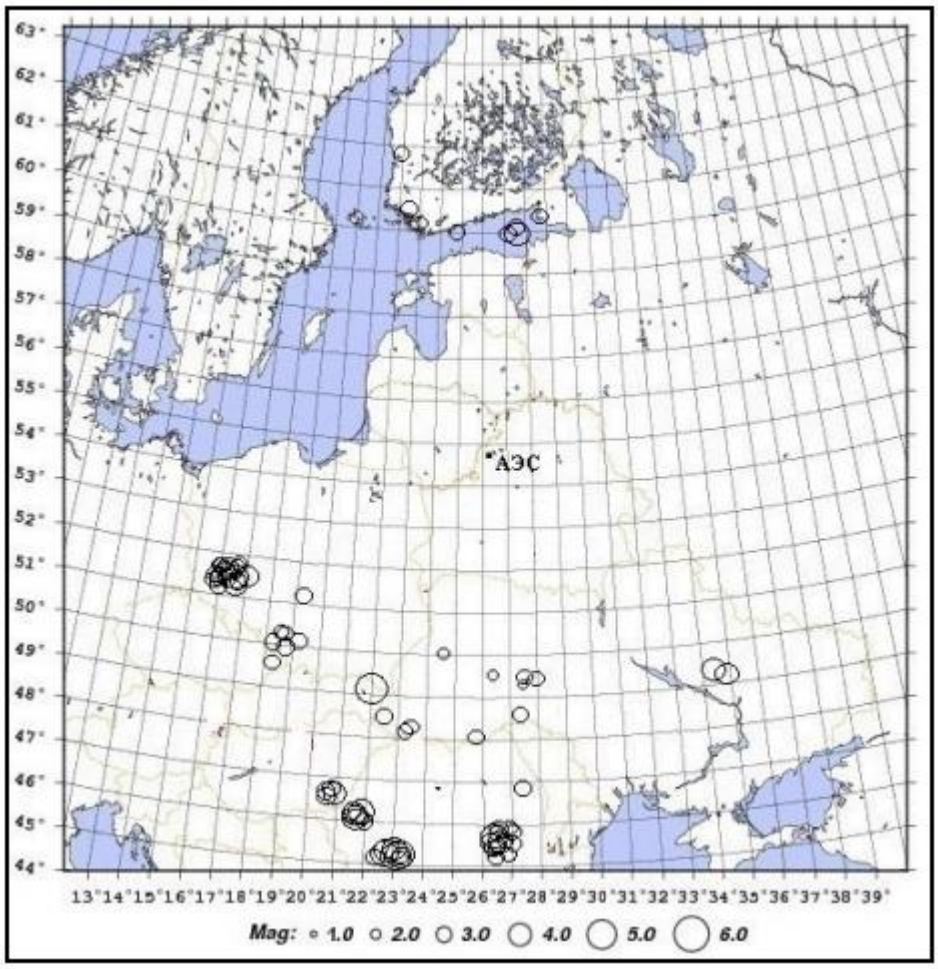
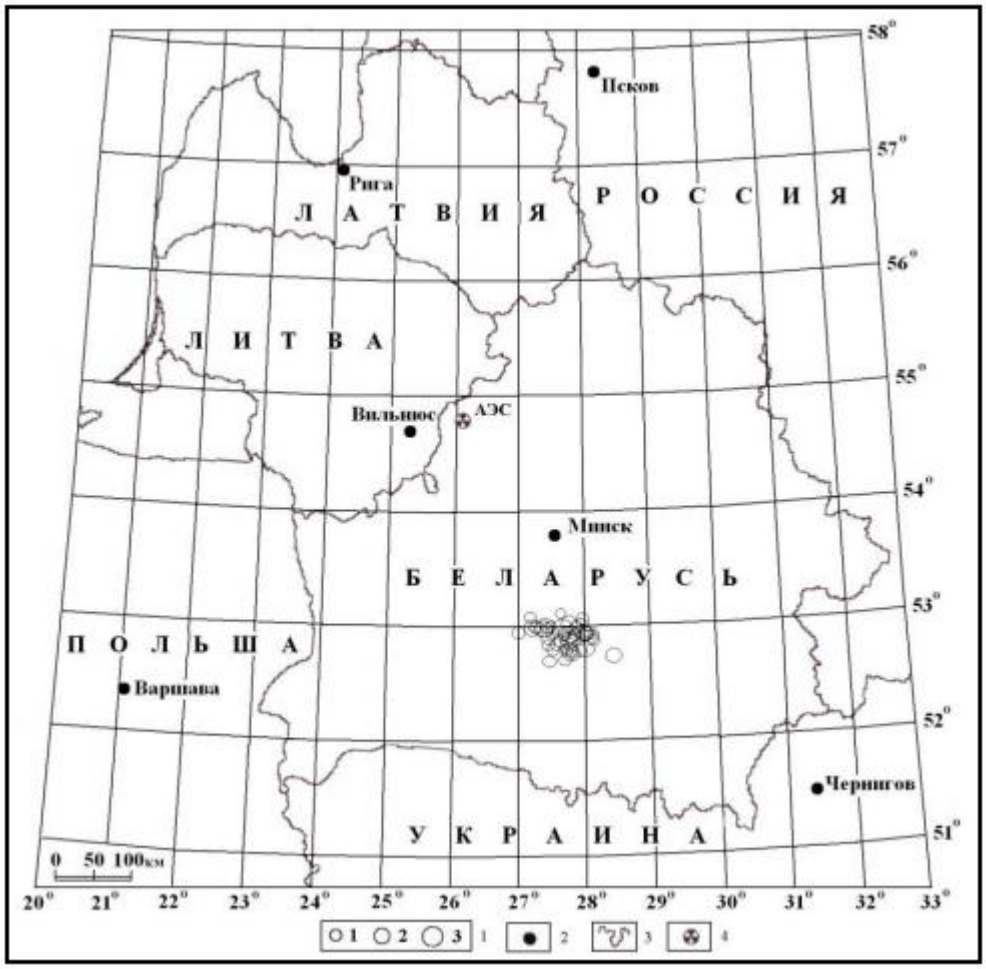


Figure 8.25 - Map of epicenters of regional earthquakes registered during the annual observation cycle of 2023

The maximum value of acceleration and the highest value of intensity were obtained from the close earthquake which has happened in Belarus on 27.01.2023 with magnitude 2.0 and maximum peak acceleration 0.0512 cm/sec2 (0.51-10-4 g) with calculated value of minus 2.1 points. The maximum value of acceleration and the highest value of intensity were obtained from the close earthquake which has happened in Belarus on 24.08.2023 with magnitude 2.8 and maximum peak acceleration 0.0094 cm/sec2 (0,09•10-4 g) with the calculated value of minus 1.1 degree (Fig. 8.26).



1 - magnitude, 2 - city, 3 - state border, 4 - Belarusian NPP

Figure 8.26 - Map of epicenters of nearby earthquakes registered during the annual observation cycle of 2023

Thus, for 2023 the maximum values of intensity of seismic impact on the site of placement of Belarusian NPP were from the distant earthquake, which occurred in Turkey with magnitude 6.9 and amounted to: peak acceleration 0.1895 cm/sec2 (1.89-10-4 g), calculated intensity 1.8.

Results of calculation of intensity of seismic impacts on the site of Belarusian NPP from distant, regional and close earthquakes registered by local seismic network for 2023 have shown that they are much lower than the values of design level, which make for design earthquake (DE) – 6 degree, for maximum calculated earthquake (MCE) - 7 degree.

6.7 Geodetic monitoring of modern motions of the Earth's crust

Observations of modern Earth's crustal motions include work to determine horizontal and vertical components of the motions.

In 2023, observations of the horizontal motion of the Earth's crust were carried out based on the GPS technology method. The use of modern satellite geodetic technologies (GPS measurements) to locate points at different periods of time makes it possible to subsequently determine the horizontal state of

displacements at the millimeter level of accuracy. Space geodesy methods are an order of magnitude higher in accuracy than measurements made by classical geodesy methods and have higher productivity, allow observations at remote points without taking into account mutual visibility, are characterized by high metrological characteristics, all-weather measurements, high-developed processing software.

The satellite geodetic network includes 18 observation points, of which 15 are depth referents, 1 is a ground referent and 2 points - with the device of forced centering (tours).

Field measurements at the points of the geodynamic testing site were carried out once a year.

According to the monitoring results for 2023, it was revealed that the average annual velocities of horizontal movements of crustal points ranged from 15.9 to 32.4 millimeters per year with an average value of 26.5 millimeters per year, the value of which does not exceed the accepted tolerance. The average direction of the movements is to the northeast along the azimuth of 62°.

For the period 2012-2023 (11 years), the velocities of horizontal point movements ranged from 24.6 to 25.7 millimeters per year with an average of 25.1 millimeters per year. The average direction of movements was to the northeast along the azimuth of 57° (Figs. 8.27, 8.28). The gradients of horizontal motion velocities in the observation area as a change in the motion amplitude per unit distance per unit time ranged from 4×10-9 to 2×10-7 1/year (Fig. 8.29).

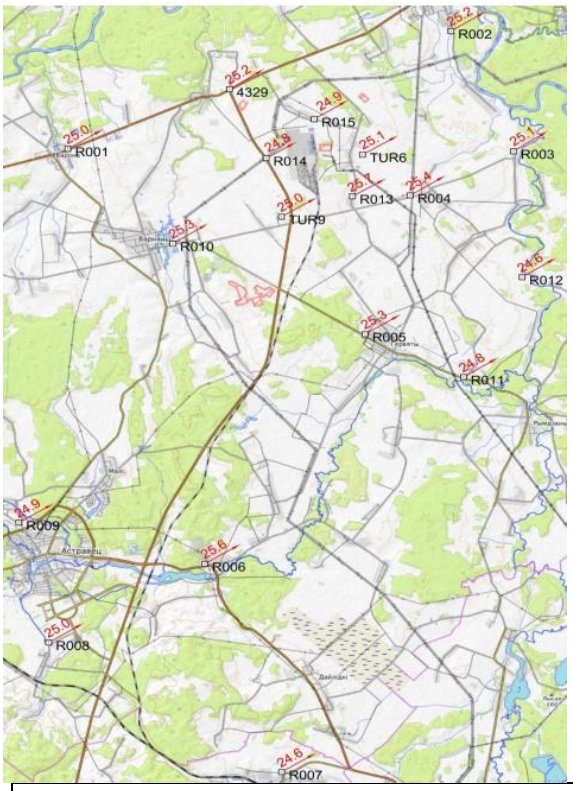


Figure 8.27 – Directions of horizontal crustal movement within the period of 2012-2023

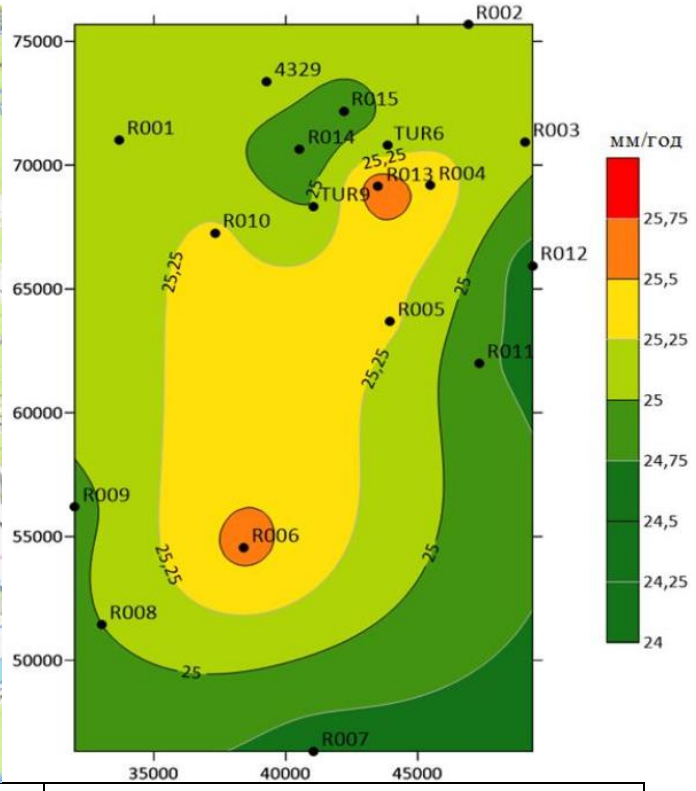


Figure 8.28 - Distribution of the rates of horizontal crustal movement recorded within the period of 2012-2023

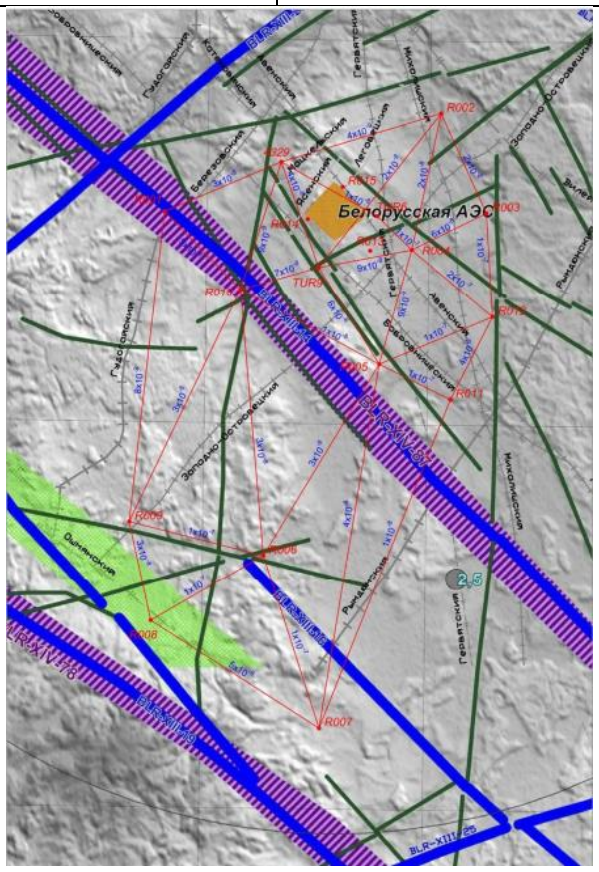


Figure 8.29 – Scheme of horizontal motion rates and velocity gradients within the period of 2012-2023

The design of the Belarusian NPP adopted critical non-exceeding velocities of modern movements - 50 millimeters per year for horizontal displacements. The point velocities measured in the investigated territory do not exceed these values.

The analysis of the results of observations of horizontal movements of the Earth crust in 2023 indicates that the values and directions of horizontal movements at the geodynamic site of Belarusian NPP coincide with the general movements of the East-European platform. Insignificant discrepancies of velocities and directions of point movements cannot indicate the presence of any local horizontal motions in the studied area.

In 2023, observations of the vertical motion of the Earth's crust were made using high-precision repeat leveling of the 1-st class.

Geometric leveling of geodetic points of geodynamic network by the method of I class was performed in order to calculate the vertical component of modern earth surface movements. Leveling of the I class was carried out in the forward and reverse directions at observance of equality of distances from the leveler to the rails, on two pairs of transition points forming two separate lines. Measurements at the observation points were made once a year.

The total length of the network is 140.01 km. The tracks consist of 14 separate lines between points and form 6 closed loop configuration with an average perimeter of 30.13 km (40 km tolerance). The network is anchored on the ground by 13 depth marks, 40 ground marks, 8 wall marks, 3 TUR-type centers and 2 temporary marks. The total number of points is 66.

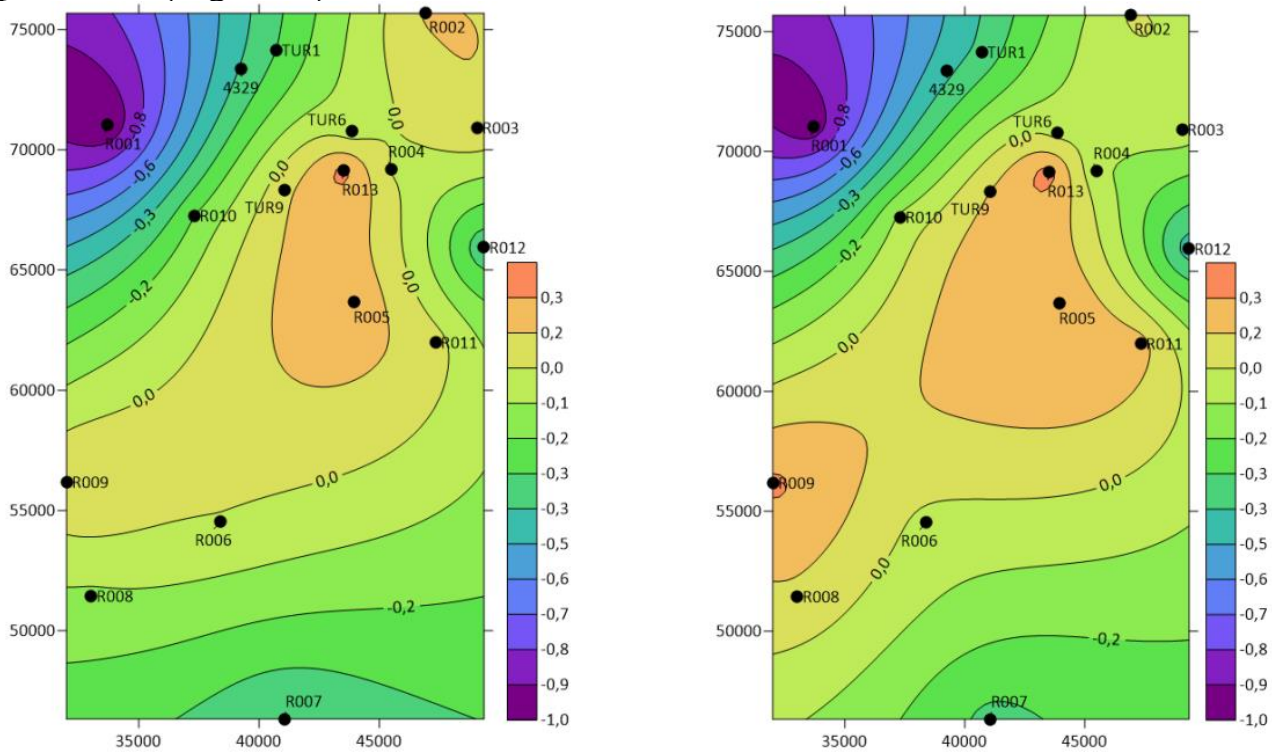
Analysis and evaluation of the results of monitoring of vertical movements and velocities of the Earth's crust for 2023 showed that the velocities of vertical movements of points ranged from (-2.88) to (-3.26) millimeters per year. Consequently, the velocities of vertical displacements of the points of the geodynamic loop are within acceptable limits (do not exceed 10 millimeters per year). The total values of the gradient of the vertical displacement rate of points for the entire territory of the geodynamic testing site for 2023 are 1.7×10-8 1/year.

According to the observations of 2012 - 2023, the total values of vertical velocity of the geodynamic loop points ranged from (0.33) to (+0.42) millimeters per year.

The weighted average values of inter-cycle displacements of the network points are in the range from (+0.29) to (-0.92) millimeters per year (Fig. 8.30).

Vertical motion velocity gradients in the observation area ranged from 4.0×10-9 to 1.7×10-7 1/year. The total values of the velocity gradient of the geodynamic loop points ranged from 1.7×10-8 to 4.9×10-8 1/year. The direction

changes insignificantly, which indicates the absence of signs of geodynamic processes (Fig. 8.31).



a) b)

Figure 8.30 - Distribution of weighted averages of vertical point movements and velocities for the period 2012 - 2023.

a) vertical movements of points b) average annual rates of movement

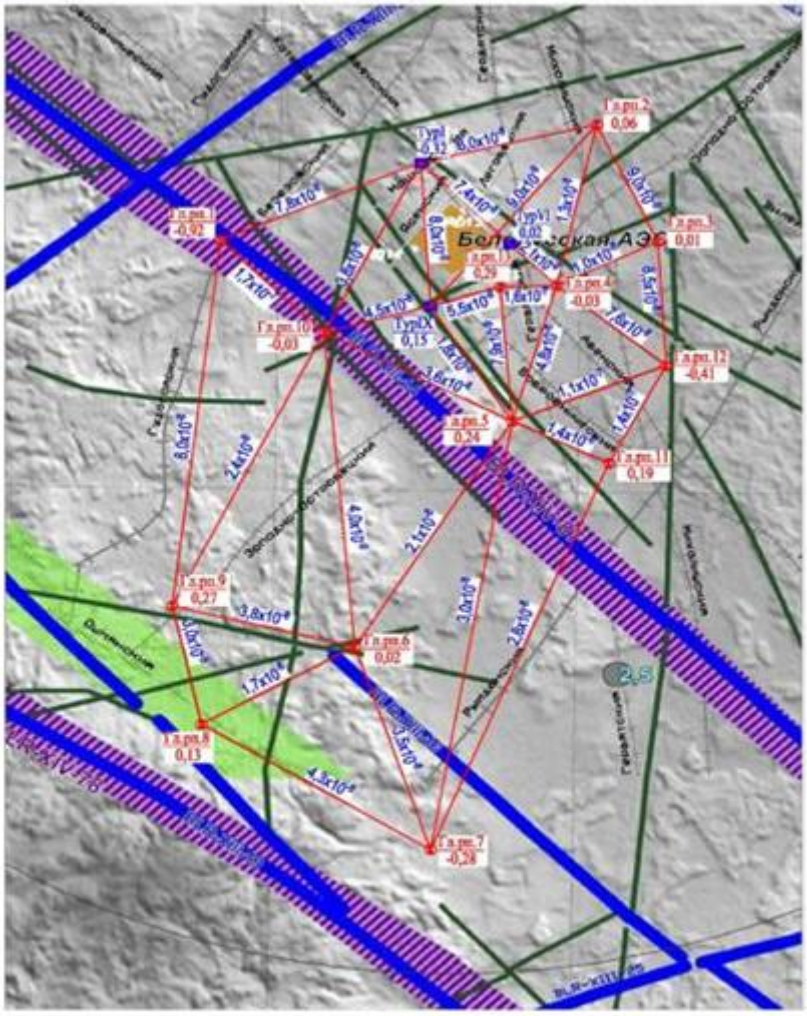


Figure 8.31 –Velocity gradients of vertical movements at the geodynamic area of the Belarusian NPP in the period of 2012 – 2023

According to the results of the obtained data it should be concluded that the directions, distances and stability criteria of the geodynamic monitoring points are stable, the values of particular accelerations do not go beyond the criteria and indicate the absence of signs of geodynamic processes in the area of placement of the Belarusian NPP.

6.8 Monitoring of pollution of the surface layer of the atmosphere, pollution of terrestrial and aquatic ecosystems, pollution of water objects, condition of aquatic biological resources

In 2023, an annual cycle of observations was carried out within the framework of environmental monitoring in the SPA and CA of Belarusian NPP. Sampling of atmospheric air, soil, water and bottom sediments was carried out,

laboratory determination of pollutant content was performed; the state and (or) degree of pollution of atmospheric air, terrestrial and aquatic ecosystems was assessed. The results showed that the level of air, water and soil pollution in 2023 did not exceed the established limits. The results of monitoring of flora, fauna and ichthyofauna in the CA of Belarusian NPP allow to draw conclusions about the stability of the environmental situation in the study area.

6.9 Radiation monitoring

In 2023 radiation monitoring in the Sanitary protection zone and Observation zone of Belarusian NPP was carried out in accordance with the Program of Environmental Radiation Monitoring in SPZ and OZ of Belarusian NPP and the Regulations on Radiation Monitoring of Belarusian NPP.

The main tasks of radiation monitoring include:

continuous systematic observations of the level of radioactive contamination of environmental objects in the SPZ and OZ;

obtaining necessary, sufficient and reliable information on the radiation situation in the SPZ and OZ;

assessment of the current state of environmental radiation monitoring objects in the SPZ and OZ of the Belarusian NPP and analysis of its change dynamics;

assessment of radiation doses to the population living in the territory of the OZ;

forecasting of changes in the radiation situation in the SPZ and OZ;

collection, summarization and transfer of information on the radiation situation and condition of environmental objects in the SPZ and OZ and on the forecast of its changes to the interested state bodies and agencies.

Radiation monitoring of airborne and liquid discharges from the Belarusian NPP

In 2023 the values of airborne and liquid discharges of radioactive substances of power units No. 1 and No. 2 of Belarusian NPP did not exceed the normative parameters established by the standards of permissible airborne and liquid discharges of radioactive substances of Belarusian NPP into the environment, approved by the order of the Chief Engineer of the nuclear power plant dated 20.06.2022 No. 278 and agreed with Gosatomnadzor (Department of Nuclear and Radiation Safety of the Ministry for Emergency Situations of the Republic of Belarus), State Institution "Grodno Regional Center of Hygiene, Epidemiology and Public Health" and the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus.

Liquid discharges of radioactive substances of power units No. 1, 2 of Belarusian NPP in the period from 01.01.2023 to 31.12.2023 are given in Table 8.3.

Table 8.3 - Liquid discharges of radioactive substances of power units No. 1, 2 of Belarusian NPP in 2023.

Nuclid	Total volumetric activity of discharges for 2023, Bq	PD (year), Bq	Index PD,%	MPD (year), Bq	Index MPD,%
^{3}H	2,24E+12	7,00E+12	32	3,50E+13	6,4
^{60}Co	6,66E+07	1,08E+09	6,17	5,42E+09	1,23
^{131}I	6,77E+07	7,46E+09	0,9	3,73E+10	0,18
^{134}Cs	6,42E+07	8,39E+08	7,65	4,20E+09	1,53
^{137}Cs	7,18E+07	1,15E+09	6,24	5,73E+09	1,25

Note: MPD - maximum permissible discharge, PD - permissible discharge

Airborne discharges of radioactive substances of power units No. 1, 2 of Belarusian NPP in the period from 01.01.2023 to 31.12.2023 is given in Table 8.4.

Table 8.4 - Airborne discharges of radioactive substances of power units No. 1, 2 of Belarusian NPP in 2023.

Nuclid	Total volumetric activity of discharges for 2023, Bq	PD (year), Bq	Index PD,%	MPD (year), Bq	Index MPD,%
Power unit No. 1					
^{3}H	3,81E+11	6,78E+13	0,56	3,39E+14	0,11
^{14}C	1,51E+10	5,08E+12	0,30	2,54E+13	0,06
^{60}Co	1,62E+06	3,62E+09	0,04	1,81E+10	0,01
^{131}I	9,34E+05	1,41E+09	0,07	7,03E+09	0,01
^{133}I	1,01E+06	2,54E+09	0,04	1,27E+10	0,01
^{134}Cs	1,15E+06	3,72E+08	0,31	1,86E+09	0,06
^{137}Cs	1,3E+06	5,60E+08	0,23	2,80E+09	0,05
NG	7,63E+12	2,04E+13	37,40	1,02E+14	7,48
Power unit No. 2					
^{3}H	5,85E+10	6,78E+13	0,09	3,39E+14	0,02
^{14}C	9,95E+09	5,08E+12	0,20	2,54E+13	0,04
^{60}Co	2,06E+06	3,62E+09	0,06	1,81E+10	0,01
^{131}I	1,35E+06	1,41E+09	0,10	7,03E+09	0,02
^{133}I	1,6E+06	2,54E+09	0,06	1,27E+10	0,01
^{134}Cs	1,13E+06	3,72E+08	0,30	1,86E+09	0,06
^{137}Cs	1,42E+06	5,60E+08	0,25	2,80E+09	0,05
NG	1,14E+12	2,04E+13	5,58	1,02E+14	1,12

Note: NG - noble gases; MPD - maximum permissible discharge, PD - permissible discharge

Gamma radiation dose rate

The results of radiation monitoring obtained in 2023 showed that the levels of ambient gamma radiation equivalent dose rate (hereinafter – gamma dose rate)

at the radiation monitoring stations of the automated radiation monitoring system were in the range of 0.052 - 0.088 μSv/h, which corresponds to the established long-term values for this region of the Republic of Belarus.

Aerosols in the ground-level layer of the atmosphere

The layout of observation points for radiation monitoring of atmospheric air in the OZ of Belarusian NPP is presented in Figure 8.32.

The values of total beta-activity in samples of radioactive aerosols of the ground-level atmospheric layer in 2023 were in the range of 1.89×10^{-5}-33.9×10^{-5} Bq/m^3, which corresponds to the background values established in the course of expeditionary surveys in 2008-2019.

In 2023, the levels of ^{137}Cs volumetric activity in aerosols of the ground-level atmospheric layer did not exceed the value of $2.3\cdot10^{-6}$ Bq/m^3, which corresponds to the previously obtained data at the stage of construction of the Belarusian NPP and since the physical start-up of power unit No. 1.

The content of ^{90}Sr in the selected aerosol samples did not exceed the value of the lower limit of the measurement range of the applied method (hereinafter referred to as LLMR), which is 0.5 Bq per sample (<0.09×10-5 Bq/m^3).

The content of ^{3}H and ^{14}C in the atmospheric air also did not exceed the previously established levels (<0.5 Bq/m^3).

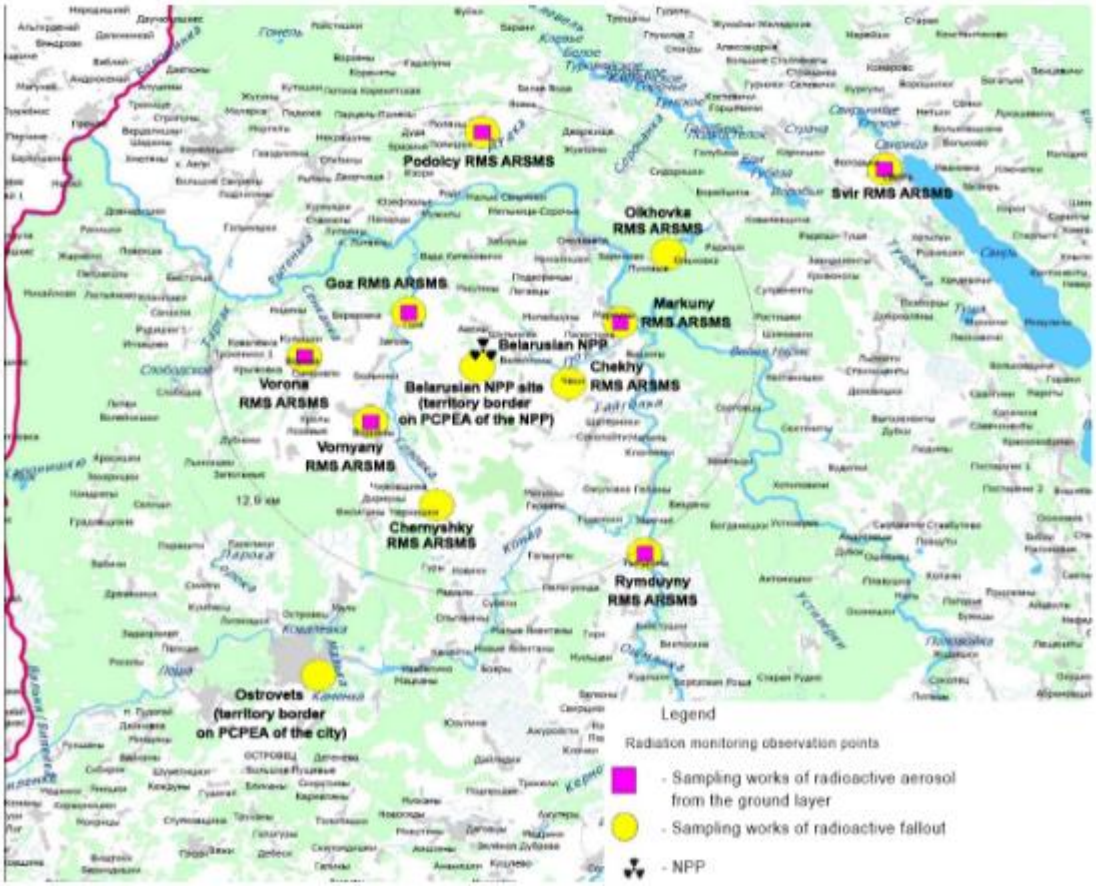


Figure 8.32 – Layout of air radiation monitoring observation points in the Belarusian NPP observation zone

Radioactive fallouts from the atmosphere

The values of total beta-activity in atmospheric fallout samples in 2023 corresponded to the average long-term steady-state values for this region and were in the range of 0.049-0.774 Bq/m^2·day.

The ^{137}Cs content in monthly fallout samples in 2023 was below the minimal detecting activity (hereinafter MDA) (<0.010 Bq/m^2·day), which is consistent with previously established background values for this parameter. The content of ^{90}Sr in all selected samples of atmospheric fallout did not exceed the LLMR (<0.2 Bq per sample).

Surface waters

The layout of surface water radioactive contamination observation points is presented in Figure 8.33.

The values of total beta activity in surface water samples in 2023 corresponded to the background values established during expeditionary surveys 2008-2019 for this region and were in the range of <0.13-0.28 Bq/dm^3.

The ^{137}Cs content in the collected surface water samples ranged from 8.62×10^{-4} Bq/dm^3 to 1.92×10^{-3} Bq/dm^3. The ^{90}Sr content in the surface water samples was below the LLMR (<0.3 Bq/dm^3). The ^{3}H content did not exceed the previously established background values and ranged from <0.10 Bq/dm^3 to 1.91 Bq/dm^3.

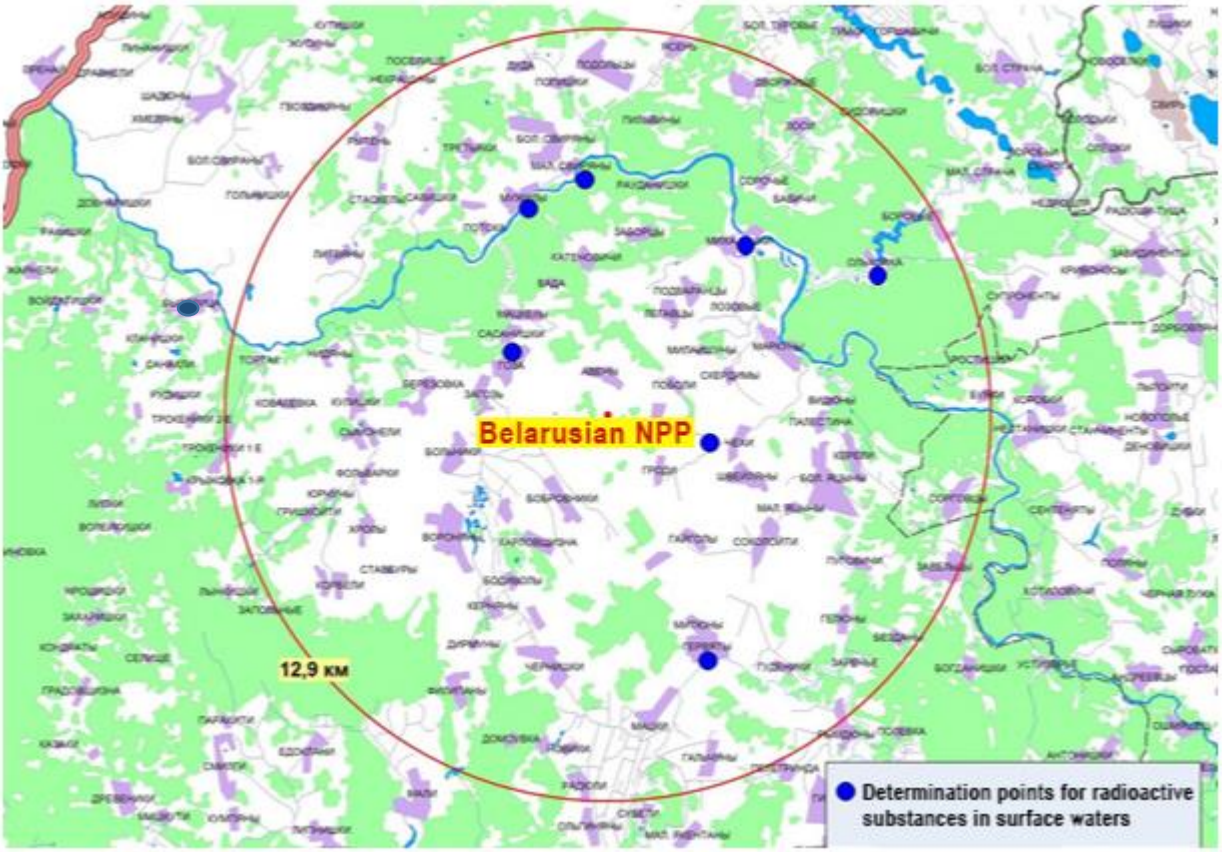


Figure 8.33 – Layout of surface water contamination observation points

Ground and drinking water

The values of total alpha activity in groundwater samples taken in 2023 from groundwater wells in the OZ and from the network of monitoring wells at the Belarusian NPP site ranged from <0.02 to 0.09 Bq/dm^3. The values of total beta-activity in groundwater samples from wells ranged from <0.15 to 1.98 Bq/dm^3, from the network of monitoring wells – <0.12 Bq/dm^3.

The maximum value of total beta activity (1.98 Bq/dm^3) was obtained in a single water sample taken from a well in the locality of Markuny. This value does not exceed "zero" background radiation level registered before the commissioning of power unit No. 1 of the Belarusian NPP (the maximum value was 2.24 Bq/dm^3). The studies have shown that the main contribution to the total beta-activity in drinking water samples taken from wells located in the OZ of the Belarusian NPP is made by the natural radionuclide ^{40}K.

In accordance with the Hygienic Standard "Radiation Exposure Assessment Criteria" approved by the Decree of the Council of Ministers of the Republic of Belarus No. 829 dated 29.11.2022 (hereinafter - HS "Radiation Exposure Assessment Criteria") the preliminary assessment of admissibility of drinking water for drinking purposes can be made by the volumetric total alpha and beta activity, which should not exceed 0.5 and 1.0 Bq/l, respectively.

The values of total alpha and beta activity in groundwater and drinking water samples taken in 2023 both from wells and from the network of observation boreholes, except for one water sample from the village of Markuny, did not exceed the screening values established in the HS "Radiation Exposure Assessment Criteria".

The content of ^{3}H radionuclide in water samples taken from the network of observation boreholes at the Belarusian NPP site ranged from 1.16 Bq/dm^3 to 2.99 Bq/dm^3, in water wells samples - from 2.26 Bq/dm^3 to 4.97 Bq/dm^3.

The ^{137}Cs content in drinking water samples taken from wells in settlements located in the observation zone was in the range <0.005-0.007 Bq/dm^3. The levels of ^{137}Cs volumetric activity in groundwater samples taken from the network of observation boreholes at the Belarusian NPP site ranged from <0.005 Bq/dm^3 to 0.008 Bq/dm^3.

The volumetric activity of ^{90}Sr in all groundwater and drinking water samples did not exceed the LLMR (<0.3 Bq/dm^3).

In accordance with HS " Radiation Exposure Assessment Criteria ", the reference levels of volumetric activity of radionuclides ^{137}Cs and ^{90}Sr are 10 Bq/L, ^{3}H - 1.0×10^4 Bq/L.

Hydrosystem objects (bottom sediments, aquatic and coastal aquatic vegetation, ichthyofauna)

The results of measurement of ^{137}Cs and ^{90}Sr content in bottom sediment samples taken in 2023 show that at all observation points the levels of radioactive contamination with these radionuclides correspond to the previously established background values and do not exceed 2.1 Bq/kg and 1.0 Bq/kg, respectively.

The results of measurement of radionuclide content in components of aquatic and coastal-water biogeocenoses of the OZ of the Belarusian NPP in 2023 show that in all observation points the levels of radioactive contamination with anthropogenic radionuclides practically correspond to the background values established in 2016-2020. In 2023, the maximum values of ^{137}Cs specific activity in aquatic and coastal-water vegetation were 0.22 Bq/kg, ^{90}Sr - 0.65 Bq/kg.

The measured values of specific activity of ^{137}Cs in ichthyofauna at the control points of the river Viliya in 2023 were in the range <0.53 - 2.89 Bq/kg. The maximum level of ^{137}Cs activity in ichthyofauna was established in one roach fish sample and amounted to 2.89 Bq/kg. The determined values of specific activity of ^{90}Sr in all samples of ichthyofauna did not exceed 0.69 Bq/kg.

The obtained results of ^{137}Cs and ^{90}Sr content in ichthyofauna are considerably lower than the reference levels established by the HS "Radiation Exposure Assessment Criteria" (^{137}Cs content in fish should not exceed 130 Bq/kg, ^{90}Sr - 10 Bq/kg).

Soils

Monitoring of radionuclide content in soils and agricultural lands is carried out at permanent observation points (Fig. 8.34). Nine points of radiation monitoring of soils and 13 points of radiation monitoring of agricultural lands have been identified in the CA of the Belarusian NPP. The results of laboratory tests of soil samples taken in 2023 showed that at the soil monitoring points the specific activity of ^{137}Cs varied from <0.16 to 11.6 Bq/kg, ^{90}Sr - from <1.0 to 1.39 Bq/kg. At the monitoring points of arable and meadow lands specific activity of ^{137}Cs varied from <0.40 to 6.4 Bq/kg, ^{90}Sr - from <1.0 to 1.58 Bq/kg. The specific activity of other monitored anthropogenic radionuclides at all monitoring sites was below the MDA.

The LAED at soil radiation monitoring points measured at a height of 1 m above the soil surface did not exceed 0.1 μSv/h.

The measurement results obtained in 2023 correspond to the previously established values.

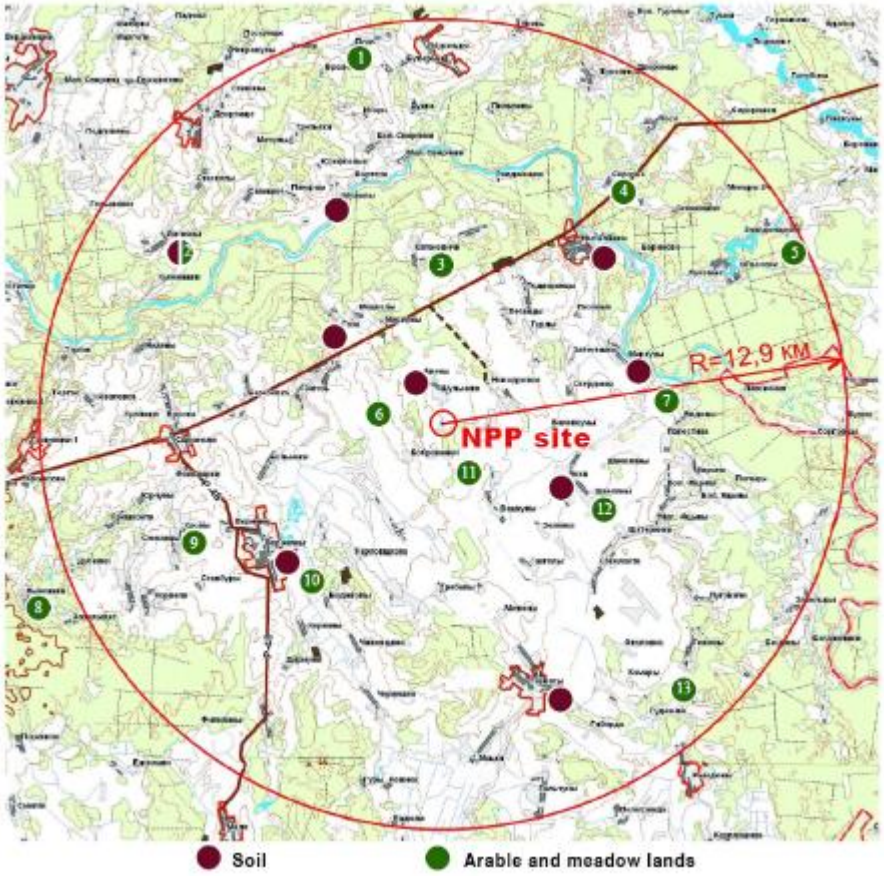


Figure 8.34 - Layout of observation points for radioactive contamination of soils and agricultural lands in the observation zone of Belarusian NPP

Ground vegetation

The level of ^{137}Cs content in samples of vegetation of meadow biogeocenosis was lower than MDA (<1.65 Bq/kg) with the maximum background value of 24.6 Bq/kg obtained at the stage of construction of the

Belarusian NPP. The specific activity of ^{90}Sr in the vegetation of meadow biocenosis was in the range <0.49-1.27 Bq/kg (maximum background value - 5.0 Bq/kg).

The highest levels of ^{137}Cs content in forest biogeocenosis samples were: medicinal plants - 18.1 Bq/kg (maximum background value - 138.0 Bq/kg), stand components - 4.2 Bq/kg (maximum background value - 93.5 Bq/kg), wild berries - <0.17 Bq/kg (maximum background value - 43.0 Bq/kg), mushrooms - 792.0 Bq/kg (maximum background value - 2348.65 Bq/kg).

The specific activity of ^{90}Sr in samples of forest biocenosis plants was in the range <1.15 - 3.85 Bq/kg (maximum background value - 4.0 Bq/kg), in mushrooms - 0.52 Bq/kg (maximum background value - 16.0 Bq/kg).

The results of comparative data analysis show that in all observation points for components of forest and meadow phytocenoses of the Belarusian NPP control area the levels of radioactive contamination with ^{137}Cs and ^{90}Sr radionuclides in 2023 correspond to the previously established background values.

Agricultural products

The values of specific activity of radionuclides ^{134}Cs, ^{137}Cs, ^{131}I and ^{90}Sr in milk samples, ^{134}Cs, ^{137}Cs and ^{90}Sr in beef samples, radionuclides ^{90}Sr, ^{51}Cr, ^{54}Mn, ^{58}Co, ^{59}Fe, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{134}Cs, ^{137}Cs in samples of feed, food and food raw materials in livestock observation points in 2023, in most cases did not exceed MDA values.

Specific activity of ^{134}Cs, ^{137}Cs and ^{131}I in milk samples collected at 7 livestock stations did not exceed MDA levels (<0.7; <0.9 and <0.7 Bq/kg, respectively). The specific activity of ^{90}Sr in milk ranged from <0.10 Bq/kg to 1.28 Bq/kg (Vorona MTF).

The obtained results of ^{137}Cs and ^{90}Sr content in milk are significantly lower than the reference levels established by HS "Radiation Exposure Assessment Criteria" (^{137}Cs content should not exceed 100 Bq/l, ^{90}Sr - 5 Bq/l).

Meat (beef) samples were taken at 2 livestock breeding points (cattle breeding and fattening complex (hereinafter - Cattle) Gervyaty, cattle breeding and feeding farm Czech Republic). The measured specific activity of ^{134}Cs, ^{137}Cs in beef did not exceed MDA levels (<0.2; <0.23 Bq/kg, respectively). The specific activity of ^{90}Sr in beef ranged from 0.12 to 0.14 Bq/kg (Czechi cattle feeding and breeding farm).

The obtained results of ^{137}Cs content in meat are significantly lower than the reference level established by HS "Radiation Exposure Assessment Criteria" (^{137}Cs content should not exceed 200 Bq/kg). Due to the fact that the content of ^{90}Sr in meat and meat products is not regulated by this standard, the assessment of radiation status of this monitoring object was performed by comparing the

obtained results with the values of "zero" radiation background, which shows the non-exceedance of the previously obtained results of "zero" radiation background for this controlled parameter (maximum background value of ^{90}Sr content in meat - 1.83 Bq/kg).

A total of 21 samples of fodder (succulent and cereals) and 11 samples of foodstuffs and food raw materials (fruits, cereals, root crops) were taken at the control agricultural observation points during this period. Specific activity values of ^{134}Cs, ^{137}Cs, ^{58}Co, ^{60}Co, ^{54}Mn, ^{59}Fe, ^{95}Nb, ^{95}Zr, ^{51}Cr, ^{141}Ce, ^{131}I in the selected samples of agricultural products did not exceed MDA levels.

Annual ambient dose equivalent (ADE) in the locality (dose equivalent characterizing the radiation situation)

Data analysis shows that in 2023 quarterly values of ambient radiation dose equivalent at all observation sites (Vornyany, Svir, Vorona, Podoltsy, Rymdyuny, Gzoa, Chechi, Markuny, Chernishki, Olkhovka) varied in the range of 0.15 - 0.21 mSv. Annual ADE values in 2023 ranged from 0.69 to 0.72 mSv, which corresponds to the established values of "zero" background radiation for this region of the Republic of Belarus.

Thus, the results of radiation monitoring in the OZ of the Belarusian NPP, obtained in 2023, indicate that the radiation situation in the area of the Belarusian NPP location remains stable, the levels of contamination by man-made radionuclides of components of the environment, agro-ecosystems and agricultural products correspond to the levels of "zero" radiation background, registered at the stage of construction and commissioning of the Belarusian NPP.

CHAPTER 9

Information on the results of monitoring at the observation points of the National Environmental Monitoring System of the Republic of Belarus, located outside the observation zone of the Belarusian NPP

9.1 Radiation monitoring

The network of observation points of radiation monitoring in the area of impact of the Belarusian NPP was established in order to oversee its performance, timely identify changes in the radiation situation, assess and forecast possible consequences of radiation impact on public health and the environment, as well as (if necessary) promptly take measures to prevent or reduce radiation impact.

National radiation monitoring is carried out outside the observation zone (12.9 km radius circle) of the Belarusian NPP.

Compilation, processing, storage of data, provision of information obtained as a result of performance of radiation monitoring in the area of impact of the

Belarusian NPP on the observation zone is conducted by the Radiation Monitoring Service of the State institution "Republican Centre for Hydrometeorology, Control of Radioactive Contamination and Environmental Monitoring" (Belhydromet).

There are **10 observation points** of radiation monitoring of the National Environmental Monitoring System (hereinafter referred to as NEMS, Figure 9.1) in the area of impact of the Belarusian NPP:

3 observation points of radiation monitoring of atmospheric air: Lyntupy, Naroch and Oshmyany.

3 observation points of radiation monitoring of surface water: the Viliya River (v. Bystrica), Lake Naroch (Naroch resort settlement) and Lake Svir (Svir settlement).

4 observation points of radiation monitoring of soil – soilscape-geochemical polygons (hereinafter referred to as LGCP): Bystrica, Svir, Gudogai and Kemelishki.

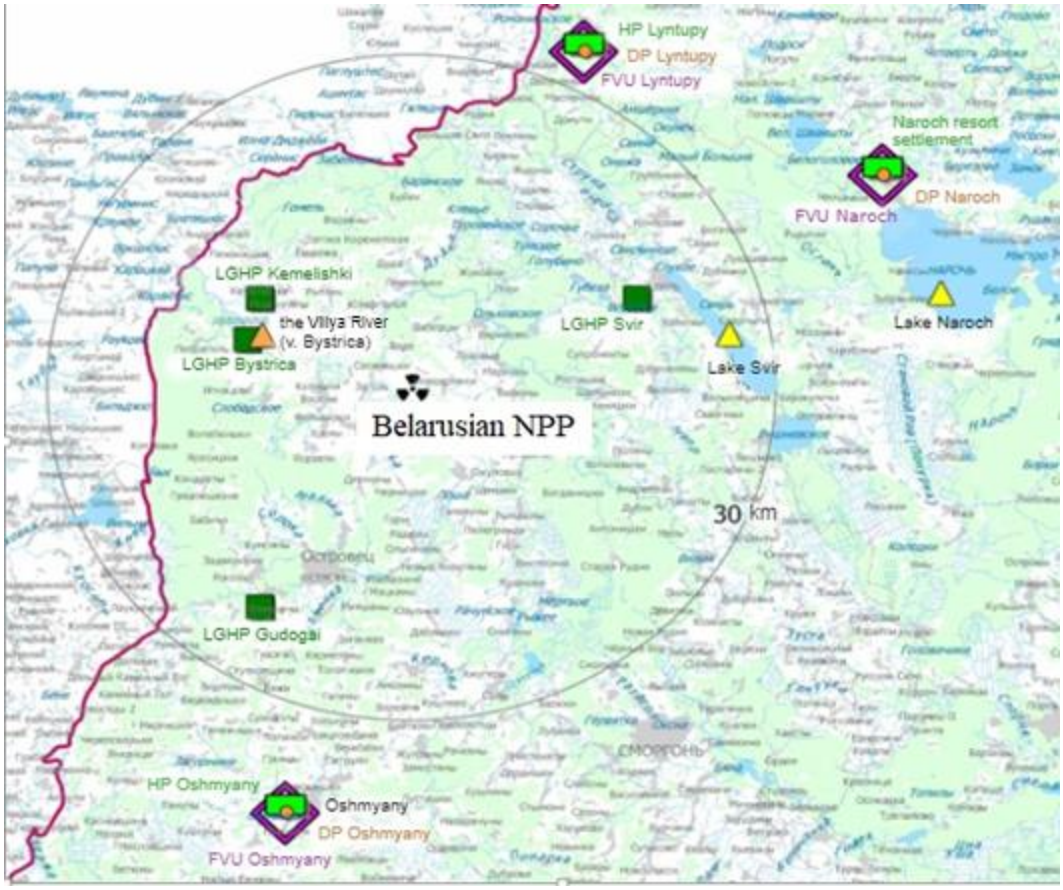


Figure 9.1 – Location scheme of the National Environmental Monitoring System of the Republic of Belarus (NSMOS) observation points of radiation monitoring located outside the observation zone of the Belarusian NPP

Legend:

Observation point of radiation monitoring of atmospheric air:

– dosimetric post (DP) – measurement of gamma radiation dose rate;

– horizontal plate (HP) – sampling of natural precipitations from the surface layer of the atmosphere;

– filter-ventilation unit (FVU) – sampling of radioactive aerosols;

Observation point of radiation monitoring of soil:

– LGHP – sampling of soil;

Observation point of radiation monitoring of surface water:

– observation point of radiation monitoring of surface water;

– transboundary observation point of radiation monitoring of surface water;

– location of NPP;

30 km – distance from NPP, km.

Radiation monitoring of atmospheric air is carried out according to the following observation parameters:

- gamma radiation dose rate;
- total beta activity (radioactive aerosols of the surface layer of the atmosphere and natural precipitations from the surface layer of the atmosphere);
- activity of gamma-emitting radionuclides in combined monthly samples (radioactive aerosols of the surface layer of the atmosphere and natural precipitations from the surface layer of the atmosphere);
- activity of Strontium-90 (^{90}Sr) in combined quarterly samples (radioactive aerosols of the surface layer of the atmosphere and natural precipitations from the surface layer of the atmosphere).

Figures 9.2 and 9.3 show monthly averages of total beta activity in samples of aerosols and natural precipitations from the surface layer of the atmosphere at the observation points located in the area of impact of the Belarusian NPP for 2023.

Figure 9.2 – Monthly averages of total beta activity in samples of aerosols from the surface layer of the atmosphere at observation points located in the area of impact of the Belarusian NPP for 2023

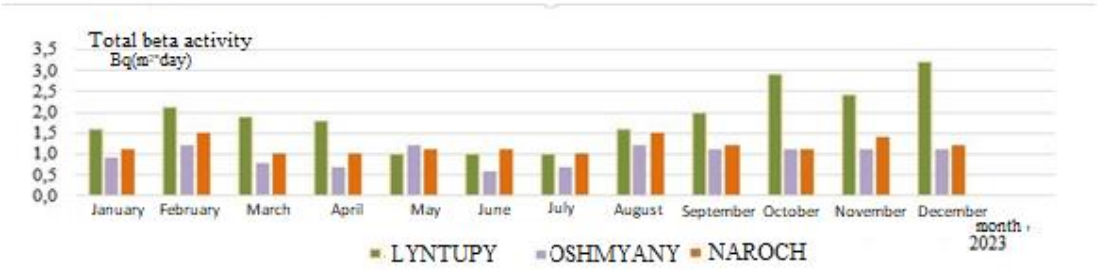


Figure 9.3 – Monthly averages of total beta activity in samples of natural precipitations from the surface layer of the atmosphere at observation points located in the area of impact of the Belarusian NPP for 2023

In 2023, the average annual rate of gamma radiation dose at the observation sites did not exceed 0.10 μSv/h (natural radiation background in the Republic of Belarus is – 0.20 μSv/h).

The total beta-activity in monthly average samples of natural precipitations and aerosols from the surface layer of the atmosphere at the observation points in the area of impact of the Belarusian NPP collected in 2023 corresponded to the established long-term values and were in the range of (3.5-20.7)×10-5 Bq/m^3 – for aerosols from the surface layer of the atmosphere; 0.6-3.2 Bq/m^2*day – for precipitations from the surface layer of the atmosphere.

The activity of gamma-emitting radionuclide (Cesium-137 (137Cs) in combined monthly aerosol samples amounted to (<0.10-0.13)×10^{-5} Bq/m^3; monthly radioactive precipitations samples were below the detection limit (<0.01 Bq/m^2*day).

The activity of Strontium-90 (^{90}Sr) in quarterly aerosol samples in most cases did not exceed the value of the lower limit of the measurement range of the applied method, which amounts to 0.2 Bq per sample. The maximum value of activity of Strontium-90 (^{90}Sr) – 0.13×10^{-5} Bq/m^3 was recorded only at one observation point of atmospheric air – Oshmyany, which correlates with the values measured at this observation point for the period from 2018 to 2022 and falls within the range *(<0.01-0.30)×10^{-5} Bq/m^3*. Strontium-90 (^{90}Sr) content in all combined quarterly samples of precipitations from the atmosphere did not exceed the value of the lower limit of the measurement range.

Radiation monitoring of surface water was carried out according to the following observation parameters:

- total alpha and beta activity,
- activity of Cesium-137 (^{137}Cs), Strontium -90 (^{90}Sr);

- activity of Cesium-137 (^{137}Cs) and Strontium-90 (^{90}Sr) in bottom sediments.

The total alpha-activity in samples of surface water collected in 2023 at water bodies in the area of impact of the Belarusian NPP was in the range <0.01-<0.05 Bq/dm^3, and the total beta activity was 0.04-0.11 Bq/dm^3.

The results of radiation monitoring of surface water in 2023 show that the volume activity of Cesium-137 (^{137}Cs) was in the range of <0.002 Bq/dm^3 to 0.006 Bq/dm^3, the volume activity of Strontium-90 (^{90}Sr) did not exceed 0.005 Bq/dm^3.

Analysis of data in the monitored rivers showed that the concentrations of the above-mentioned radionuclides and total alpha and beta activities in 2023 were below the reference levels in drinking water which were established by the Hygienic Standard "Criteria for Assessment of Radiation Exposure", adopted by the Resolution of the Council of Ministers of the Republic of Belarus dated November 29, 2022 No.829 (the reference level for drinking water is 10 Bq/l for Cesium-137 (^{137}Cs) and Strontium-90 (^{90}Sr); 0.5 Bq/l 1.0 Bq/l for total alpha and beta activities, respectively).

The results of measurements of Cesium-137 (^{137}Cs) and Strontium-90 (^{90}Sr) in bottom sediments samples collected in 2023 at all observation sites show that the activity values for these radionuclides corresponded to the previously established values and do not exceed 6.5 Bq/kg and 14 Bq/kg, respectively.

Radiation monitoring of soil, located outside the observation zone of the Belarusian NPP, was carried out according to the following observation parameters:

- gamma radiation dose rate,
- distribution of activity of Cesium-137 (^{137}Cs) и Strontium-90 (^{90}Sr) in soil at a depth of 10 cm in layers with a step of 1 cm.

At observation points of radiation monitoring of soil (LGCP) specific activity of Cesium-137 (^{137}Cs) varied from <1.0 to 8.8 Bq/kg, Strontium-90 (^{90}Sr) – <1.0 to 4.9 Bq/kg.

Thus, the activity of the mentioned radionuclides (Cesium-137 (^{137}Cs), Strontium-90 (^{90}Sr) corresponds to the values recorded before the Chernobyl NPP accident and global fallout caused by nuclear weapons tests in the middle of the last century.

The gamma radiation dose rates measured at a height of 1 m and 3-4 cm from the underlying soil surface did not exceed 0.10 μSv/h.

The results of radiation monitoring for 2023 conducted at the observation points of NEMS, which are located in the area of impact of the Belarusian NPP, show that the measurement results correspond to the established long-term

values. Launching of power unit No. 1 and power unit No. 2 of the Belarusian NPP did not have negative impact on the radiation situation of the environment.

9.2 The results of monitoring of surface water in the water of the Viliya River 0.3 km northeast of Bystrica settlement for 2023.

Regular monitoring of surface water is carried out in the context of the National Environmental Monitoring System of the Republic of Belarus at the observation points of the state observation network for surface water.

At the point of observation of surface water of the Viliya River (0.3 km northeast of Bystrica settlement (10.0 km from the border with the Republic of Lithuania) surface water is monitored based on hydrochemical, hydrobiological and hydromorphological indicators.

The assessment of water quality of surface water bodies was carried out in accordance with the national regulations on the quality of surface water bodies, as well as threshold values of indicators for the Viliya River, established by the Technical Protocol of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus and the Ministry of Environment of the Republic of Lithuania on cooperation in monitoring and exchange of information on the state of transboundary surface water dated April 10, 2008.

The results of monitoring of surface water for 2023 did not reveal any new trends in the water quality of the Viliya River compared to the results of previous years' monitoring (see Table 9.1).

Table 9.1 – The results of monitoring in the water of the Viliya River in 0.3 km northeast of Bystrica settlement for 2023.

Parameter	MPC for the Viliya River	Threshold values of indicators for the Viliya River according to the Technical Protocol	Average annual rate
Suspended substances (mg/dm^3)	no more than 25	-	7.48
Dissolved oxygen (mgO_2/dm^3)	During the ice-cover period, there should be at least 6, open – 8	≤2.0	10.6
Five-day bod (mgO_2/dm^3)	3	23.0	2.58
COD_{Cr} (mgO_2/dm^3)	25	100	33.2
Ammonium ion (mgN/dm^3)	0.39	3.9	0.056
Nitrite ion (mgN/dm^3)	0.024	0.2	0.014

Nitrate ion (mgN/dm^3)	9.03	12.0	1.185
Phosphate ion (mgP/dm^3)	0.066	1.0	0.028
Total phosphorus (mg/dm^3)	0.2	1.5	0.077
Total iron (mg/dm^3)	0.370	-	0.342
Manganese (mg/dm^3)	0.100	-	0.0995
Copper (mg/dm^3)	0.0043	0.05	0.004
Zinc (mg/dm^3)	0.030	1.0	0.023
Nickel (мкг/dm^3)	34	50	0.36
Petroleum products (mg/dm^3)	0.05	0.7	0.017
Anionic synthetic surface-active substance (mg/dm^3)	0.1	1.0	<0.025
Kjeldahl nitrogen (mg/dm^3)	5	-	1.5
Hydrogen index (pH)	6.5-8.5	6.0-9.0	8.18
Cadmium (mg/dm^3)	0.005	0.01	<0.0005
Calcium (mg/dm^3)	180	-	56.0
Magnesium (mg/dm^3)	40	-	23.14
Water mineralization (mg/dm^3)	не более 1000	-	275.0
Arsenic (mg/dm^3)	0.05	-	0.002
Mercury (µg/dm^3)	0.07	5.0	<0.2
Lead (µg/dm^3)	14	100.0	<5
Sulfate ion (mg/dm^3)	100	-	25.84
Chloride ion (mg/dm^3)	300	-	16.04
Chromium (mg/dm^3)	0.005	0.05	0.0009

According to the results of monitoring for 2023, the ecological condition (status) of the Viliya River is classified as good (2 quality class by hydrobiological indicators, 2 quality class by hydrochemical indicators, 1 quality class by hydromorphological indicators).

CHAPTER 10
Information and educational activities in the field of radiation and environmental monitoring

Since 2009, the NPP Information Center in Ostrovets has been operating within the structure of Belarusian NPP. The Center is designated for informing the population about nuclear power engineering and construction of the Belarusian NPP.

On the basis of the Information Center specialists of the Information and Public Relations Department and other employees of the State Enterprise

"Belarusian NPP" give lectures on the development of the world nuclear industry, on the selected NPP project, on modern and reliable technologies used in the construction of Belarusian NPP. Materials on the environmental impact assessment of the Belarusian NPP are freely available at the Information Center.

The work of the Information Center (holding events with visitors, organizing excursions to the construction site of Belarusian NPP) is carried out exclusively on a gratuitous basis.

In 2023, the NPP Information Center was visited by 5,101 people in 228 delegations. Compared to 2022, the number of visitors increased by 40%.

Lectures, excursions, seminars were held for the visitors of the Information Center, covering the construction of the Belarusian NPP, peculiarities of the NPP-2006 project, safety systems used at modern nuclear power plants, organization of radiation and environmental monitoring, the impact of NPPs on the ecology of the region and other topics.

Figure 10.1 - NPP information center

Practical assistance was provided to representatives of domestic and foreign mass media (hereinafter - mass media) in preparation of TV spots, reports and interviews on the progress of construction of the Belarusian NPP.

Press tours were organized for domestic and foreign mass media to cover the visit of the President of the Republic of Belarus A.G. Lukashenko to the Belarusian NPP and the progress of construction of the Belarusian NPP.

Reports on the work of the Belarusian NPP were prepared for the regional socio-political newspaper "Astravetskaya Prauda". Assistance was provided in preparation of special reports for Belteleradiocompany, CJSC "Second National TV Channel", VGTRK (Russia) and others.

The practice of cooperation with the newspaper "Energetika of Belarus" on preparation of materials about Belarusian NPP employees in the column "NPP in Faces" was continued.

Information support was provided in preparation of materials on the work of the Belarusian NPP for the sectoral mass media: "Energy Strategy", "Energy of Belarus".

It was organized the participation in the XXVII Belarusian Energy and Environmental Forum "EnergyExpo 2023", International Forum and Exhibition "Eurasia - Our Home", exhibition within the framework of the 67th session of the IAEA General Conference.

In order to promptly and comprehensively cover the construction and operation of the Belarusian NPP, to provide more active and meaningful information about nuclear power to the youth audience, the official pages of the enterprise are maintained in popular social networks "Facebook", "Vkontakte", "Odnoklassniki", "Instagram". Belarusian NPP's YouTube account continues to be updated with video content.

The content of the company's website is regularly updated. Since 2022, in on-line mode, the company's website in the "Radiation Situation" section reflects up-to-date information on the radiation background in the OZ of Belarusian NPP with the update frequency of 30 minutes.