REPORT
Results of Radiation and Environmental Monitoring within the Belarusian Nuclear Power Plant Location Area

2024

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INTRODUCTION

The 2024 Report on Results of Radiation and Environmental Monitoring within the area of location of the State Enterprise "Belarusian Nuclear Power Plant" (hereinafter referred to as the "Belarusian NPP") is compiled as part of performing the Belarusian NPP Post-Project Analysis Program (agreed with the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus on 23 December 2014) to implement commitments of the Republic of Belarus under the Convention on Environmental Impact Assessment in a Transboundary Context (Article 7). The monitoring was implemented through the Belarusian NPP's employees as well as with involvement of specialised Belarusian organisations.

CHAPTER 1
BELARUSIAN NPP GENERAL CHARACTERISTICS

The Belarusian NPP is located in the Ostrovets District, Grodno Oblast, Republic of Belarus, 18 km northeast of the town of Ostrovets (Fig. 1.1).

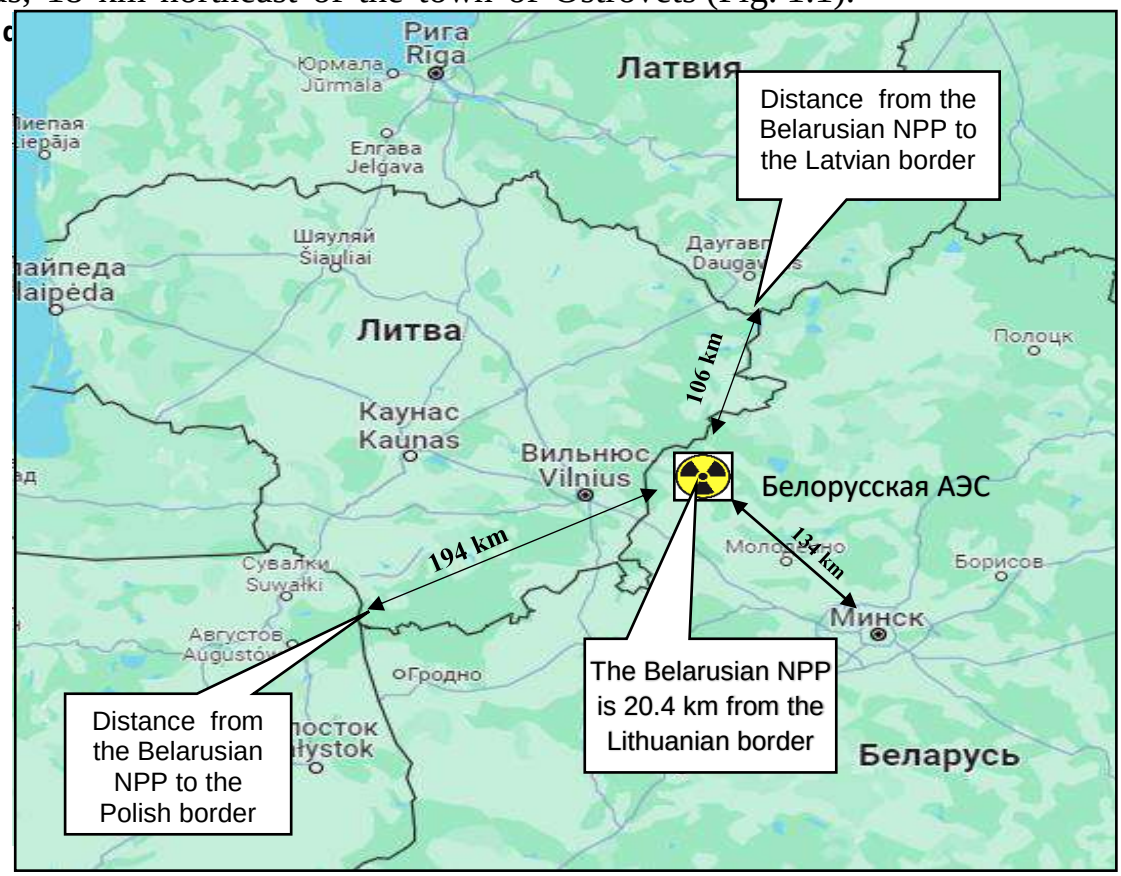


Figure 1.1 – Map-sheme of the Belarusian NPP location

The adjoining states 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) and 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 a cumulative electric power capacity of up to 2,400 MW and operating VVER-1200 reactors is built according to the Russian "NPP-2006" Project belonging to the 3+ generation design near the town of Ostrovets, Grodno Oblast. The Belarusian NPP Project complies with the most up-to-date so-called "post-Fukushima" reliability and safety standards due to implementing innovative "passive safety systems" capable of operating without the operators' intervention even in case of complete NPP de-energisation.
The NPP VVER-1200 power unit schematic diagram is shown in Figure 1.2.

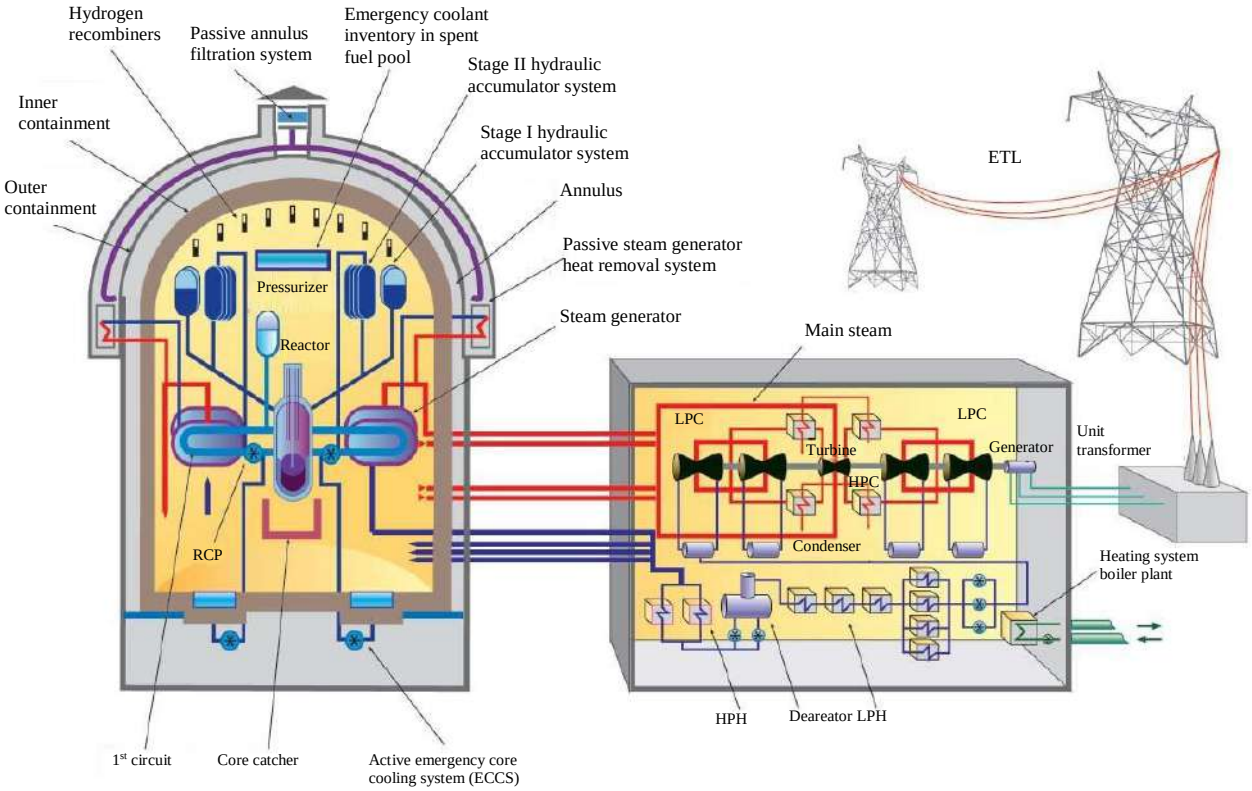


Figure 1.2 – NPP VVER-1200 power unit schematic diagram

Target key technical and economic features:

power unit installed nominal capacity – 1,200 MWe;
number of power units – 2;
power unit service life – 60 years;
efficiency (net) – 33.7%;

NPP balance – not more than 7.15% of rated capacity.

The Belarusian NPP Project safety is based on the defense-in-depth principle, i.e. the use of a system of barriers to the ionising radiation propagation and radioactive substance emission into the environment.

The barrier system comprises as follows:

– fuel matrix preventing fission products from releasing under the fuel element can;

– fuel element can preventing fission products from entering into main circulation circuit coolant;

– main circulation circuit preventing fission products from entering under the containment;

– containment system excluding the release of fission products into the environment.

The Belarusian NPP Project safety has been repeatedly confirmed by the International Atomic Energy Agency (hereinafter referred as the "IAEA") and the World Association of Nuclear Operators experts. Belarus-gained successful experience while implementing the nuclear power plant project was duly appreciated by the international nuclear community.

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

According to the Project, the Belarusian NPP site territorial boundaries coincide with the boundaries of the buffer area (hereinafter referred to as the "BA"), and the radiation-control area (hereinafter referred to as the "RCA") measuring 12.9 km.

The Belarusian NPP uses a circulating service water supply system with cooling towers and spray cooling ponds.

The water intake facilities site for making up the service water supply system is located 7 km to the north of the Belarusian NPP site on the Viliya River at Malye Sviryanki settlement. The second-stage pumping station site is located 0.25 km to the north of Matskely settlement.

The water intake facilities for the utility and drinking water supply system are located 6 km to the south-east of the Belarusian NPP near Gaigoli settlement and Popishki settlement. The water intake facilities comprise 4 water intake sites and one utility and drinking water treatment plant site.

CHAPTER 2
BELARUSIAN NPP CORE OPERATIONS

The third scheduled preventive repair (hereinafter referred to as the "SPR-3") has been performed at the Belarusian NPP power unit No. 1 from 03.12.2024 to 27.01.2025.

The following has been performed within the SPR-3 framework: partial refuelling, the Belarusian NPP master equipment and safety systems maintenance, as well as the scheduled operations of the in-service control of metal and technical inspection of equipment and pipelines.

The first scheduled preventive repair (hereinafter referred to as the “SPR-1”) was performed at the Belarusian NPP power unit No. 2 from 26.07.2024 to 14.10.2024.

The following has been performed within the SPR-1 framework: full core offload, fuel element integrity control of all 163 fuel assemblies and partial refuelling, the Belarusian NPP master equipment and safety systems maintenance, as well as the scheduled operations of the in-service control of metal and technical inspection of equipment and pipelines.

The Belarusian NPP power units generated a total of 38.232 billion kWh of electric power since the time of hooking up to the power grid up to 01.01.2025. The substituted natural gas equivalent due to electric power generation since the first synchronisation of the Belarusian NPP No. 1, 2 power units’ turbine generators with the power grid of the Republic of Belarus amounts to about 10 billion m^3.

Figure 2.1 – Belarusian Nuclear Power Plant

To improve the system of nuclear and radiation safety during commissioning and subsequent operation of Belarusian NPP, to obtain outside expertise from foreign specialists, the Belarusian NPP actively cooperates with international organisations, such as IAEA, WANO, European Nuclear Safety Regulators Group and others.

Through the interaction with WANO, in 2024, the State Enterprise “Belarusian NPP” representatives participated in 33 events, while 5 events were held at the Belarusian NPP site within the framework of the 2024 Action Plan of Cooperation between the WANO Moscow Centre and the State Enterprise “Belarusian NPP”.

The NPP operation status is continuously monitored in cooperation with WANO.

The areas of cooperation with IAEA include as follows:

– technical cooperation project BYE2008 “Improving the Belarusian NPP operational safety during the NPP commissioning and operation” extended till 31.12.2025;

- the IAEA international technical assistance project BYE2009 “Enhancing Safety, Reliability and Efficiency of Nuclear Power Plant at the Initial Stage of its Operation” (responsible organisation – SPA “Belenergo”) is approved and under implementation;
- a working visit of the IAEA Director General R. Grossi to the Belarusian NPP site took place;
- a working visit of the Belarusian Project Manager of the IAEA Technical Cooperation Program took place to discuss issues of cooperation with the IAEA and implementation of the current BYE2008 technical cooperation project;
- employees of the State Enterprise “Belarusian NPP” participated in the 68th Session of the IAEA General Conference, as well as in the IAEA-organised 15 international events;
- 10 IAEA expert inspections as part of the IAEA Safeguards Implementation were received.

In addition, a number of activities within the framework of bilateral cooperation with foreign countries was undertaken at the Belarusian NPP site, with the most notable of these being as follows:

- visit of the RF Sakhalin Oblast Governor;
- 2 meetings of the Belarusian-Hungarian Expert Group on Cooperation in the Field of Nuclear Energy within the framework of the Memorandum of Understanding between the Ministry of Energy of the Republic of Belarus and Paks II Nuclear Power Plant plc. (Hungary).

CHAPTER 3
BELARUSIAN NPP INTEGRATED MANAGEMENT SYSTEM POLICY AND RADIATION SAFETY POLICY AND THEIR IMPLEMENTATION

In 2020, the Belarusian NPP introduced the Integrated Management System Policy (hereinafter referred to as the “IMS Policy”). The environmental management system is a part of the IMS.

In 2021 the Belarusian NPP reissued the IMS Policy of the State Enterprise “Belarusian NPP”. The Belarusian NPP management made commitments to implement the IMS Policy, including the environmental protection by preventing, mitigating and minimising potential adverse environmental impacts associated with the Enterprise operations.

In 2024, the IMS Policy was updated; the updated document sets the following objectives in terms of environmental management:

production of electric power and heat energy while ensuring safety, including environmental safety, as the highest priority of the NPP operations;

sustainable management of natural resources.

The above objectives are to be achieved by implementing the applicable requirements and other commitments made in the field of environmental protection.

The IMS Policy is shared with all new recruits at the time of environmental induction training.

In 2024, the Belarusian NPP implemented the IMS policy by as follows:

complying with requirements of the legislation of the Republic of Belarus in the field of environmental protection and sustainable management of natural resources;

demonstrating leadership by managers of all levels for safety reasons;

exercising internal forms of control over operations;

protecting the environment by preventing, mitigating and minimising potential adverse environmental impacts associated with the Enterprise operations.

The Belarusian NPP radiation safety policy was introduced on 22 April 2019 and updated on 24 September 2024.

Exercising its functions as an operating organisation subject to the regulatory legal acts of the Republic of Belarus in the area of nuclear energy use, the State Enterprise "Belarusian NPP" demonstrates its commitment to radiation safety as one of the priorities of the activity for use of nuclear energy.

The State Enterprise "Belarusian NPP"-set radiation safety Policy goal: providing protection of life and health of the present and future generations of people, as well as the environment from harmful effects of ionising radiation at the level complying with the current requirements.

The above goal is to be achieved by as follows:

implementing activities for the use of nuclear energy and ionising radiation sources, excluding an adverse effect on the living conditions of the population of the Republic of Belarus and being regulated by the radiation safety provisions set forth in the international treaties, agreements and conventions ratified by the Republic of Belarus, legislation of the Republic of Belarus, local legal acts of the Enterprise, as well as by radiation safety recommendations contained in the IAEA documents;

defining functional responsibilities of the Enterprise personnel and representatives of the organisations involved in the radiation safety activities and their liability for compliance with the imposed radiation safety requirements;

identifying and implementing a set of institutional and technical measures aimed at increasing the radiation safety level;

forming and continuously improving the safety culture of the Enterprise personnel and also representatives of the organisations involved.

The State Enterprise "Belarusian NPP" implementing the Radiation Safety Policy of the State Enterprise "Belarusian NPP", follows the below stated three main principles:

prohibiting all types of activities for use of ionising radiation sources in case the benefit obtained is not in excess of the risk of potential harm caused by the irradiation being additional to the natural background exposure;

not exceeding main radiation dose limits for the personnel and population set by the legislation of the Republic of Belarus;

maintaining the lowest possible and achievable level of exposure to radiation doses and the number of exposed persons when ionising radiation sources are used, taking into account the economic and social factors.

To comply with the above principles the Enterprise management assumes the following obligations:

bringing Radiation Safety Policy to the attention of all Enterprise employees, explaining and consistently implementing it in practice, conveying its convictions that lie behind the Policy to the personnel by setting an example with its own behaviour and managerial practice;

demonstrating leadership on radiation safety issues;

providing necessary institutional and structural conditions for effective functioning of the radiation safety management process;

monitoring and optimising radiation doses to the Enterprise personnel and representatives of the organisations involved by implementing the ALARA principles;

promoting training and the Enterprise personnel development in the field of radiation safety;

examining and supporting any employees' initiatives aimed at maintaining and improving radiation safety.

CHAPTER 4
ENVIRONMENT AND QUALITY MANAGEMENT SYSTEM

The IMS developed and operated by the Belarusian NPP is a set of interrelated documented and manageable processes aimed at achieving target indicators, provided that established requirements are complied with.

The Enterprise-operated IMS integrates such safety aspects as nuclear safety, radiation safety, industrial safety, fire safety, engineering safety, nuclear security, environmental safety, labour protection by separation of the appropriate processes, as well as such elements as quality assurance, human and institutional factors and socio-economic aspects. The highest priority of the Enterprise's operation is safety.

To date, the Enterprise has implemented, operates, keeps current and also certified in the National System of Conformity Attestation of the Republic of Belarus the following:

Quality Management System for the production of electricity and heat, performance of the customer's and developer's functions, delivery of engineering services during construction of 1-4 complexity class facilities for compliance with the requirements of STB ISO 9001-2015 "Quality Management Systems. Requirements" (Certificate of Conformity No. BY/112 05.01.003.01.01263 dated 10.09.2024, valid up to 01.12.2025);

Health and Safety Management System in the pursuit of occupational activities for electricity and heat production for compliance with the requirements

of STB ISO 45001-2020 “Occupational health and safety management systems. Requirements and guidance for use” (Certificate of Conformity No. BY/112 05.04.003.01.01265 dated 10.09.2024, valid up to 12.12.2026);

Environmental Management System (hereinafter referred to as the “EMS”) for the production of electricity and heat for compliance with the requirements of STB ISO 14001-2017 “Environmental management systems. Requirements and guidance for use” (Certificate of Conformity No. BY/112 05.10.003.01. 01264 dated 10.09.2024, valid up to 12.12.2026).

In 2024, the Enterprise continued activities to maintain and operate the IMS within the framework of the current IMS, including as follows:

IMS policy and objectives were updated;

Quality policy was updated;

the IMS Coordination Council functioned and was predominantly tasked to coordinate the operation of the Enterprise within the IMS framework, maintain and constantly upgrade the IMS and assure follow-up the decisions taken at the meetings held by the Coordination Council;

IMS documents for various areas of the Enterprise's activities (policies, guidelines, Enterprise standards, Regulations, process certificates, quality assurance programs, etc.) were developed;

process risks are analysed and assessed, Risk Registers and Risk Management Programs for the IMS processes were developed;


НАЦИОНАЛЬНАЯ СИСТЕМА ПОДТВЕРЖДЕНИЯ СООТВЕТСТВИЯ РЕСПУБЛИКИ БЕЛАРУСЬ

СЕРТИФИКАТ СООТВЕТСТВИЯ

СТБ ISO 14001

Зарегистрирован в реестре № BY/112 05.10. 003.01 01264

Дата регистрации 10 сентября 2024 г.

Действителен по 12 декабря 2026 г.

Республиканское унитарное предприятие «Белорусская атомная электростанция»

Место нахождения юридического лица:
Республика Беларусь, 231220, Гродненская область, Островецкий район, Ворнянский с/с (2/7, административно-лабораторно-бытовой корпус (00UYA))

Место осуществления деятельности:
Республика Беларусь, 231220, Гродненская область, Островецкий район, Ворнянский с/с (2/7, административно-лабораторно-бытовой корпус (00UYA))

регистрационный номер в Едином государственном регистре юридических лиц и индивидуальных предпринимателей 190919639

Настоящий сертификат соответствия удостоверяет, что система менеджмента окружающей среды производства электрической и тепловой энергии **соответствует требованиям СТБ ISO 14001-2017 (ISO 14001:2015, IDT)**

Дополнительная информация:
Внесены изменения в юридический адрес организации.
Основание: письмо держателя сертификата соответствия (вх. № 13520 от 18.05.2024).
Выдан взамен бланка №0336941. Дата первичной регистрации 28.04.2021.
Выдан взамен № BY/112 05.10. 00345 00946, дата регистрации 15.12.2023.

Заместитель директора Т.Э.Якушевич

М.П.

№ 0347572

IMS internal audits, including verification of compliance with the requirements of quality assurance programs with execution of relevant documents (programs, plans, reports, corrective action plans) are performed;

external audits of Supplier Management Systems, including verification of compliance with the requirements of Quality Assurance Programs with execution of relevant documents (programs, plans, reports, corrective action plans);

existing IMS processes are monitored at regular intervals (once every 3 months);

management-performed analysis;

Measures on improving the IMS are being continuously implemented.

In 2024 the Certificate of Conformity was reissued due to the change of the Enterprise legal address: Certificate of Conformity No. BY/112 05.10. 003.01.01.01264 dated 10.09.2024, valid up to 12.12.2026, was issued.

In addition, in 2024, an independent body for management systems certification, i.e. the Republican Unitary Enterprise “Belarusian State Institute of Metrology” routinely

assessed the Environmental Management System for compliance with the requirements of STB ISO 14001-2017.

As a result, the EMS operation was positively assessed.

In its environmental safety activities, the Enterprise is guided by the following key principles:

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

mandatory assessment of the proposed activity impact on the environment by identifying and assessing the environmental aspects of operations;

identification of high environmental risks as a result of the Enterprise operations and development of measures aimed at preventing or minimising the NPP-related adverse effect on the environment and management of high environmental risks;

provision of transparency and accessibility of environmental information.

To achieve high environmental performance of the Enterprise, the following activities were implemented in 2024 by the Environmental Protection Department:

the Enterprise standard STO 1.1.1.016.0087-2024 “Environmental Management System Manual” was developed;

the 2024 Process Risk Register PP ISU 04-OOOS was updated.

scientific research work on the topic “Scientific substantiation of maximum permissible aluminum concentrations in water of surface water bodies of the Viliya River basin for further calculation and determination of constant aluminum concentration values when discharging wastewater into the Viliya River by the Belarusian NPP.”

CHAPTER 5
MAIN DOCUMENTS REGULATING THE BELARUSIAN NPP ENVIRONMENTAL PROTECTION ACTIVITIES AND OPERATIONS RELATING TO FUNCTIONING OF RADIO-ECOLOGICAL MONITORING OF THE ENVIRONMENT

Environmental safety activities at the State Enterprise “Belarusian NPP” are implemented subject to the Belarusian legislation requirements:

1. Convention on Environmental Impact Assessment in a Transboundary Context (adopted in Espoo on February 25, 1991).
2. Law of the Republic of Belarus No. 208-Z of October 10, 2022 “On Regulation of Safety in the Use of Atomic Energy”.
3. Law of the Republic of Belarus of November 26, 1992, No. 1982-XII “On Environmental Protection”.
4. Law of the Republic of Belarus No. 198-Z of June 18, 2019 “On Radiation Safety”.
5. Law of the Republic of Belarus No. 2-Z of December 16, 2008 “On the Protection of Atmospheric Air”.

6. Law of the Republic of Belarus No. 271-Z of July 20, 2007 “On Waste Management”.

7. Code of the Republic of Belarus No. 406-Z of July 14, 2008 “Subsoil Code of the Republic of Belarus”.

8. Code of the Republic of Belarus of April 30, 2014, No. 149-Z “Water Code of the Republic of Belarus”.

9. Code of the Republic of Belarus No. 425-Z of July 23, 2008 “The Land Code of the Republic of Belarus”.

10. Decree of the Council of Ministers of the Republic of Belarus dated July 14, 2003 No. 949 “On the National Environmental Monitoring System in the Republic of Belarus”.

11. Resolution of the Council of Ministers of the Republic of Belarus No. 482 of April 28, 2004 “On Conducting Certain Types of Environmental Monitoring and Use of Their Data”.

12. Resolution of the Council of Ministers of the Republic of Belarus No. 576 of May 17, 2004 “On Conducting Radiation Monitoring and Use of Its Data”.

13. Resolution of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus dated October 11, 2013 No. 52 “On the Observations in the Field of Environmental Protection and Rational (Sustainable) Use of Natural Resources”.

14. STB ISO 9001-2015 “Quality Management Systems. Requirements”.

15. STB ISO 14001-2017 “Environmental Management Systems. Requirements with Guidance for Use”.

16. GOST ISO/IEC 17025-2019. “General Requirements for the Competence of Testing and Calibration Laboratories.”

17. Norms and Rules for 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 of April 13, 2020.

18. Norms and Rules for Nuclear and Radiation Safety "Safety of Nuclear Power Plants within the Buffer Area and the Radiation Control Area. Requirements for Organisation and Provision of Radiation Monitoring" approved by Resolution of the Ministry for Emergency Situations of June 30, 2016 No. 29.

19. Hygienic Standard “Indicators of Safety and Harmlessness of Water of Water Bodies for Drinking and Household and Municipal and Amenity Water (Recreational) Use and Water in a Swimming Pool”, approved by Resolution of the Council of Ministers of the Republic of Belarus of January 25, 2021 No. 37.

20. Sanitary Rules and Norms 2.1.2.12-33-2005 “Hygienic Requirements for the Protection of Surface Waters from Pollution”.

21. Sanitary Rules and Norms “Requirements for the Maintenance of Surface Water Bodies at their Recreational Use”, Hygienic Standard “Permissible Values of Water Safety Indicators of Surface Water Bodies for Recreational Use”, approved by Resolution of the Ministry of Health of the Republic of Belarus on December 5th 2016 No. 122.

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

CHAPTER 6
TECHNICAL COMPETENCE AND LABORATORY CONTROL INDEPENDENCE ASSURANCE SYSTEM AS PER GOST ISO/IEC 17025-2019

The Enterprise operates two laboratories accredited in the National Accreditation System of the Republic of Belarus for compliance with requirements of GOST ISO/IEC 17025-2019. General Requirements for the Competence of Testing and Calibration Laboratories.

1. An industrial laboratory (hereinafter referred to as the “SSS IL”) was established in the Supporting System Shop (hereinafter referred to as the “SSS”) complying with the criteria of the National Accreditation System of the Republic of Belarus and is accredited for compliance with requirements of GOST ISO/IEC 17025-2019 “General Requirements for the Competence of Testing and Calibration Laboratories» (Accreditation Certificate No. BY/112 2.4928 of 19.05.2017).

The SSS IL is accredited to analyse the drinking water quality by the following indicators: sampling (GOST 31862-2012), ferrum (GOST 4011-72 Para 2), odour (GOST 3351-74 Para 2), taste (GOST 3351-74, Para 3), colour (GOST 31868-2012, method B), turbidity (GOST 3351-74, Para 5), pH index (STB ISO 10523-2009), total hardness (GOST 31954-2012, method A), dry residue (GOST 18164-72, Para 3.1), permanganate index (STB ISO 8467-2009), total microbial count (MUK RB 11-10-1-2002 Para 8.1), thermotolerant coliform bacteria (MUK RB 11-10-1-2002, Para 8.2), common coliform bacteria (MUK RB 11-10-1-2002, Para 8.2), sulphite-reducing clostridia spores (MUK RB 11-10-1-2002, Para 8.4), synthetic surface active substances (FR.1.31.2014.17189 (Federal Environmental Regulatory Documents 14.1:2:4.158-2000 (M01-06-2013)), petroleum products (FR.1.31.2012.13169 (Federal Environmental Regulatory Documents 14.1:2:4.128-98 (M 01-05-2012)).

The SSS IL is also accredited for analysing the quality of surface water and waste water by the following indicators: sampling (GOST 31861-2012, STB 17.13.05-29-2014/ISO5667-10:1992, STB ISO 5667-6-2021), mass concentration of hydroxyethylidene diphosphonic acid of zinc disodium salt (MVI.MN 6332-2021), suspended solids (MVI.MN 4362-2012), water salt content (MVI.MN 4218-2012), total phosphorus (GOST 18309-2014, method Г), total ferrum (STB 17.13.05-45-2016), pH index (STB ISO 10523-2009), chemical oxygen demand (FR.1.31.2012.12706 (PND F14.1:2:4.190-2003)), phosphate ion (GOST 18309-2014, method Б), 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), sulphate ion (STB 17.13.05-42-2015), synthetic surface active substances (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 of zinc disodium salt (AMI.MN 0015-2021), Kjeldahl nitrogen concentration (MVI.MN 4139-2011), biochemical oxygen demand (BOD) with dilution (STB 17.13.05-22-2011/ISO 5815-1:2003), biochemical oxygen demand (BOD) without dilution (STB 17.13.05-23-2011/ISO 5815-2:2003).

Accreditation Certificate validity: up to 19.05.2027.

2. The radiation situation of the environment in the Belarusian NPP BA and RCA is monitored by using the automated control system of radiation situation (hereinafter referred to as the "ACSRS") and radiation monitoring laboratory (hereinafter referred to as the "RML") of the radiation safety shop accredited in the National Accreditation System of the Republic of Belarus for compliance with GOST ISO/IEC 17025-2019 "General Requirements for the Competence of Testing and Calibration Laboratories" (Accreditation Certificate No. BY/112 1.1824 of 10.09.2021).

The ACSRS is configured for continuous monitoring of the radiation situation in the Belarusian NPP BA and RCA. The ARMS I&C complex includes 10 radiation monitoring stations, 9 of which are located within the RCA and 1 - at the surveillance point outside the RCA (Svir settlement), the automatic weather station (Vornyany settlement), 2 mobile radiometric laboratories, the main central control station at the Belarusian NPP site) and backup central control station in the town of Ostrovets.

Environmental radiological monitoring laboratory (ERML) performs periodic laboratory monitoring of the radionuclides content in the environment (ambient air, atmospheric precipitation and snow cover, soil, groundwater, surface water, bottom sediments, aquatic and ground vegetation) in the Belarusian NPP BA and RCA, as well as in local agricultural products and food products (vegetables, fruits, milk, meat, fish, etc.).

CHAPTER 7
INDUSTRIAL OBSERVATIONS IN THE FIELD OF ENVIRONMENTAL PROTECTION AND RATIONAL (SUSTAINABLE) USE OF NATURAL RESOURCES AT THE BELARUSIAN NPP

The Belarusian NPP bears full responsibility for environmental safety at all life cycle stages.

Subject to Article 94 of the Law of the Republic of Belarus "On Environmental Protection" and in accordance with the Decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus dated October 11, 2013 No. 52, the following local legal acts and monitoring schedules were developed for arranging industrial observations in the field of environmental protection and rational (sustainable) use of natural resources at the Belarusian NPP:

Organisation Standard STO 1.1.1.006.0009-2022 "Basic Rules of Environmental Protection at a Nuclear Power Plant";

Instruction for performing industrial observations in the field of environmental protection and rational (sustainable) use of natural resources at the Belarusian NPP;

Instruction for management of industrial waste at the Belarusian NPP;

Regulation for radiation monitoring at the Belarusian NPP;

Program of environmental radiation monitoring in the buffer area and radiation control area of the Belarusian NPP;

Instruction on control of radioactive substances emissions and releases at the Belarusian NPP;

Schedule of observations within local monitoring;

Schedule of industrial observations of contaminant emissions into the atmospheric air from stationary sources;

Sketch map of the location of sources of contaminant emissions into the atmospheric air within local monitoring;

Sketch map of observation wells as part of local groundwater monitoring;

Sketch map of location of contaminant emission sources and release sources at the production sites of a natural resources user.

The facilities of industrial environmental surveillance at the Belarusian NPP include as follows:

buildings, structures, equipment, systems networks, etc. recorded on the Belarusian NPP balance sheet which may adversely affect the environment.

Natural resources such as:

surface water within the area of location of waste water discharge sources;

groundwater within the area of location of identified or potential sources of groundwater contamination;

land (including soil) within the area of location of identified or potential sources of their contamination;

flora resources recorded on the Belarusian NPP balance sheet.

Engineering system subject to industrial surveillance:

domestic and technical water supply systems;

sanitary sewer systems of the free access zone;

industrial storm water drainage system;

sanitary sewer systems of the controlled access zone;

petroleum products waste sewer;

the system of wastewater sewered from the NPP into the Viliya River and formed by blowdown water from cooling towers and discharged salt effluents from water treatment plants which are not suitable for reuse in the in-plant process water recirculation system of technical water supply and are not subject to treatment;

water reuse and recycling systems;

waste water treatment systems;

stationary sources of contaminant emissions into the atmospheric air, including gas cleaning plants and systems for cleaning exhaust gas from mobile emission sources;

industrial waste storage facilities;

industrial waste intermediary storage facilities.

The following is also subject to industrial surveillance:

operation and production process management techniques directly or indirectly affecting the environmental quality;

waste generation sources, including production facilities, shops, sections, processes and specific technological processes;

other facilities which are used or may be used in the course of performing economic and other activities;

fuel, raw materials and materials used in economic and other activities;

quantitative and qualitative composition of contaminant emissions into the atmospheric air;

quantitative and qualitative composition of wastewater discharged into water bodies, sewerage systems and wastewater drainage networks.

The industrial observation results serve as the basis for drawing up Inspection Reports or Instruction Acts (in the event of violations of environmental legislation).

Sampling and measurement in the field of environmental protection is performed in-house at the State Enterprise "Belarusian NPP", as well as with the involvement of accredited testing laboratories within the contractual relationship.

Subject to Decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus No. 5 dated January 11, 2017, the State Enterprise "Belarusian NPP" from 22.07.2020 is entered into the list of legal entities involved in local monitoring. The following are monitored locally:

emissions of contaminants into the atmospheric air from process and other equipment, technological processes, machinery and mechanisms (4 emission sources from boiler plants Nos. 0001, 0002, 0003, 0004, Ostrovets);

wastewater discharged into surface water bodies, including through the storm water drainage system, and into surface water in the area of location of wastewater discharge sources (wastewater discharge point into the Viliya River, monitoring section on the Viliya River and control section on the Viliya River);

groundwater in the area of identified or potential sources groundwater contamination (3 observation wells, Enterprise territory, Ostrovets);

soils (grounds) in the area of identified or potential sources of their contamination (16 sample areas in the Enterprise territory and in its buffer area, Ostrovets).

CHAPTER 8
ENVIRONMENTAL IMPACT

8.1. Atmospheric Air Protection

The total contaminant emissions from all Enterprise sites specified in the Inventory Report of Contaminant Emissions into the Atmospheric Air (hereinafter referred to as the "Inventory Report") amount to 90.683 tons per year. The total actual volume of contaminant emissions from all facilities in 2024 amounted to 18.924 tons, which account for 20.87% of the total determined gross amount of emissions. This indicator is lower compared to that of 2023 period (19.3457 tons - 21.34 % of the total

determined volume). Due to abnormally high atmospheric air temperatures during the winter heating period, boiler plants consumed less gas in 2024 that accordingly resulted in lower emissions of contaminants into the atmospheric air compared to those in 2023.

Subject to the Inventory Report, the number of existing contaminant emission sources located at all Enterprise facilities is 130, including: stationary source of emissions - 106, fugitive emission sources – 24.

Main sources contributing to contaminant gross emissions from the Enterprise facilities are provided in Table 8.1.

Table 8.1 Major contaminant emission sources at the State Enterprise "Belarusian NPP"

No.	Contaminant emission source	Emission determined by Inventory Report, t/y	Actual amount of emissions in 2023, t/y	Actual amount of emissions in 2024, t/y
1	Treatment facility complex (TFC)	8.503	8.503	8.174
2	Diesel-generator unit (DGU)	25.14	5.69	4.06
3	Auxiliary boiler (AB)	51.41	0.114	3.316
4	Free access zone shops	2.92	1.75	0.893
5	Boiler plant of military community charged for NPP security (Modular gas boiler (MGB)).	0.698	0.313	0.371

The contribution of the major contaminant emission sources to the gross emissions of the Enterprise in 2024 is shown in Figure 8.1.

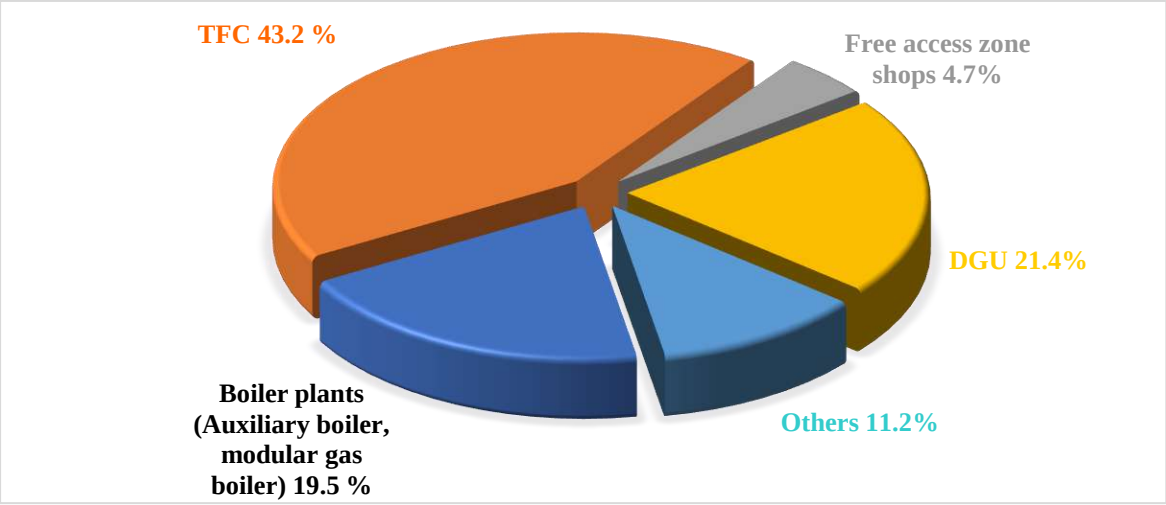


Figure 8.1 – Gross emissions from major contaminant emission sources at the Belarusian NPP in 2024, %.

Draft standards of permissible contaminant emissions into the atmospheric air have been developed for 64 sources of contaminant generation and emissions at the Enterprise facilities. These standards are included into the Permit for contaminant emissions into the atmospheric air.

According to the Permit for contaminant emissions into the atmospheric air No. 04/12.0098 dated 19.05.2023, the permissible emission limits is 62.955197 tons per year. The actual gross emission of contaminants released in the atmospheric air from controlled stationary emission sources under the Permit in 2024 amounted to 12.891 tons which accounted for 20.5% of the set standardised value.

The dynamics of contaminant emissions in tons from the Enterprise boiler plants compared to the previous years is provided in Fig. 8.2.

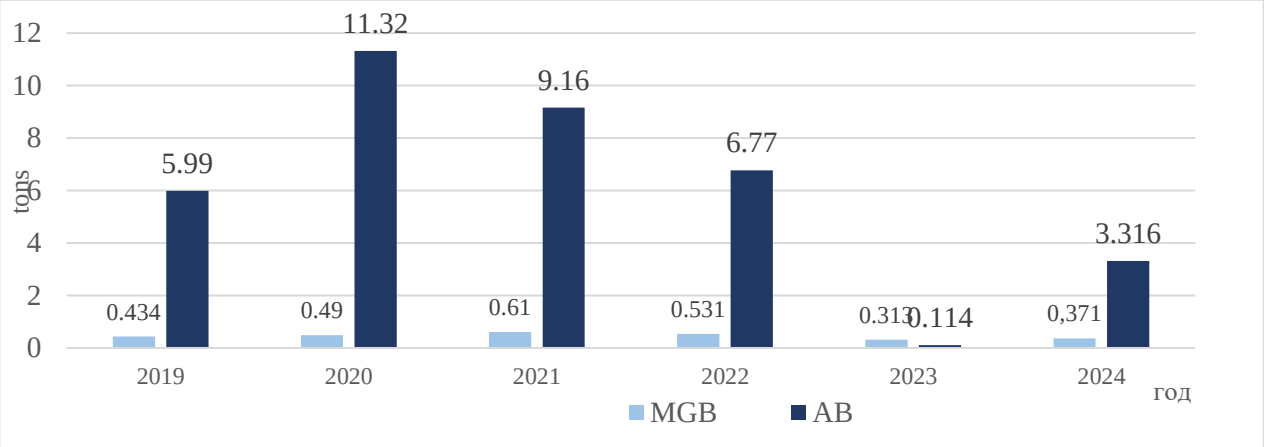


Fig. 8.2 Dynamics of contaminant emissions from Belarusian NPP boiler plants, t/y

In 2024, SPR-1 was performed at the power unit No. 2. On 4 December 2024 a normal shutdown of the power unit No. 2 was performed for supporting systems sensor diagnostics. Specifically, contaminant emissions from AB are due to unscheduled operation of boilers conditioned by production necessity to maintain the Enterprise heat loads an also to perform commissioning works.

The Enterprise emissions contain 1-4 hazard class contaminants, of this, 1st hazard class substances account for 0.000460 tons, 2nd hazard class substances - 3.081 tons, 3rd hazard class substances - 1.796 tons and 4th hazard class and unclassified hazard substances - 14.046 tons. The contribution of emissions of contaminants grouped by hazard class to the total actual emissions in 2024 is provided in Figure 8.3.

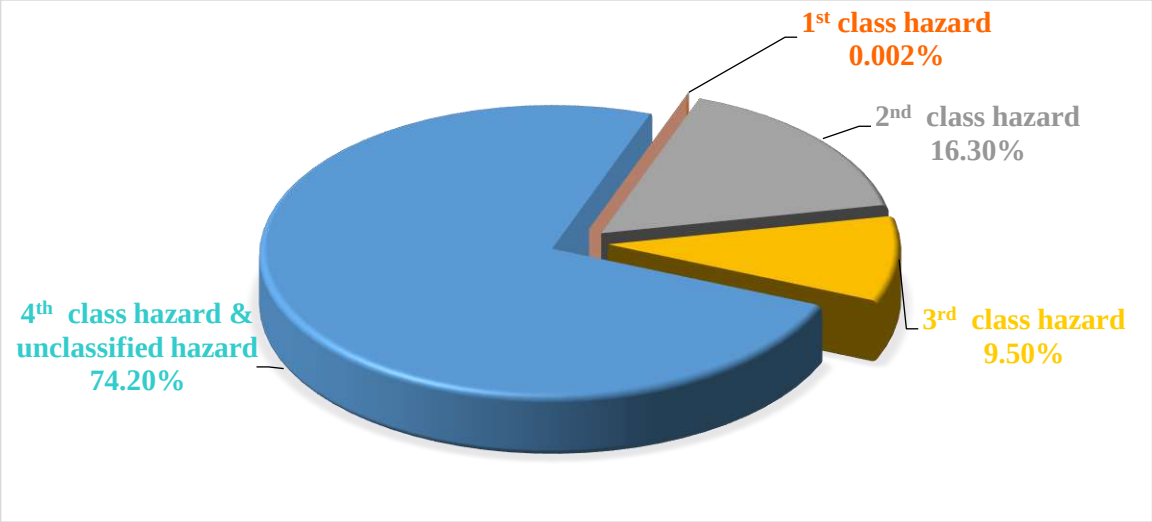


Figure 8.3 Composition of contaminant emissions into atmosphere in 2024, %.

In 2024, the analytical (laboratory) control of contaminant emissions from the impact-producing facilities was performed under the contract with RUE "Lida CSMC" No. 48/5, namely, MGB, AB, treatment facilities complex and workshops of the free access zone. During the reporting period, 23 measurements of contaminant emissions were performed for 14 contaminants, with measurements being formalised by Protocols No. 69-ZV, No. 148-ZV, No. 209-ZV, No. 4142-2024, No. 258-ZV and No. 302-ZV.

Permissible limits of contaminant emissions into the atmospheric air from all emission sources were not exceeded.

8.2 Industrial Waste Management

According to the Law of the Republic of Belarus "On Waste Management" dated July 20, 2007, No. 271-Z, the State Enterprise "Belarusian NPP" separately collects the generated industrial waste.

In 2024, containers were purchased to separately collect industrial waste generated during the scheduled preventive repair. Instructions for waste management during the SPR were developed for the contractors' employees involved in the scheduled preventive repair.

In 2024, the preplanned industrial waste inventory was made.

Over the period of 2024, the State Enterprise "Belarusian NPP" generated 601.691 tons of industrial waste (2023 – 384.5 tons). As of the end of 2024, 80.396 tons of waste, 1,363 pcs of mercury containing lamps, were in the interim storage.

The production waste breakdown in tons by hazard classes for the reporting year is shown in Fig. 8.4.

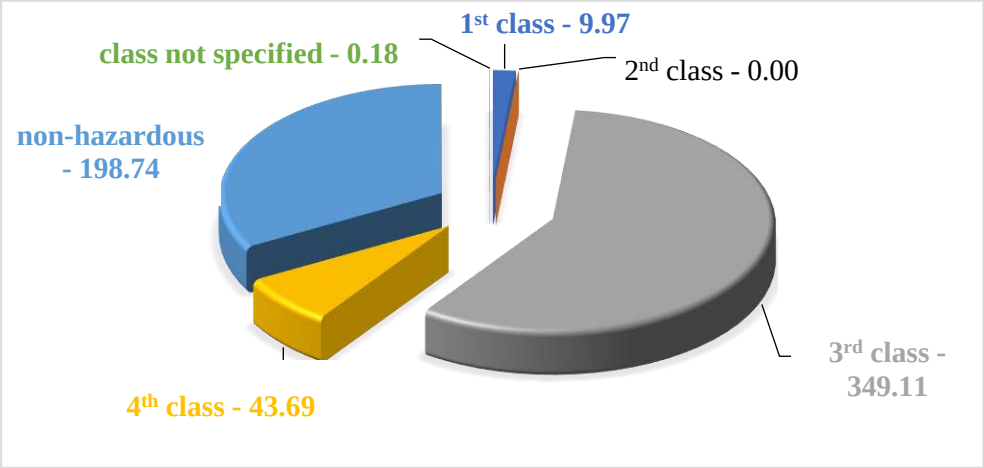


Figure 8.4 Generation of industrial waste in 2024 with breakdown by hazard class, tons

In the reporting year, industrial wastes were transferred to the waste use and disposal facilities in accordance with the permits and concluded contracts, as well as moved to interim storage sites in the territory of the Enterprise.

The share of secondary material resources of the total waste accounted to 14.5 % (in 2023 – 6.4 %). The increase in the waste transferred for disposal is due to scheduled preventive maintenance of power unit No. 1 and No. 2 and implementation of relevant production processes.

The dynamics of transfer of the industrial waste to the use and disposal facilities, in tons, compared to previous years is shown in Fig. 8.5.

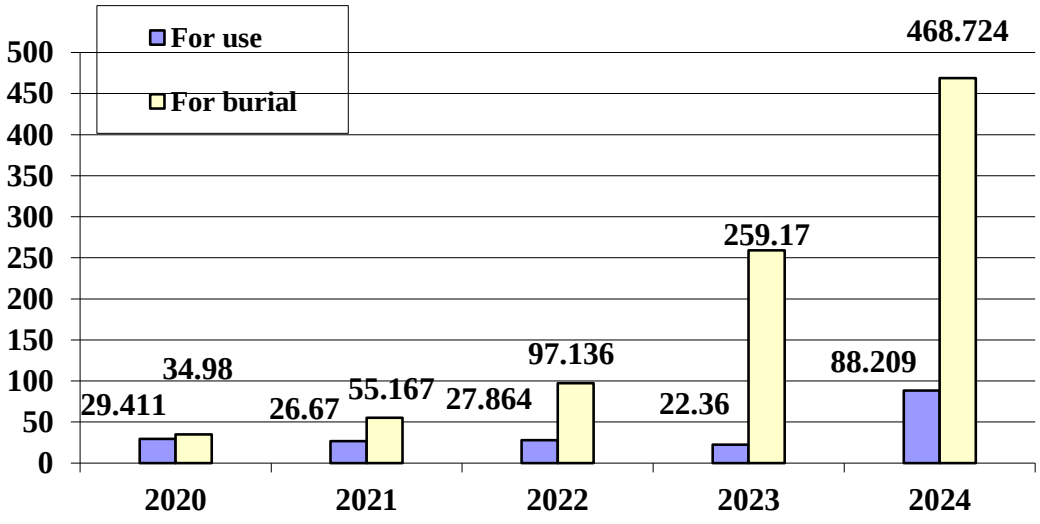


Figure 8.5 Dynamics of transfer of the industrial waste to the use and disposal facilities, tons

Mercury-containing waste (mercury and fluorescent lamps) is transferred for disposal as one transport unit accumulates: in 2020 and 2021 - 0 pcs, 2022 – 1,460 pcs, 2023 – 1,117 pcs, 2024 - 0 pcs.

During the Belarusian NPP operation in 2024, radioactive waste (after preliminary partitioning before treatment) was generated in the following quantities:

At power unit No. 1:

very low-level radioactive waste and solid waste of the controlled access zone – 99.7278 m^3;

very low-level solid radioactive waste – 22.489 m^3;

low-level solid radioactive waste – 8.9695 m^3;

intermediate-level radioactive solid waste – 4.906 m^3;

high-level solid radioactive waste – 0.32 m^3;

At power unit No. 2:

very low-level radioactive waste and solid waste of the controlled access zone – 84.4313 m^3;

very low-level solid radioactive waste – 26.088 m^3;

low-level solid radioactive waste – 9.854 m^3;

intermediate-level radioactive solid waste – 2.819 m^3;

high-level solid radioactive waste – 0.06 m^3.

After treatment and containerisation, the solid radioactive waste was placed in the solid radioactive waste storage facility in 448 containers (metal drums of 0.2 m^3 each) filled with very low-level waste and controlled access zone solid waste (155 drums – power unit No. 1, 133 drums – power unit No. 2). 2), very low level solid radioactive waste (42 drums – power unit No. 1, 72 drums – power unit No. 2), low level solid radioactive waste (15 drums – power unit No. 1, 19 drums – power unit No. 2), intermediate-level solid radioactive waste (10 drums – power unit No. 1, 2 drums – power unit No. 2), in total – 89.6 m3.

8.3 Use and protection of water resources

The Belarusian NPP managed water consumption and water disposal in accordance with the limits specified in the Permit for special water use No. 04.12.0397 dated 17 June 2022, without exceeding the design and set values.

Water consumption and water disposal in 2024 compared to previous years are shown in Table 8.2.

Table 8.2 Water consumption and water disposal at State Enterprise “Belarusian NPP” in 2024

Indicator	Water use limits set subject to Permit for special water use, thous. m^3/y	Value, thous. m^3				
		2020	2021	2022	2023	2024
1. Extracted (produced) received water, total	70,682.2	5,527.4	29,567.8	29,537.8	49,686.5	60,814.146
2. Water used for Enterprise’s needs, total	34,392.0	160.8	15,382.2	22,509.8	3,590.4	4,064.743
3. Water transferred to other organisations	36,253.7	5,366.7	14,185.6	6,930.3	139.1	48.424
4. Waste water discharged to surface water body	31,781.3	4,155.2	19,176.6	21,998.0	26,408.2	30,991.633

Conducting local monitoring of wastewater and surface water at 3 observation points (site of waste water discharge to the Viliya River, background monitoring section and control section on the Viliya River), as well as of drinking water quality is performed by the accredited laboratory of the Enterprise Support Systems Shop (Accreditation Certificate No. 112 2.4928, valid up to 19.05.2027). In addition, to perform a full scope of production observations, accredited third-party laboratories are contracted.

Over the period from January to December 2024, 26 tests of waste water and surface water samples collected at 3 observation points of local monitoring were performed, with 124 protocols of measurements in the field of environmental protection being formalised.

Subject to observation results, no values were exceeded over the reporting period.

8.4 Groundwater Protection

In 2024, 3 observation wells at the Belarusian NPP site were entered into the List of observation points for local environmental monitoring.

Groundwater monitoring in the areas of location of identified or potential sources of groundwater contamination includes the following 3 types of work:

groundwater level dynamics monitoring;

groundwater temperature monitoring;

groundwater chemical composition dynamics monitoring.

The chemical analysis included determination of the biochemical oxygen demand (BOD_5), level of mineralisation, pH, temperature, chemical oxygen demand (COD_{Cr}), total ferrum, potassium, sodium, sulphate ion and chloride ion.

In March 2024, subject to the contract with BelGidrotekhproekt Limited Liability Company groundwater samples from 3 observation wells were tested and a Protocol

for measurements in the field of environmental protection No. 595-khal/2024 of 24.04.2024 was formalised.

Observations results revealed no excessive values over the reporting period.

8.5 Integrated Environmental Monitoring

In 2024, the Belarusian NPP performed integrated environmental monitoring in the RCA and BA.

Manpower and resources of specialised accredited organisations of the Republic of Belarus were contracted to perform those works.

According to the Belarusian NPP Monitoring Programmes, the following types of monitoring were implemented in 2024:

groundwater regime observations;

monitoring of meteorological processes, phenomena and factors, including, inter alia, meteorological and microclimate observations;

aerological monitoring;

surface water regime observations;

seismological monitoring;

geodetic monitoring of present-day crustal motion;

monitoring of contamination/pollution of the surface layer of the atmosphere, terrestrial and aquatic ecosystems, water bodies and the state of aquatic biological resources;

radiation monitoring.

8.5.1 Groundwater regime observations

In 2024, the groundwater regime observations included three types of activities: groundwater level dynamics monitoring; groundwater temperature monitoring; monitoring of groundwater chemical composition dynamics and potential contamination of it. The chemical analysis included the measurement of water physical properties, mineralisation level, water hardness, free and aggressive CO_2, O_2 oxidizability, ions Cl^-, SO_4^{2-}, HCO_3^-, Ca^{2+}, Mg^{2+}, Na^+, K^+, Fe_{total}, pH, BOD_5, COD_{Cr}.

The monitoring was performed on the equipped observation wells (piezometric observation well network comprises 26 well clusters) (Fig. 8.6, 8.7).

Figure 8.6 Piezometric well cluster

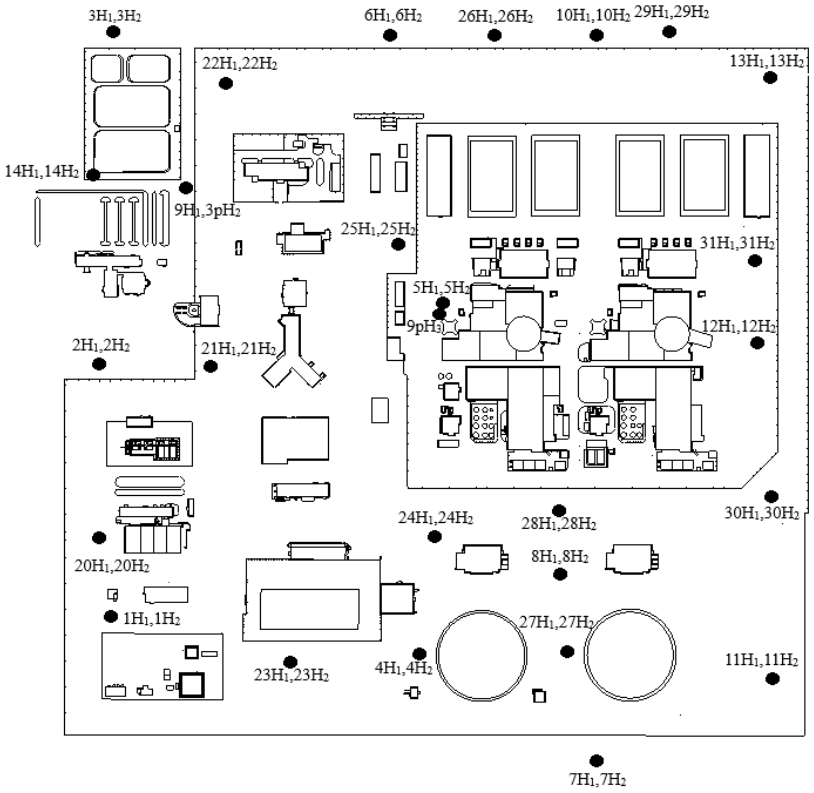


Figure 8.7 – Schematic diagram of observation well clusters

The 2024 ground water monitoring resulted in completion of the full scope of activities aimed at determining the groundwater regime.

The Belarusian NPP site is located in the groundwater transit zone. In 2024, the decreasing trend in groundwater levels in observation wells continued.

The groundwater level regime of the observation wells at the Belarusian NPP site generally correlates with the fluctuations of daily precipitation recorded by the Markuny meteorological station (hereinafter referred to as the “MS”), as shown in Figs. 8.8-8.9, and remains largely stable throughout the year (an average amplitude of fluctuations during the year is not in excess of 0.56 m). Water levels in the observation wells located in the Sozhsky H2 terminal moraine aquifer fluctuated in the range of 157.37 and 165.19 m of the Baltic Elevation System (hereinafter referred to as the “BS”) with an average value of BS 160.94 m. The amplitude of water level fluctuations within these piezometers during 2024 varied from 0.32 to 0.93 m with an average of BS 0.60 m.

The water level in the only observation well constructed in the Sozhsky H3 terminal moraine aquifer fluctuated insignificantly during 2024 - at absolute levels from 150.42 to 151.02 m BS with an average value at the level of BS 150.78 m, and the amplitude of fluctuations was 0.60.

The recorded groundwater level dynamics indicates the absence of “hydrogeological windows” on the site and adjacent area through which intensive groundwater recharge due to infiltration of atmospheric precipitation and impregnation of harmful chemicals captured by it in groundwater is possible.

Diagram of groundwater fluctuations in Sozhsky terminal moraine aquifer system

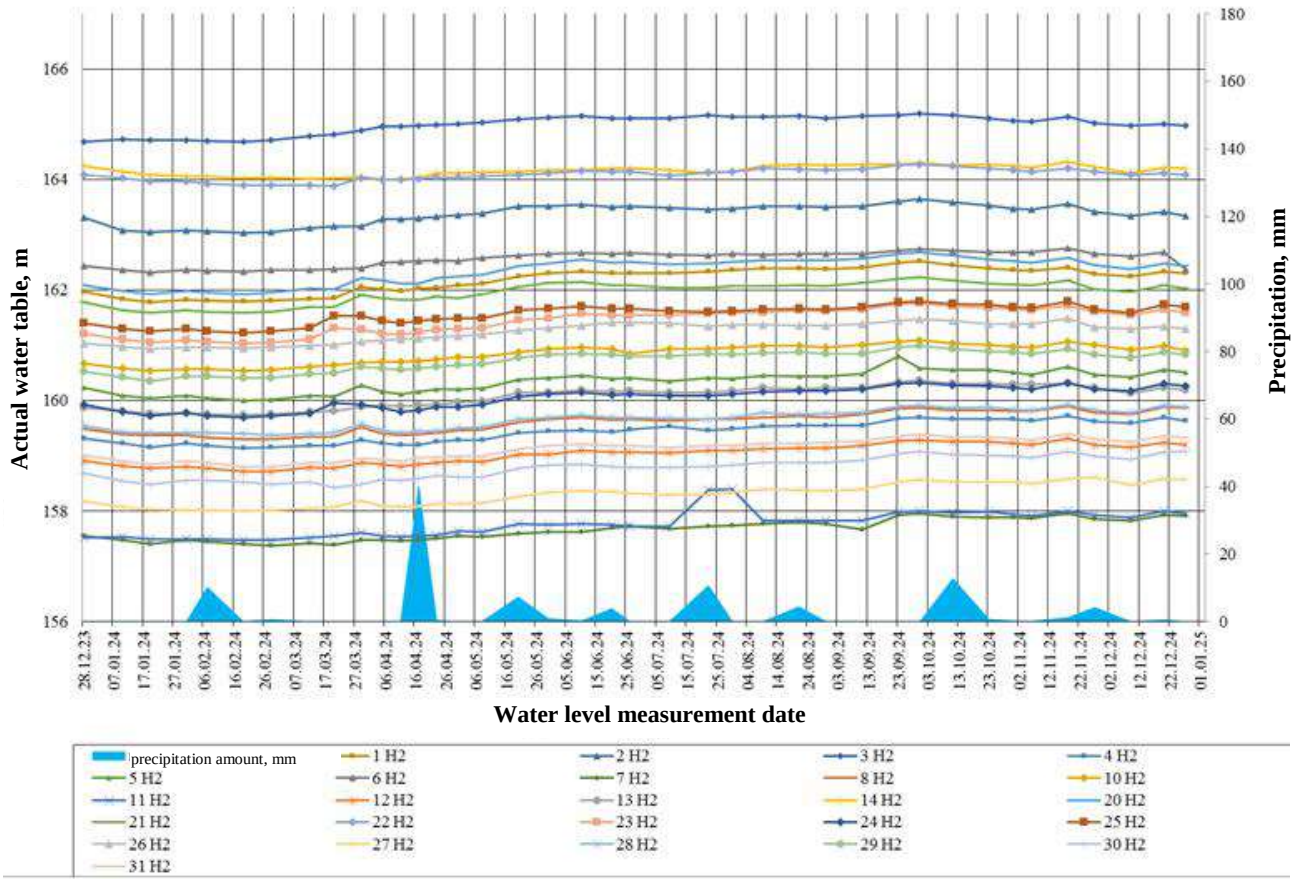


Figure 8.8 Diagram of groundwater fluctuations in Sozhsky terminal moraine aquifer horizon in 2024

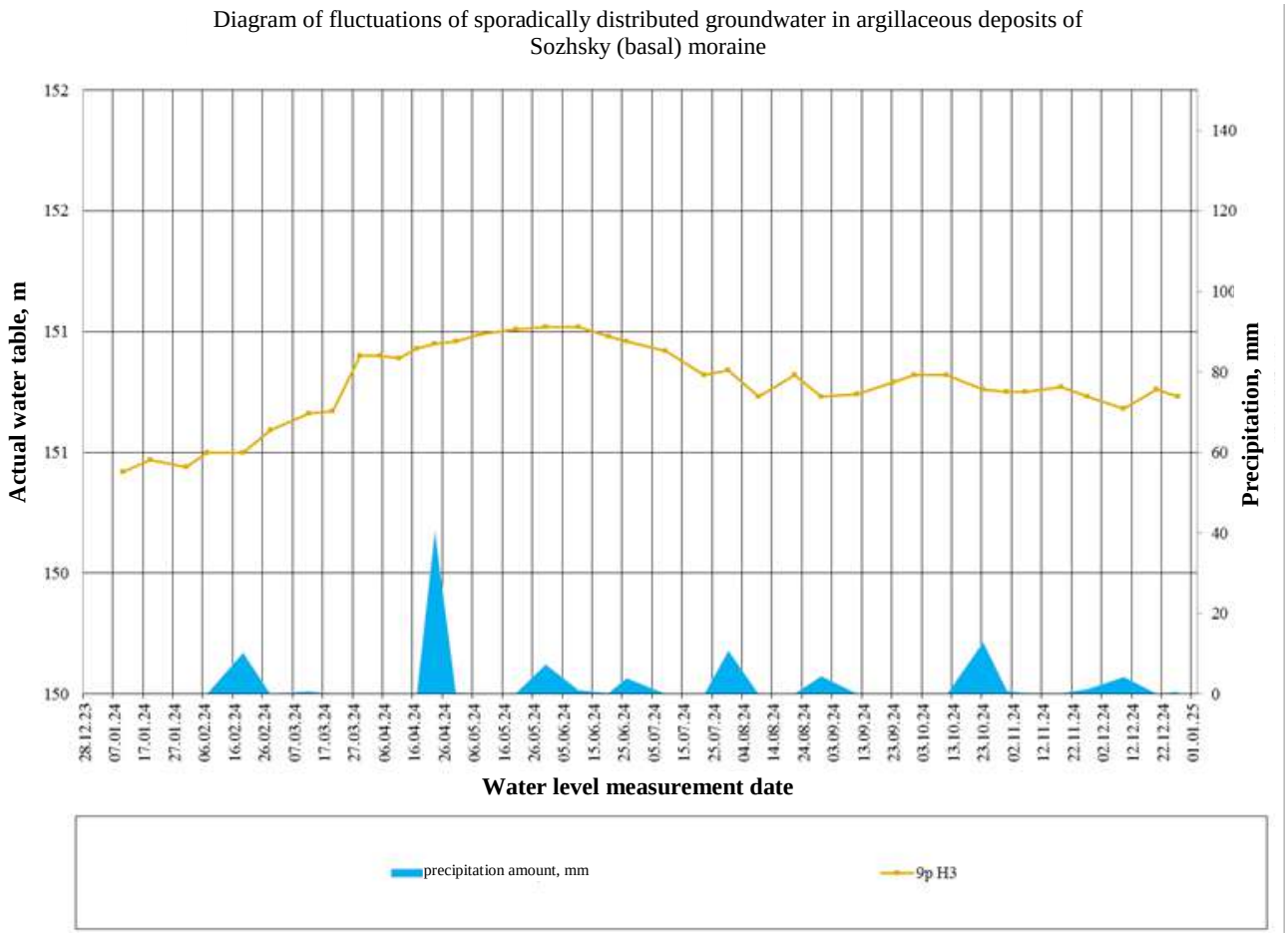


Figure 8.9 Diagram of fluctuations of sporadically distributed groundwater in argillaceous deposits of Sozhsky (basal) moraine in 2024

The temperature regime of groundwater of observation wells on the Belarusian NPP site largely correlates with climatic factors (average daily atmospheric air temperature) as shown in Figs 8.10-8.11.

Composite indices of sporadically distributed groundwater and temporary perched groundwater temperature regime in 2024 are as follows:

- temperature changes from 6.7°C to 12.8°C, average – 9.8° C;
- maximum amplitude of temperature fluctuation – 4.9° C;
- minimum amplitude of temperature fluctuation – 0.4° C;
- average amplitude of temperature fluctuation – 1.8° C.

Composite indices of groundwater temperature regime of the Sozhsky terminal moraine aquifer in 2024:

- temperature changes within half a year from 8.0 to 11.1°C, average – 9.0°C;
- maximum amplitude of temperature fluctuation – 1.8°C;
- minimum amplitude of temperature fluctuation – 0.7° C;
- average amplitude of temperature fluctuation – 0.7° C.

The temperature regime of sporadically distributed groundwater in argillaceous deposits of Sozhsky (basal) moraine is characterised as follows:

- temperature changes within half a year from 8.2 to 9.2° C, average – 8.5° C
- temperature fluctuation amplitude – 1.0° C.

According to OST 41-05-263-86 classification, groundwater of observation wells on the Belarusian NPP industrial site area is characterised as cold all year round (temperature is not beyond the range of 4-20° C). In general, the temperature regime of groundwater remains stable.

Diagram of temperature fluctuations of groundwater in Sozhsky terminal moraine aquifer system

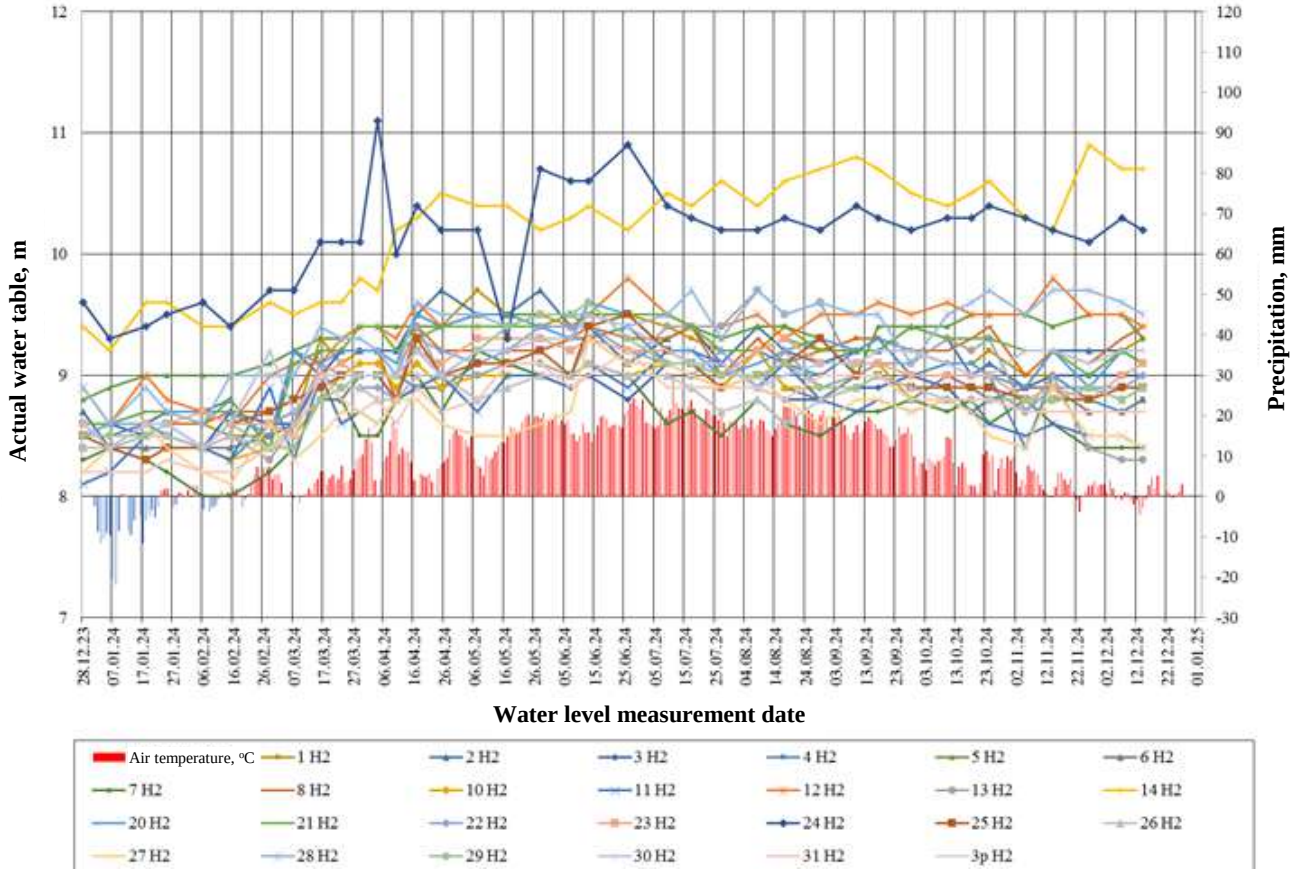


Figure 8.10 Chronological diagram of temperature fluctuations of groundwater in Sozhsky terminal moraine aquifer system in 2024

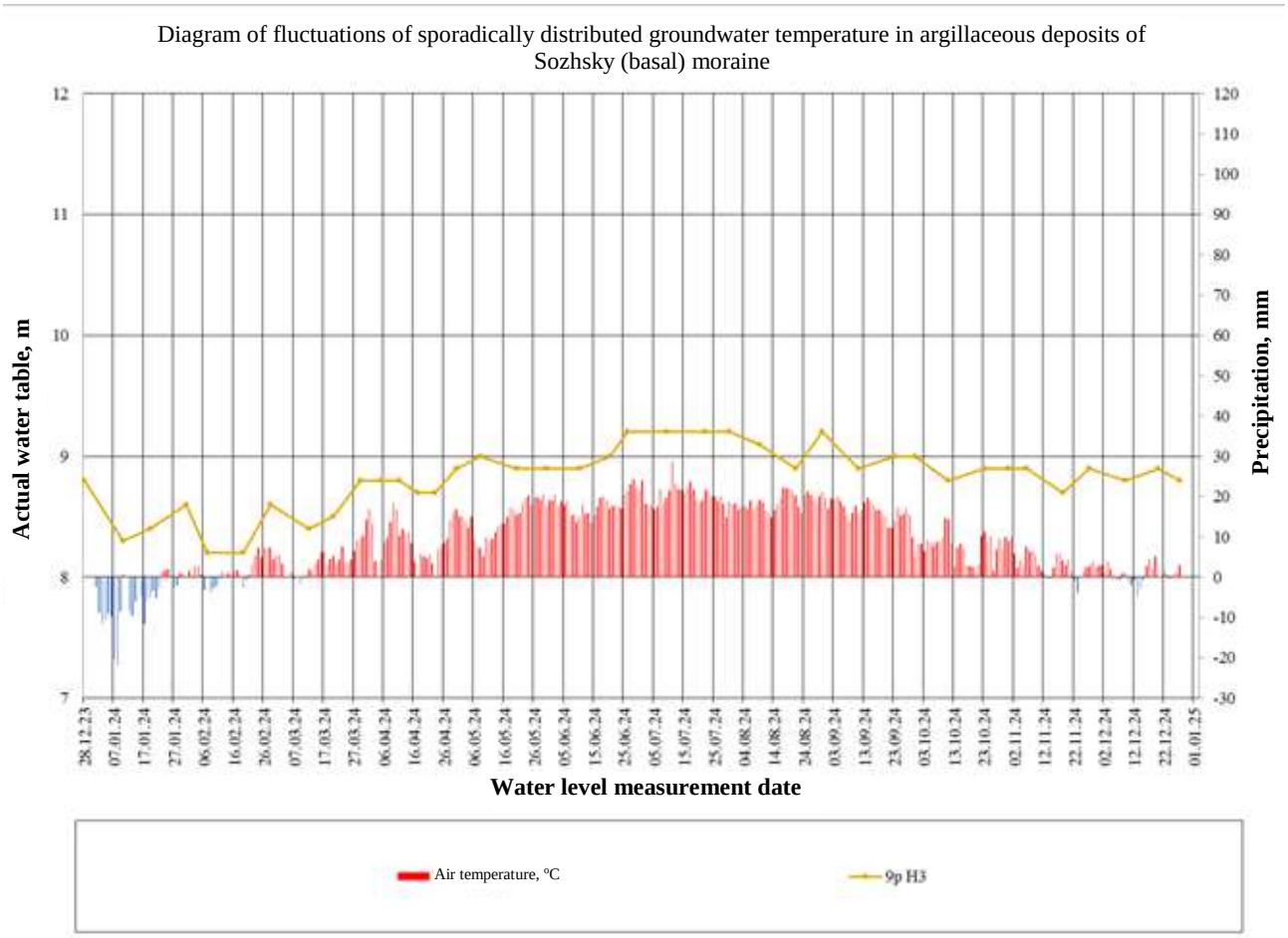


Figure 8.11 Chronological diagram of fluctuations of sporadically distributed groundwater temperature in argillaceous deposits of Sozhsky (basal) moraine in 2024

In 2024, the following types of laboratory water sample tests were performed: water physical properties (turbidity, transparency, sediment, odour, taste and colour), determination of chloride, sulphate, hydrocarbonate ions, ions of calcium, magnesium, sodium, potassium, total ferrum, acidity (pH), BOD_5, COD_{Cr}, water hardness and mineralisation, CO_2 free and aggressive acidification.

By its chemical composition the groundwater is fresh (less than 1 g/dm^3) hydrocarbonate magnesium-calcium with mineralisation from 82 mg/dm^3 to 492 mg/dm^3 (with an average value of 268 mg/dm^3). The pH value is within the norm (MAC 6-9) and varies from 7.3 to 9.1 (with an average value of 7.9). In terms of degree hardness, groundwater is classified from very soft to hard (total hardness from 1.2 to 7.2 mg-eq/l (average - 4.1 mg-eq/l), which is in good agreement with indicators obtained in 2023. The content of aggressive carbon dioxide in the collected groundwater samples was not in excess of 8.8 mg/l, while in most samples, like in 2023, aggressive acid was not detected at all (values below detection limit). The average free carbon dioxide content was 6.9 mg/l. Oxidizability of the collected samples fluctuated from 0.56-3.8 mgO_2/dm^3 throughout the year, averaging 1.27 mgO_2/dm^3/year. The COD_{Cr} seasonal mean value varied from 7.8 to 8.1 mgO_2/dm^3 during the year, and BOD_5 varied from 1.9 to 3.7 mgO_2/dm^3. Single BOD_5 and COD_{Cr}

values fluctuated in the range from 0.4 to 10.0 mgO_2/dm^3 (2.6 mgO_2/dm^3) and from 5.0 to 16.2 mgO_2/dm^3 (8.1 mgO_2/dm^3), respectively.

Like in 2023, in 2024, hydrocarbonates prevail in the groundwater anionic composition. Fluctuations in the values of the to-be-determined anions content during 2024 were as follows: hydrocarbonates 40.0-347.7 mg/dm^3; chlorides 2.6-71.3 mg/dm^3; sulphates 1.9-50.2 mg/dm^3; carbonates 0 (not detected)-6.0 mg/dm^3. Calcium and magnesium cations prevail in the groundwater cation composition. Fluctuations in the values of the to-be-determined anions content during 2024 were as follows: calcium 9.8-96.9 mg/dm^3, magnesium 7.6-46.5 mg/dm^3, sodium 2.3-22.8 mg/dm^3, potassium 0.6-4.8 mg/dm^3 and ferrum 0.3-24.0 mg/dm^3.

According to the results of regime observations in 2024, concentrations exceeding maximum permissible levels were not found in groundwater of observation wells.

In general, during the observation period, the groundwater chemical composition was relatively stable. No surface contamination of groundwater caused by the technological cycle of the Belarusian NPP was observed.

8.5.2 Monitoring of meteorological processes, phenomena and factors

In 2024, 8-term observations of meteorological parameters were performed at the Markuny MS, as well as a complex of special observations: gradient observations of air temperature and humidity, wind velocity at 0.5 and 2 m heights, observations of glaze-ice phenomena, measurements of soil temperature at depth, and observations of evaporation from the water surface (Figs. 8.12, 8.13).

Figure 8.12 – Markuny MS

In 2024, the average air temperature according to the Markuny MS data was 9.1° C and that of soil - 11.2 °C. The coldest month of 2024 was January with an average monthly air temperature of minus 5.2° C, the hottest month was July with an average temperature of 20.0 °C. The absolute maximum air temperature of 31.7 °C was recorded on 28.06.2024, the absolute minimum was observed in January (08.01.2024) and it was minus 25.8 °C.

Mean annual relative air humidity was 86%. Mean monthly values of relative air humidity varied from 69% in May to 98% in November and December. The lowest value of relative air humidity was recorded in May and it was 25%. 7 “dry” days were observed in May when the minimum value of relative humidity was below 30%. The maximum number of “humid” days with relative humidity above 80% at 03:00 p.m. was observed in January, February - 22, 23 days respectively, in November, December - 28 days each, in October - 18 days, while in other months their number was less than 12 days. The diurnal variation of relative humidity during all months shows a decreasing trend in the daytime hours with minimum values at 03:00 p.m. local time. From March to September, relative humidity and saturation deficiency have a strongly pronounced diurnal variation, in other months it is more smoothed out.

The water vapour partial pressure repeats variations of mean monthly air temperature and increases from winter to summer, reaches maximum mean monthly values in July (18.9 mb, respectively) and decreases again by the end of the year to values of 6-7 mb.

During 2024, the mean monthly pressure at the Markuny MS varied from 993.7 hPa to 1003.0 hPa and averaged 999.0 hPa. The highest atmospheric pressure was recorded on November 9th reaching 1020.1 hPa, the lowest - 964.7 hPa on February 7th.

Figure 8.13 Markuny MS measuring instruments

In 2024, the number of days with precipitation was 196, of which 84 days were characterised by the low-intensity precipitation (up to 1 mm), in 40 days daily precipitation totals exceeded 5 mm. Analysis of the distribution of the number of days with different precipitation totals in 2024 at the Markuny MS showed that days with the highest daily precipitation totals were observed in February, April, July, September and October. The months with the highest number of days with precipitation were recorded in January, February and November, December - 20-24 days per month. The daily precipitation depth exceeding 20 mm was observed in April, July and September and it was 36 mm, 46 mm and 28 mm, respectively.

During the year, the winds of north-western and western directions prevailed. Usually east wind directions are characterised by the lowest frequency (Fig. 8.14).

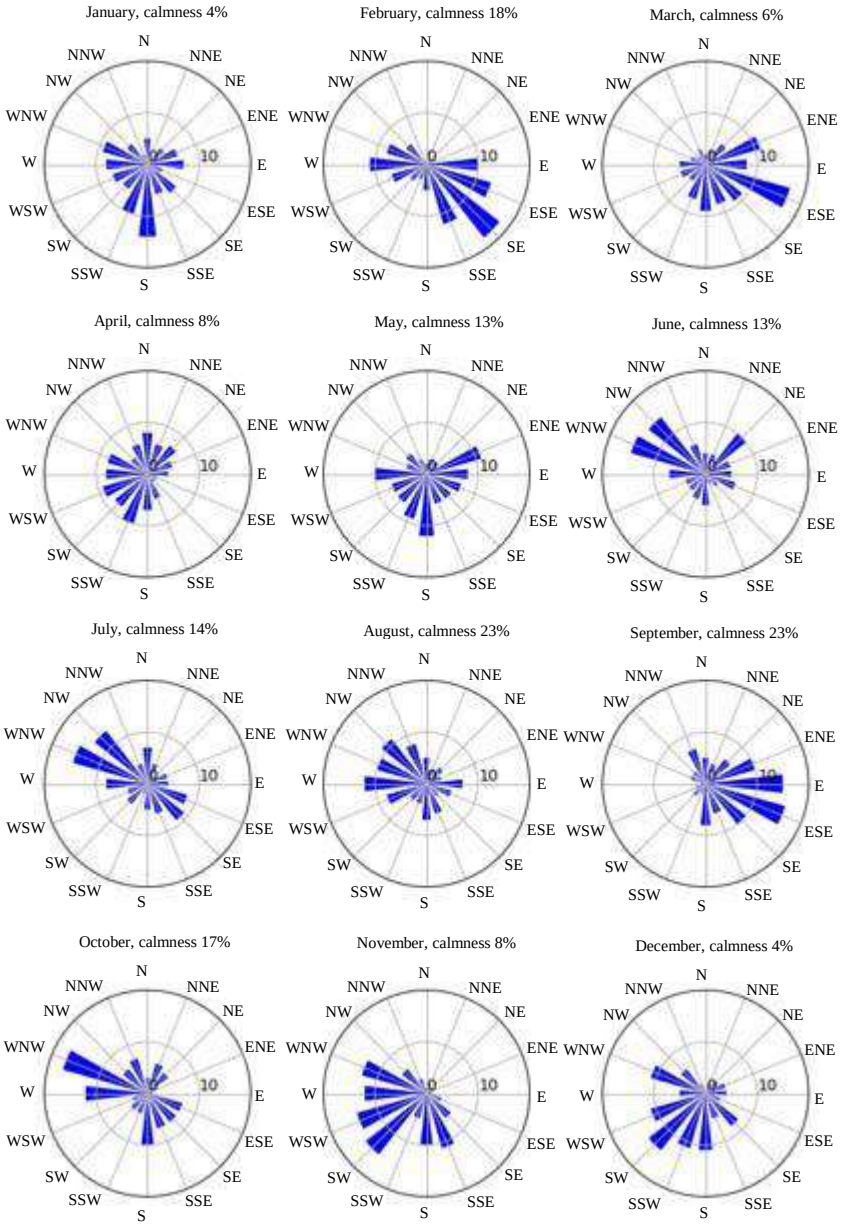


Figure 8.14 Windrose diagram according to the Markuny MS in January-December 2024

The average annual wind speed in 2024 was 3.0 m/s, while the highest average monthly values during the cold period of the year were recorded in January and February – 4-4.1 m/s, in November and December – 4.3-4.5 m/s. The least windy months were August and September, with the average monthly wind speed ranging from 1.9 to 2.0 m/s.

In an average year, wind speed frequency within 0-1 m/s accounted for 28 %, the winds frequency with a speed of 2-3 m/s during the year accounted for 38 %, with a speed of 4-5 m/s - 21 %, with a speed of 6-7 m/s - 9 %, the frequency of stronger winds was less than 3 % in 2024. The frequency of calmness and winds with a speed of 1 m/s were most frequently recorded over the period from May to October – 30-40%.

The maximum gust speed between hours of observation was the highest in April and July and reached 21 and 23 m/s, respectively. Slightly lower maximum gust speed was recorded in December - 19 m/s, in February and November it was 18 m/s. In January, March and August, gust speed reached 15-16 m/s, in May, June, September and October – 13-14 m/s.

Comparison of the observation series obtained during 2015-2024 at the Markuny/Oshmyany/Lyntupy MSs allow the conclusion to be made regarding the representativeness of meteorological observations of the Markuny meteorological station in relation to the analogue stations.

All of the above indicators allow for the conclusion that it is possible to use long-term data of the above mentioned analogue stations for calculation of meteorological parameters for monitoring purposes in the area of the Belarusian NPP location.

8.5.3 Microclimate observations

In 2024, microclimatic observations were continued in the Belarusian NPP area. Microclimate observations were conducted at 10 points on two profiles. Profile No. 1 Michalishki-Chekhi is oriented from north to south, profile No. 2 Chekhi-Bobrovniki - from east to west (Fig. 8.15). Observations are conducted twice daily from 06:00 to 07:00 a.m. and from 06:00 to 07:00 p.m.

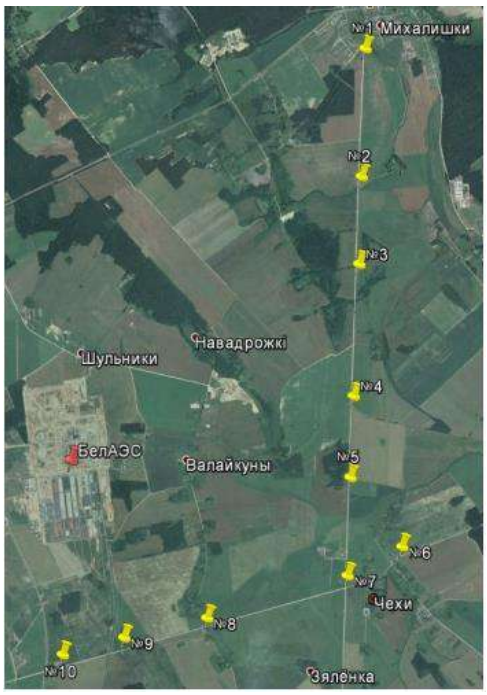


Figure 8.15 Layout of microclimate observation points

According to the monitoring results, the combined air temperature variation charts showed almost complete compatibility between the air temperature values at the pickets and at Lyntupy MS, Markuny MS and Oshmyany MS both in the morning and in the evening.

To perform the comparative analysis, atmosphere meteorological parameters values in the pickets location area were taken (data of the central point - picket 7 and end observation points - picket 1 and picket 10). The comparison was made using current data (6 a.m. and 6 p.m.) of the Lyntupy MS, Markuny MS and Oshmyany MS.

The combined air temperature variation graphs at pickets showed as follows: over the 10-year observation period from 2015 to 2024, the lowest air temperature values were recorded in January 2016 – minus 9.6° C (morning) and minus 7.4° C (evening); the highest air temperature values were recorded in the morning in July 2024 (19.6° C) and in the evening in July 2021 (25.5°) (Figs. 8.16-8.18).

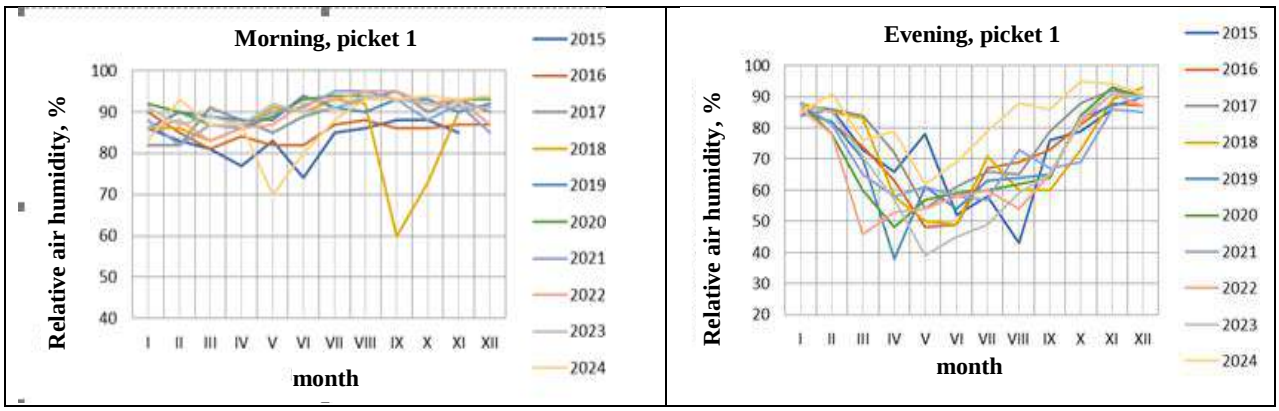


Figure 8.16 Combined air temperature variation graphs at picket 1 over 2015-2024 observation period

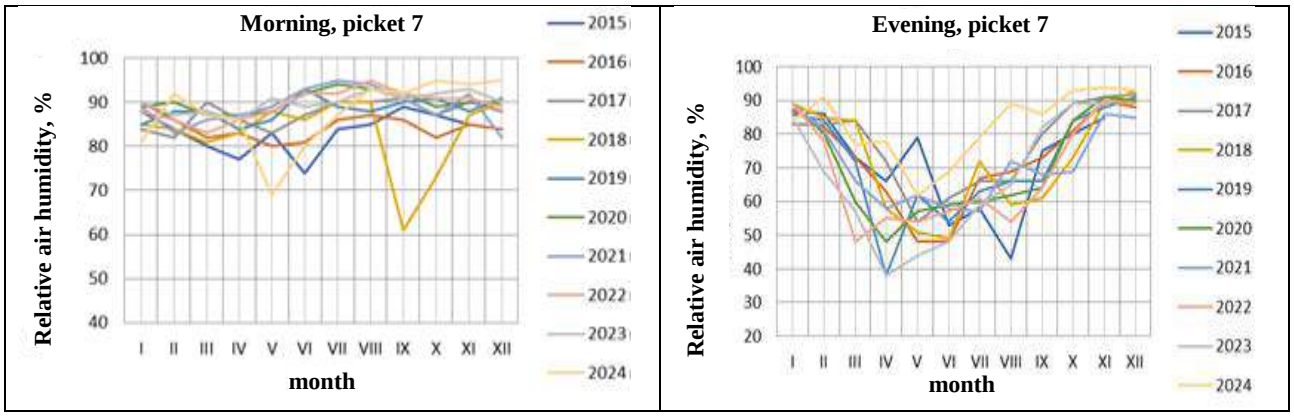


Figure 8.17 Combined air temperature variation graphs at picket 7 over 2015-2024 observation period

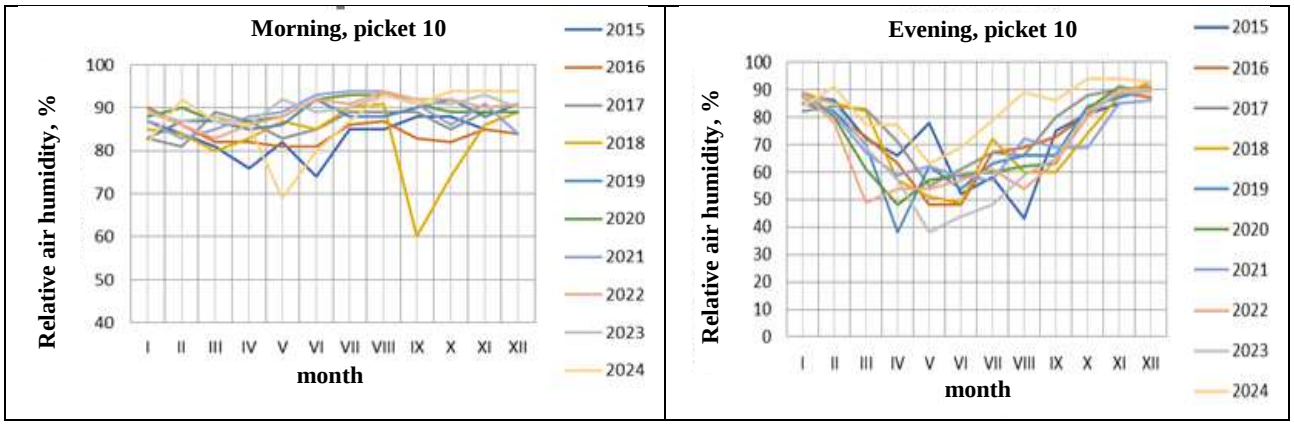


Figure 8.18 Combined air temperature variation graphs at picket 10 over 2015-2024 observation period

The combined relative humidity variations graphs showed that actually no large differences exist between the morning relative humidity values at the meteorological stations and those at the pickets. In the evening time the readings varied to a greater extent.

Combined air relative humidity variation graphs at the pickets over the 2015-2024 observation period showed that the driest air in the morning was recorded in September 2018 (relative humidity 60%). The driest air in the evening over the entire observation period was recorded in April 2019 (relative humidity 38%). Correspondingly, the most humid air in the morning was in September 2017, in July, August 2021, in August, September 2022, in October, December 2024 (95%), and in the evening – in October 2024 (95%). The maximum annual average relative humidity in the morning was observed in 2020 and 2021 (91 %), and the minimum annual average relative humidity in the evening was observed in 2022 and 2023 (68 %) (Figs. 8.19-8.21).

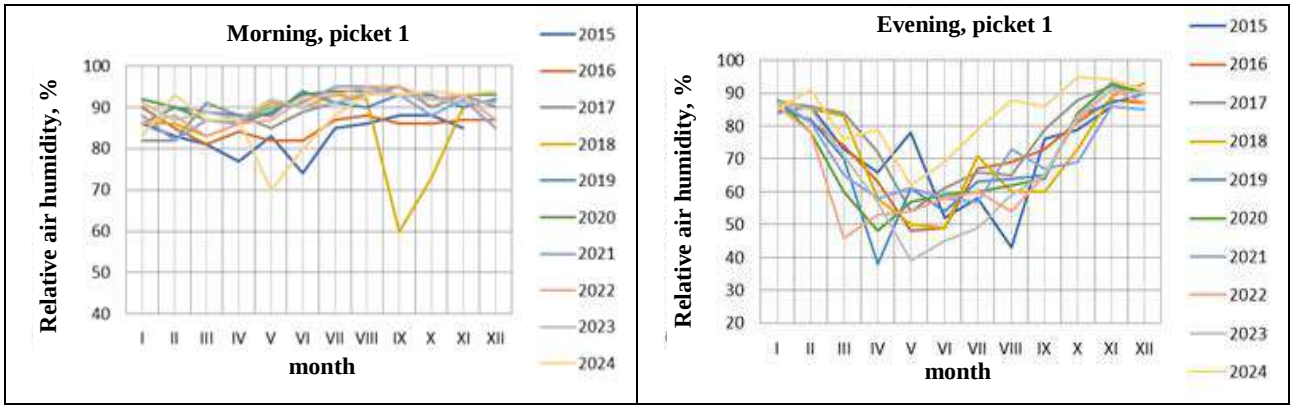


Figure 8.19 Combined air relative humidity variation graphs at picket 1 over 2015-2024 observation period

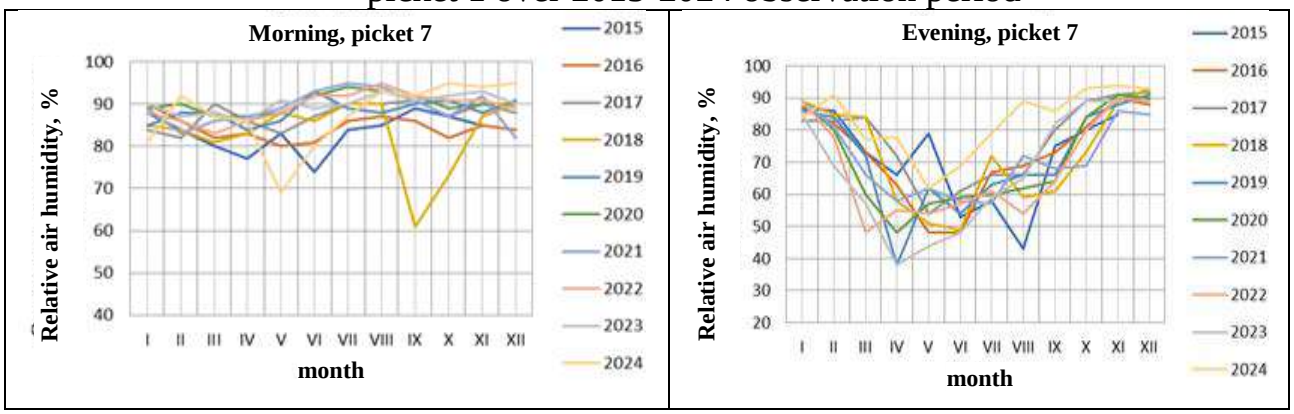


Figure 8.20 Combined air relative humidity variation graphs at picket 7 over 2015-2024 observation period

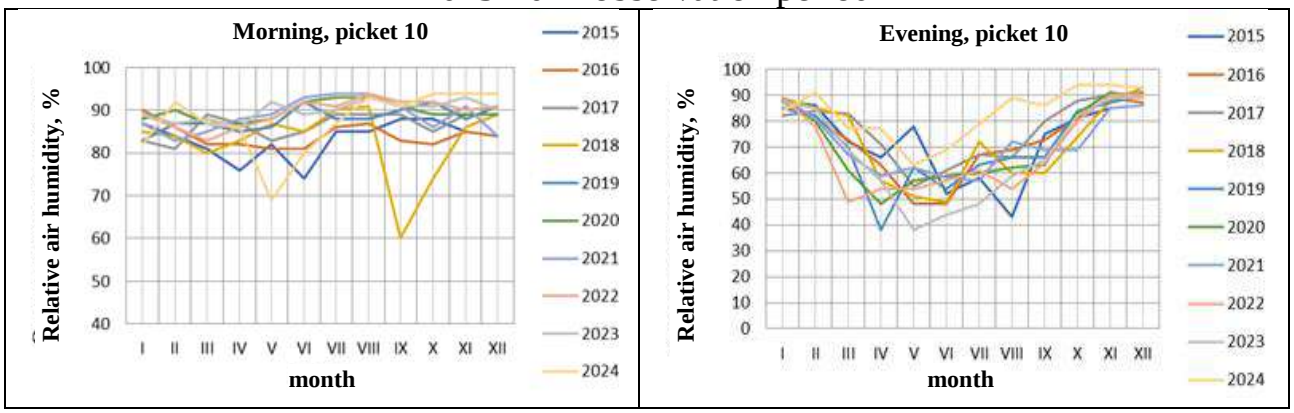


Figure 8.21 Combined air relative humidity variation graphs at picket 10 over 2015-2024 observation period

The combined wind velocity variation graphs showed that the wind velocity values at the meteorological stations and pickets fluctuate against each other during the entire observation period, and the dynamics of these fluctuations are similar.

Combined wind velocity variation graphs at the pickets showed that over the 10-year observation period from 2015 to 2024, the maximum wind velocity values were recorded in December 2024 (4.0 m/s in the morning and 4.2 m/s in the evening) and the minimum wind velocity values were recorded in the morning in August 2022 (0.2 m/s) (Figs. 8.22-8.24).

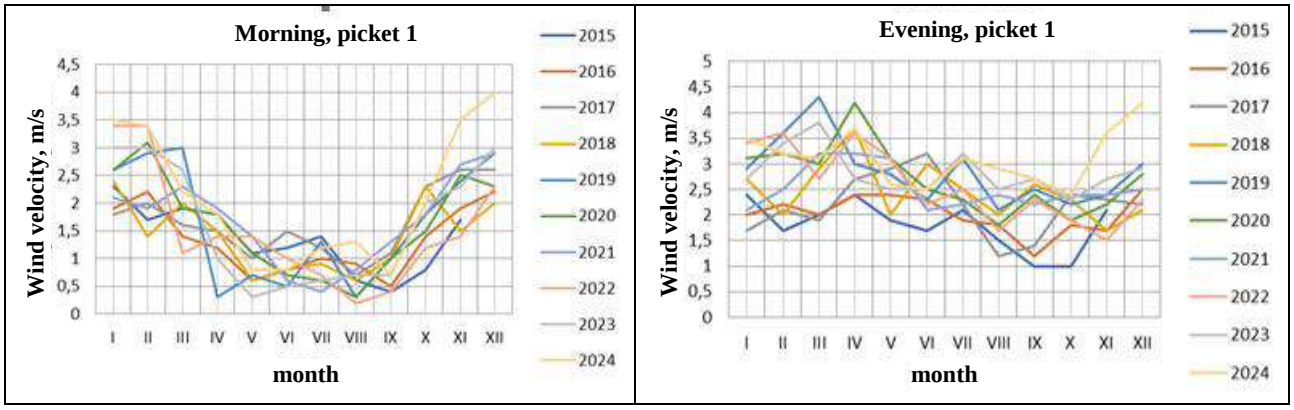


Figure 8.22 Combined wind velocity variation graphs at picket 1 over 2015-2024 observation period

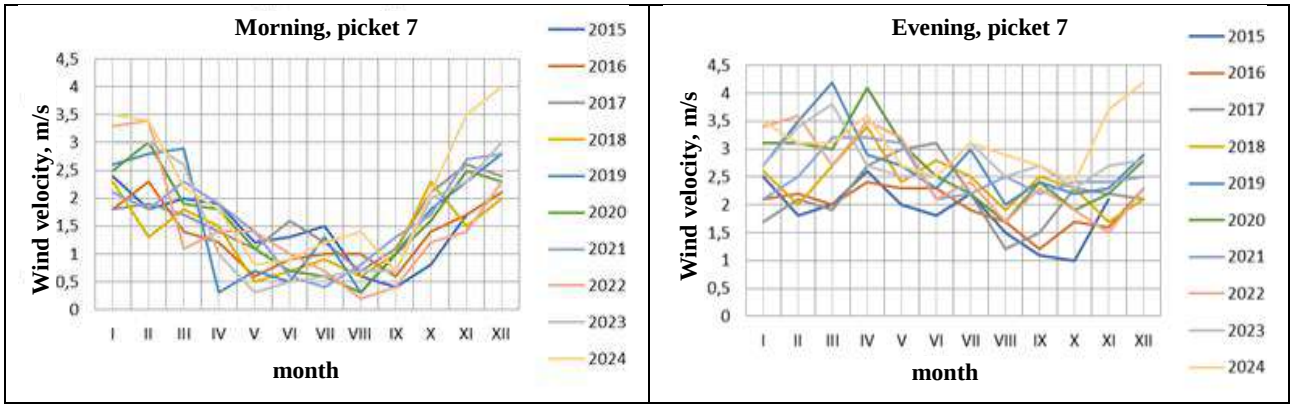


Figure 8.23 Combined wind velocity variation graphs at picket 7 over 2015-2024 observation period

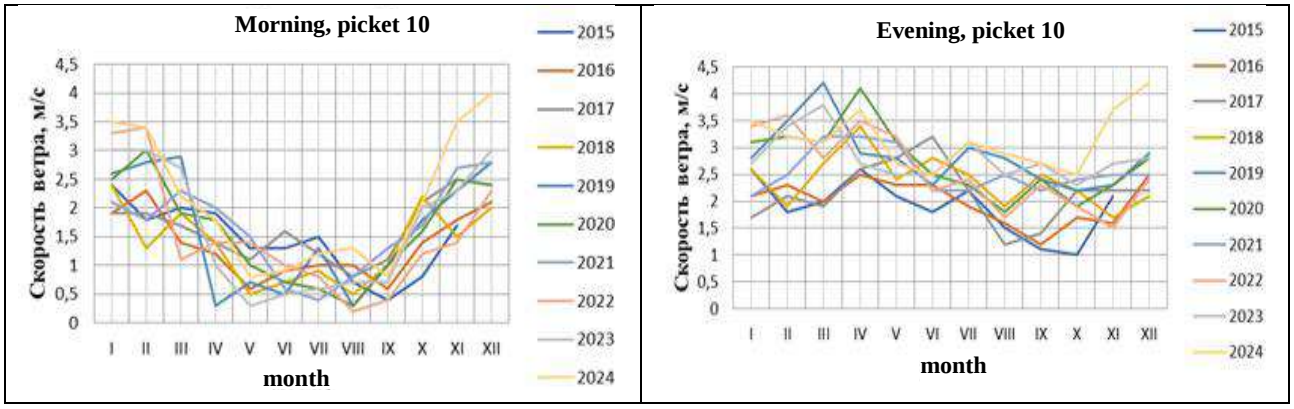


Figure 8.24 Combined wind velocity variation graphs at picket 10 over 2015-2024 observation period

The analysis of the main meteorological atmosphere parameters distribution in cold and warm seasons of the year in the study area (profiles Mikhalishki – Chekhi and Chekhi – Bobrovniky) showed that no microclimatic anomalies were recorded in the Belarusian NPP observation area.

Natural and climatic features of the area correspond to yearly seasonality, microclimatic indicators change regularly and predictably. 2024 data show that the operation of cooling towers has no significant environmental impact.

8.5.4 Aerological monitoring

In 2024, exploration within the aerological monitoring of the atmospheric boundary layer condition (hereinafter referred to as the ABL) was performed at Markuny MS. The calculated characteristics of the atmospheric dispersion conditions by seasons and in general for a year at different altitudes were obtained. The ABL main characteristics were analysed. The observations were performed using the SODAR/RASS measurement system (Fig. 8.25).

Figure 8.25 SODAR measurement system

The 2024 observation results showed that vertical temperature gradients and temperature inversions are indicative of intercepting layers presence in the ABL and qualitatively characterise the impurities dispersion conditions. In an average year, the vertical temperature gradient is positive and varies for the 0-300, 0-600 and 0-900 m layers within the range of 0.13-1.62° C/100 m. Among different types of inversions, raised inversions prevail. Total frequency of unfavourable stability classes (E and F) in specific seasons of the exploration period is not in excess of 16.1% (winter).

Data analysis showed that during 2020-2024, the total frequencies of unfavourable stability classes (E and F) were minor and ranged 5.1-10.9% (annual averages). During the spring months, when unfavourable impurities dispersion conditions frequently occur in the ABL, the total frequencies of unfavourable stability classes (E and F) varied from 4.8% (2020) to 15.2% (2023). The D class (ranging from

35.8-35.9% in 2020-2021 to 50.7-52.8% in 2022-2024), which is favourable for dispersion of impurities, prevailed over 2020-2024 period.

Average wind velocities are moderate, and generally south-western winds prevail over the exploration period (Fig. 8.26).

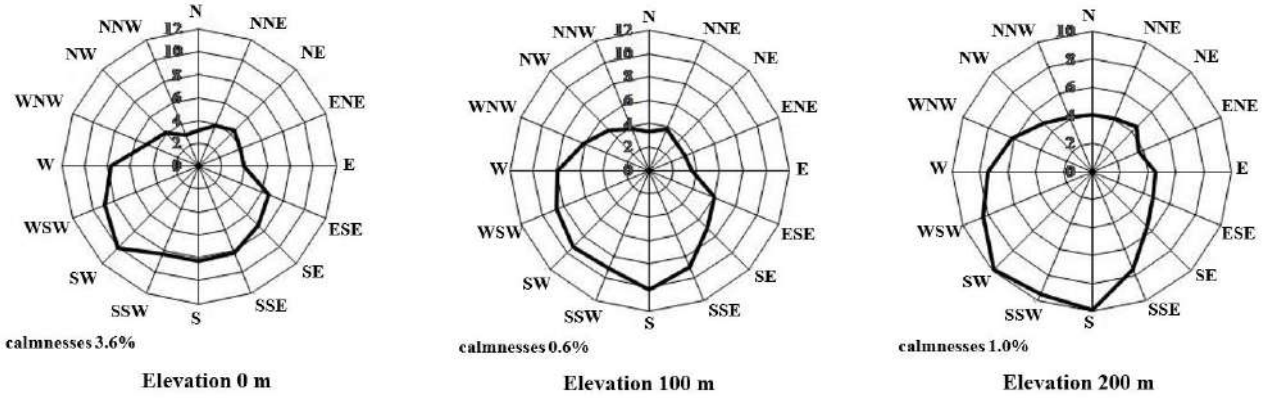


Figure 8.26 Average annual wind rose at elevation 0, 100 and 200 m in 2024

Thus, low interannual variability and interannual stability is typical for the estimated values of the ABL aerological characteristics.

The obtained results suggest that favourable atmospheric dispersion conditions are largely characteristic of 2024.

8.5.5 Surface water regime observations

The annual complex level, runoff, thermal regimes, water turbidity and ice phenomena observations on the rivers of Viliya, Stracha, Gozovka and Polpa were completed in 2024 (Fig. 8.27).

Figure 8.27 Water gauge station

The results of the water level regime observations in 2024 revealed that the water level of the Viliya River near the settlement of Malye Sviryanki varied from 2.0 m BS (24.07.204) to 3.90 m BS (25.04.2024). The average water level in 2024 was 2.62 m BS (Figure 8.28).

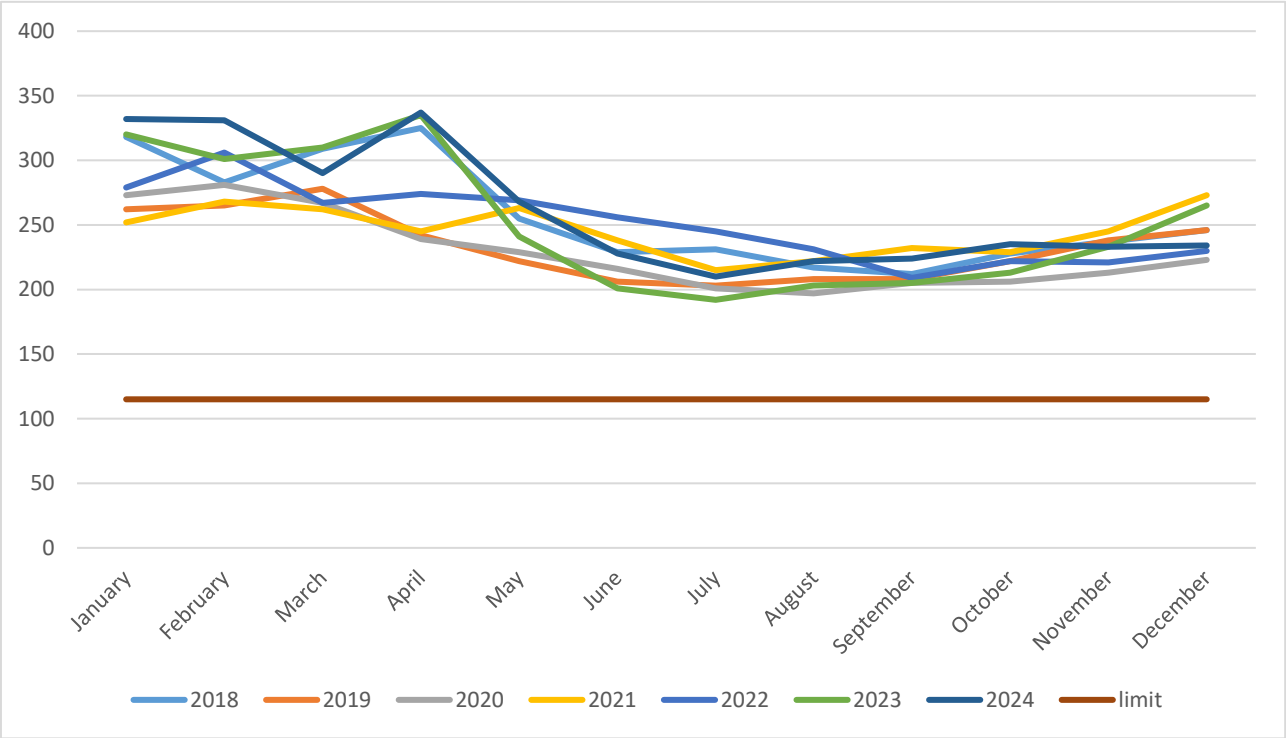


Figure 8.28 Graph of water level measurement at the water gauge station of the Viliya river (Malie Sviryanky settlement) in 2018-2024, m, BS

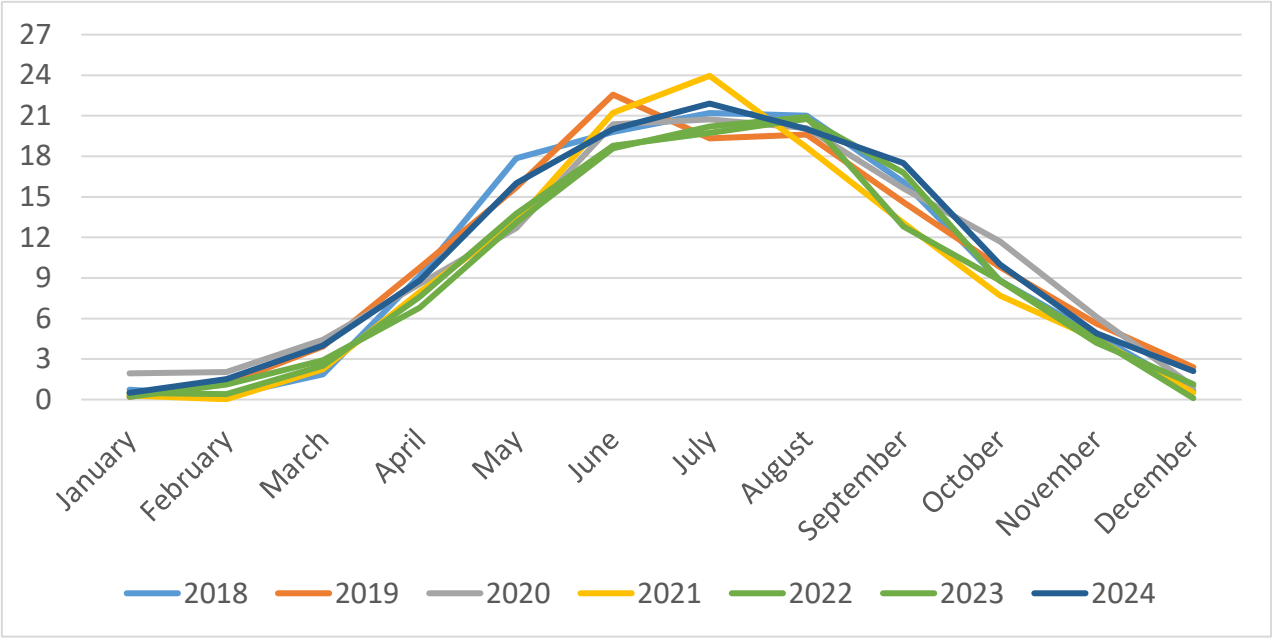
The maximum and minimum values of the Viliya River level measured in 2024 was not in excess of the estimated parameters limits adopted as a design basis.

In general, the level regime in the explored rivers in 2024 was characterised by a low amplitude throughout the year being within the measurement range of previous observation years.

The results of the temperature regime observations in 2024 revealed that the Viliya River water temperature at the of Malie Sviryanky settlement varied from 0.1° C (03, 08-10.01) to 24.6° C (22.07.2024). The average water temperature in 2024 was 10.6° C (Fig. 8.29).

It should be noted that the maximum values of the Viliya River water temperature measured in 2024 were not in excess of the limits of the estimated parameters adopted as a design basis.

In general, the temperature regime of the rivers under exploration in 2024 was within the measurement range of previous years of observations.



8.29 Graph of water temperature measurement at the water gauge station of the Viliya River (Malye Sviryanki settlement) in 2018-2024, °C.

The flow regime observation results 2023 revealed that the Viliya River water discharge at the settlement of Malye Sviryanki varied from 32.5 m^3/s (24.07.2024) to 183 m^3/s (29.02.2024). The average water discharge is 2024 was 72.3 m^3 /s (Fig. 8.30). The maximum and minimum values of measured water discharges of the Viliya River obtained in 2024 are within the limits of the estimated parameters adopted as the design basis.

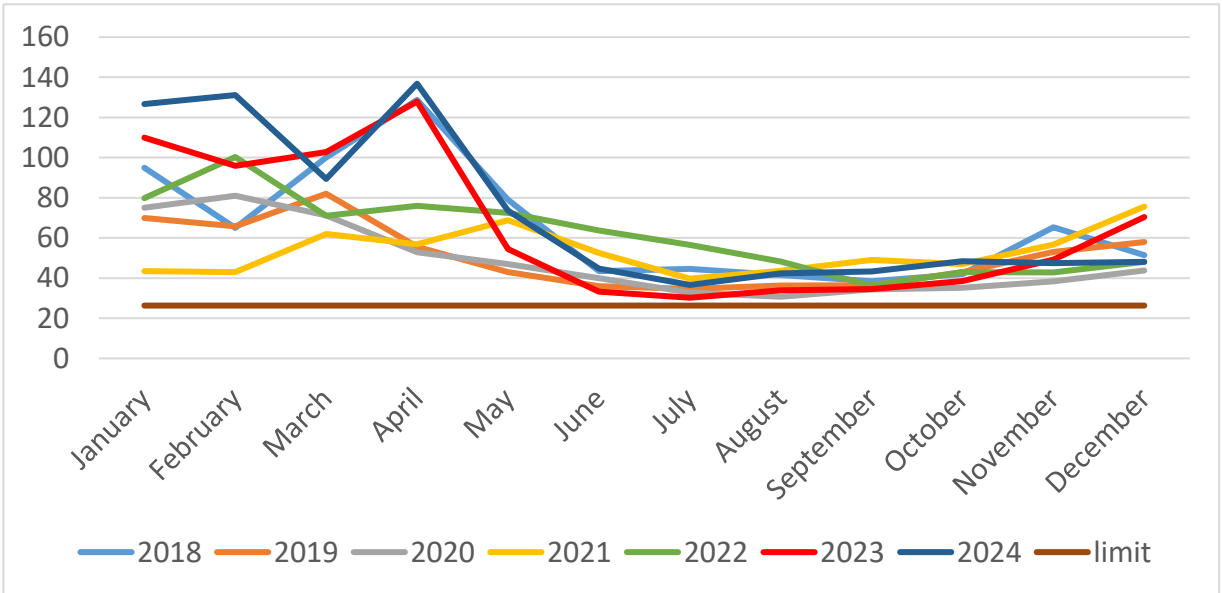


Figure 8.30 Graph of water discharge measurement at the water gauge station of the Viliya River (Malye Sviryanki settlement) in 2018-2024, m^3/s.

Ice phenomena on the rivers under exploration were observed only during January 2024 due to warm weather. On the Viliya River, over the period of January 2-8, 2024, shore ice and slush ice drift were observed, then incomplete ice coverage established, and the river freed of ice by the end of the month. The 2024-2025 winter was characterised by the absence of stable ice phenomena at all hydrological stations due to the absence of long-term subzero air temperatures. The average flow velocity in the Viliya River near the settlement of Malye Sviryanki in 2024 was 0.68 m/s, the maximum - 0.94 (14.04.2024), the minimum - 0.57 m/s (17.07.2024).

In 2024, water was sampled during all phases of the hydrological regime at four water gauging stations (Viliya River, Stracha River, Gozovka River and Polpa River) to determine the chemical composition of water over the following range of indicators: water physical properties, suspended solids, hardness, gases dissolved in water, pH, content of principle ions, nutrients, Si, Fe, BOD_5 (5 days), petroleum products, synthetic surface active substances, phenols, heavy metals and pesticides.

Subject to the results of the "Day 1" analysis, the river water is classified as weakly alkaline for most of the year, the hydrogen index value (pH) varied from 7.55 to 8.50.

The oxygen regime remained favourable for stable functioning of watercourse ecosystems. Dissolved oxygen content complied with the established quality standards and varied from 6.90 mgO_2/dm^3 to 11.8 mgO_2/dm^3.

In 2024, higher BOD_5 values were characteristic of the rivers. The average annual value of this indicator for the Viliya River was 13.9 mgO_2/dm^3 that may be conditioned by warmer climatic parameters in 2024 compared to previous years.

In 2024, contents below the limit of determination were recorded for the following substances: sulphides and hydrogen sulphide, lead, nickel and molybdenum; below the MAC: petroleum products copper, potassium, sodium, calcium, sulphates, chlorides and nitrates.

The average annual values of suspended substances in water were not in excess of MAC, and one-time exceedances were due to the presence of a large amount of intensive precipitation in 2024.

Substances for which exceedances of MAC were recorded in 2024 are typical contaminants of the country's surface water: ferrum total, manganese, phosphates, ammonium and nitrite ions. The increased content of biogenic substances may also be due to the year's warmer climatic characteristic, when higher river water temperature contributed to enhancement of biogenic processes in watercourses.

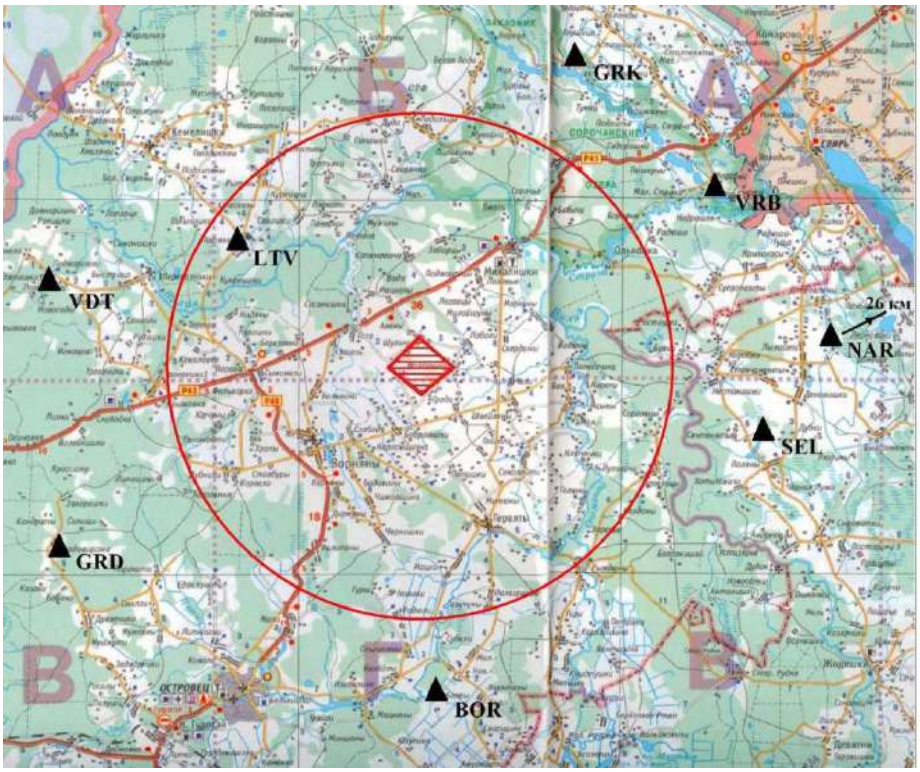
According to the results of microbiological studies, no exceedances of values of safety indicators of river water quality were detected. Water samples meet the Hygienic Standards requirements.

The results of the hydrological characteristics update revealed no factors prohibiting and/or limiting the Belarusian NPP operation.

The data obtained as a result of performed works provide evidence of the absence of significant impacts of the Belarusian NPP operation on the background natural indicators.

8.5.6 Seismological Monitoring

Seismic parameters at the site of the Belarusian NPP location are monitored by 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 operates 24/7 with continuous recording of signals transmitted by natural and artificial sources of seismic vibrations and registers seismic events in a wide range of epicentral distances and energies (Fig. 8.31).



Legend:

▲ - seismic stations: Boyary - BOR; Gradovshchizna- GRD; Vadatishki - VDT; Selishche - SEL; Vorobyi - VRB; Gornaya Kaimina - GRK; Litvyany - LTV; Naroch - NAR, ◈ - Belarusian NPP site outline.

Figure 8.31 – Location map of seismic stations in the area adjacent to the Belarusian NPP

Distant, regional and close earthquakes, as well as technogenic seismic events (explosions) were informatively recorded during the reporting period based on the processed recording data. Local earthquakes in the near zone up to 30 km from the NPP site were not recorded by the local observation network during the reporting period.

The Catalogue of distant earthquakes with magnitude M ≥ 6.0 for annual observation cycle contains information on 222 earthquakes. The Catalogue of regional earthquakes for the annual cycle contains information on 172 earthquakes. The Catalogue of close earthquakes (R = 30 - 300 km) for the annual cycle of observations

contains information on 62 earthquakes. The Catalogue of technogenic seismic events for the annual cycle includes 263 explosions.

In 2024 all close earthquakes were recorded in the southern part of Belarus (Soligorsk mining area), with epicentral distance from 200 to 300 km from the Belarusian NPP site. Earthquakes epicentres are confined to the Pripyat non-linear seismogenic superzone of potential earthquake sources (hereinafter referred to as the "PES"), which is the most extensive and active geodynamic structure within Belarus. This superzone includes a number of zones, which in their turn are subdivided into subzones: the North Pripyat seismogenic zone (Luban, Berezino and Gomel subzones), the Central Pripyat seismogenic zone and the South Pripyat seismogenic zone (Slovechnenskaya and Turovskaya subzones). The main factor for delineation of the PES Pripyatskaya superzone was its confinement to the Pripyat-Dnieper-Donets paleorift seismotectonic province. Such structures are characterised by increased seismicity on other ancient platforms. Heavy earthquakes usually occur in the marginal parts of the structures, small earthquakes - in the central part of the deflection. They are mainly associated with longitudinal faults, fragments of which are active at the new tectonic evolution stage. Concentration of close earthquake sources (in 300 km zone from the Belarusian NPP location site) is observed in the north-western part of Pripyat superzone. Close earthquake epicentres are located in the Central-Pripyat seismogenic zone and two seismogenic subzones - Luban and Berezino. Seismotectonic potential of the Central-Pripyat seismogenic zone (M_{max} = 3.5; h = 5 km; I = 4 - 5 magnitude). Seismotectonic potential of two seismogenic subzones: Luban (M_{max} = 4.0; h = 5 km; I = 5 - 6 magnitude) and Berezino (M_{max} = 4.5; h = 10 km; I = 6 - 7 magnitude).

The magnitude range of the recorded close earthquakes for the second half of 2024 was M = 0.8 - 2.9 and for the annual cycle – M = 0.8 - 2.9 is not in excess of the seismotectonic potential of the PES zones where their epicentres are located.

Regarding earthquakes producing greatest seismic effect on the NPP site, the following parameter values were obtained for the annual cycle of 2024. The maximum acceleration value and the maximum intensity value were obtained from the distant earthquake, which occurred in the Kyrgyzstan-Xinjiang border region on 22.01.2024 with magnitude of 7.0 and maximum peak acceleration of 0.089 cm/sec^2 ($0.89 \bullet 10^{-4}$ g) with estimated value of 0.9 magnitude (Fig. 8.32).

Figure 8.32 Map of epicentres of distant earthquakes with M ≥ 6.0 recorded during the annual observation cycle of 2024

The maximum acceleration value and the maximum intensity value are obtained from the regional earthquake which occurred in Romania on 16.09.2024 with 5.2 magnitude and maximum peak acceleration of 0.0687 cm/sec^2 (0.69-10^{-4} g) with estimated value of 0.3 magnitude (Fig. 8.33).

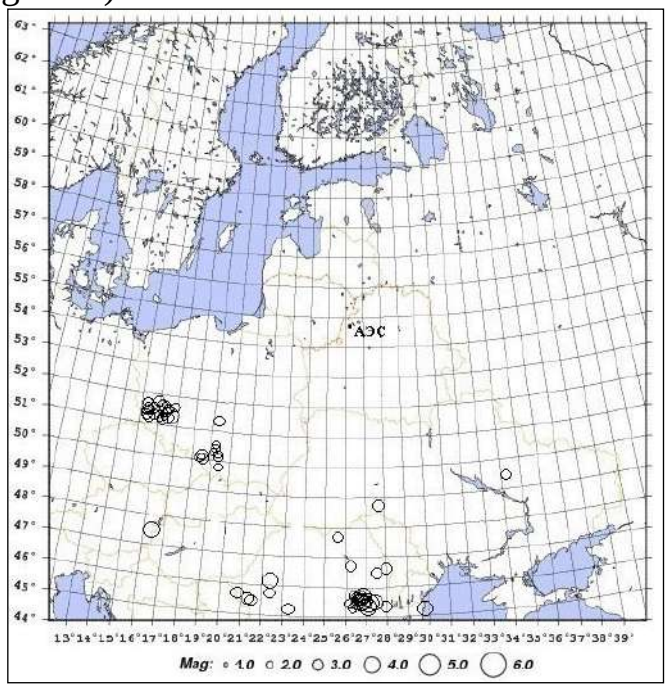


Figure 8.33 Map of epicentres of regional earthquakes recorded over the annual observation cycles of 2024

The maximum acceleration value and the maximum intensity value were obtained from the close earthquake which occurred in Belarus 03.03.2024 with 2.5 magnitude and maximum peak acceleration of 0.009 cm/sec^2 ($0.09 \cdot 10^{-4}$ g) with estimated value minus 1.3 magnitude (Fig. 8.34).

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

Figure 8.34 Map of epicentres of close earthquakes recorded over the annual observation cycle of 2024

Thus, for the year 2024 the maximum intensity of seismic effect on the Belarusian NPP site is 0.9 magnitude from the distant earthquake which occurred in the Kyrgyzstan-Xinjiang border region on 22.01.2024 with 7.0 magnitude, that is considerably lower than the values of design level which are 6 magnitude for the design earthquake (DE), for the maximum design earthquake (MDE) - 7 magnitude.

8.5.7 Geodetic monitoring of present-day crustal motion

The present-day crustal motion observations include the works to determine the horizontal and vertical components of motion.

In 2024, observations of the horizontal crustal motion using GPS technologies were performed. The use of sophisticated satellite geodetic technologies (GPS measurements) to locate points at different periods of time subsequently allows the state of horizontal motions to be determined at the millimetre accuracy level. The space geodesy methods are an order of magnitude higher in accuracy than accuracy of measurements made by classical geodesy methods and have higher effectiveness, making it possible to perform observations at remote points without regard to mutual visibility and are characterised by high metrological performance, all-weather measurements and highly advanced processing software.

The satellite geodetic network comprises 18 observation points, of which 15 are deep benchmarks, 1 ground benchmark and 2 points with a forced centring device (tripod).

Field measurements at the geodynamic polygon points were performed once a year.

The 2024 monitoring results revealed that the average annual velocities of horizontal motions of crust points ranged from 18.8 to 30.4 millimetres per year, with an average value of 24.5 millimetres per year, the value of which is not in excess of the accepted tolerance. An average direction of motion to the northeast along the azimuth of 50°.

Over the period of 2012-2024 (13 years), the velocity of horizontal motions of the points were in the range of 24.7 - 25.6 millimetres per year with an average value of 25.2 millimetres per year (Figs. 8.35, 8.36). The horizontal motion velocity gradients in the observation area ranged from 4×10^{-11} to 2×10^{-7} 1/year as the change in the amplitude of motion per unit distance per unit time (Fig. 8.37).

Figure 8.35 Diagram of directions of horizontal motions of points between epochs, 2012-2024

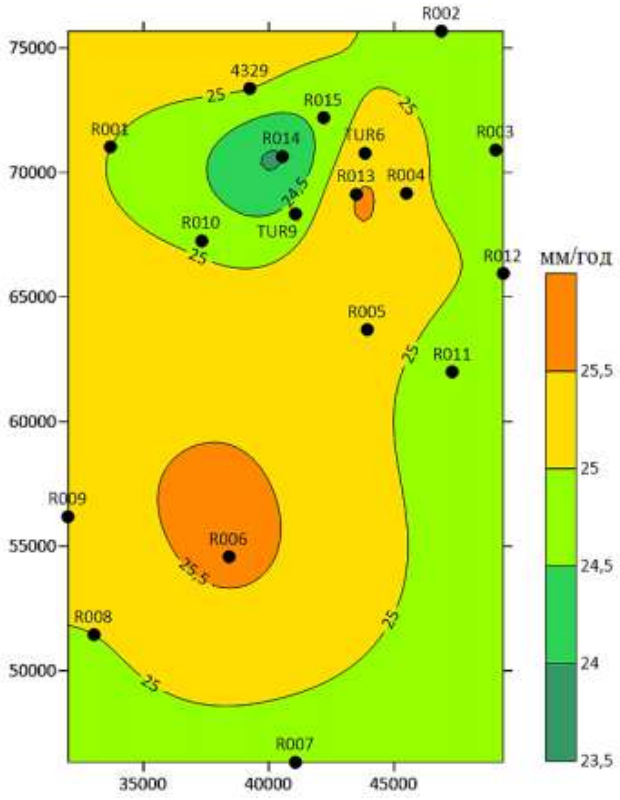


Figure 8.36 Distribution of velocities of horizontal motion of points recorded in 2012-2024

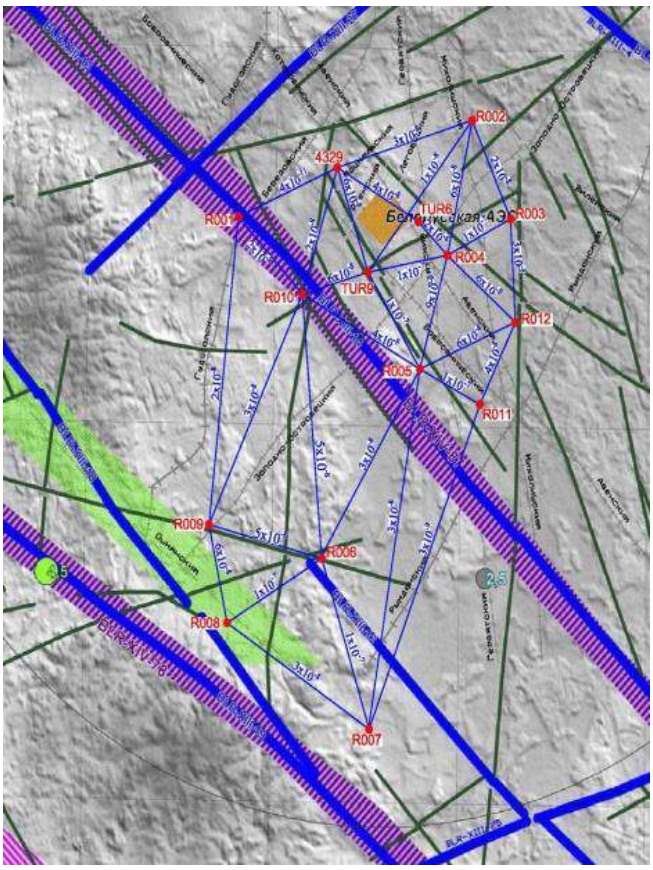


Figure 8.37 Diagram of horizontal motion velocity and velocity gradients between epochs, 2012-2024

The Belarusian NPP project adopted critical non-exceedance velocities of present-day motion - 50 millimetres for horizontal displacements per year. The point velocities measured in area under study are not in excess of these values.

The analysis of the results of observations of the crust horizontal motions in 2024 suggests that the values and directions of horizontal motions at the geodynamic polygon of the Belarusian NPP matches the values and directions of the general motions of the East European platform. Insignificant discrepancies of velocities and directions of motion of points may not indicate the presence of any local horizontal motions in the area under study.

In 2024, the vertical crustal motion was monitored using high-precision re-levelling of class I.

Geometric levelling of geodetic points of the geodynamic network subject to the I class method was performed to calculate the vertical component of the present-day crust motions. I class levelling was performed in forward and reverse directions while keeping equal distances from a levelling instrument to rods by two pairs of transition points forming two separate lines. Measurements at the observation points were performed once a year.

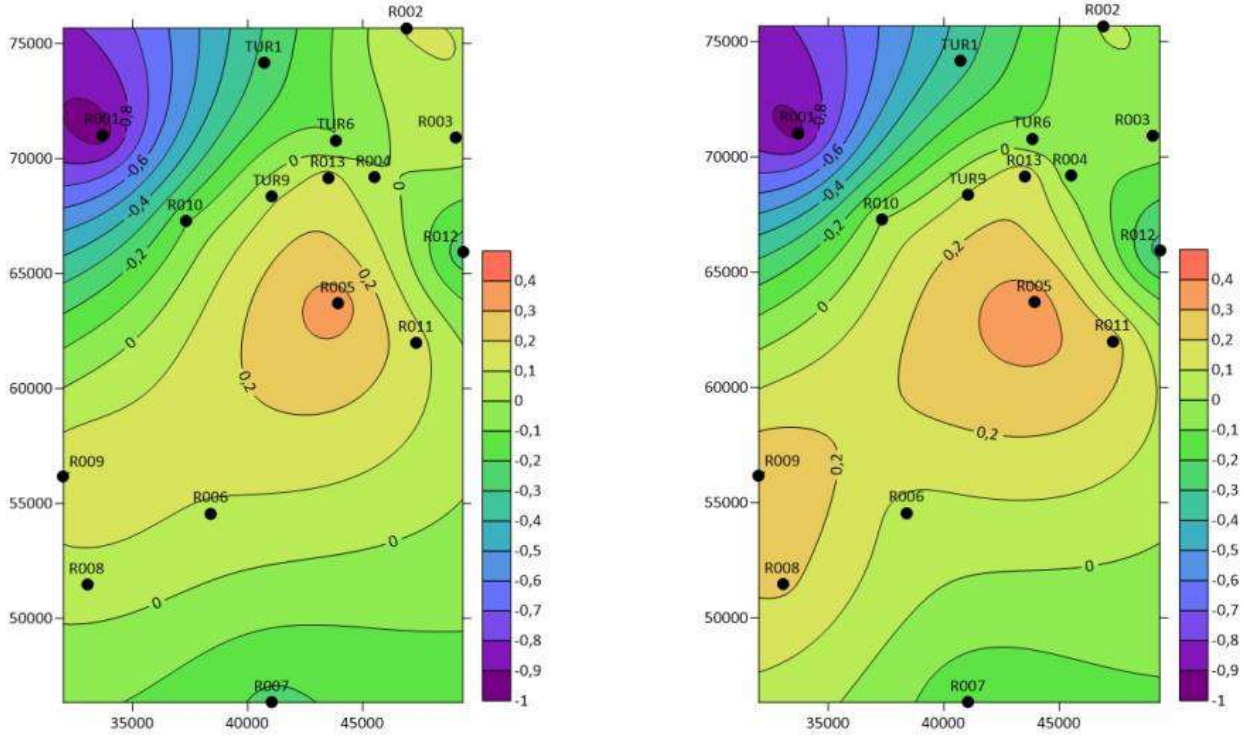
The network total length is 139.91 km. Traverses consist of 14 separate lines between the points and form 6 closed polygons with an average perimeter of 30.13 km (tolerance 40 km). The network is secured on the ground by 13 deep benchmarks, 38 ground benchmarks, 9 wall benchmarks, 3 TUR-type centres and 2 temporary benchmarks. The total number of points is 65.

Analysis and evaluation of the results of monitoring of crust vertical motions and velocities in 2024 showed that the vertical motion velocities of points ranged from (-1.92) to (+3.11) millimetres per year. Therefore, the velocities of vertical displacements of the points of the geodynamic polygon are within acceptable limits (not exceeding 10 millimetres per year). The total values of points vertical displacement rate gradient for the entire geodynamic polygon area throughout 2024 are 2.2×10^{-8} 1/year.

The 2012-2024 observation data indicate the total values of vertical velocity of the geodynamic polygon points ranged from (-0.33) to (+0.49) millimetres per year.

The weighted average inter-cycle displacements of the network points range from (+0.35) to (-0.93) millimetres per year (Fig. 8.38).

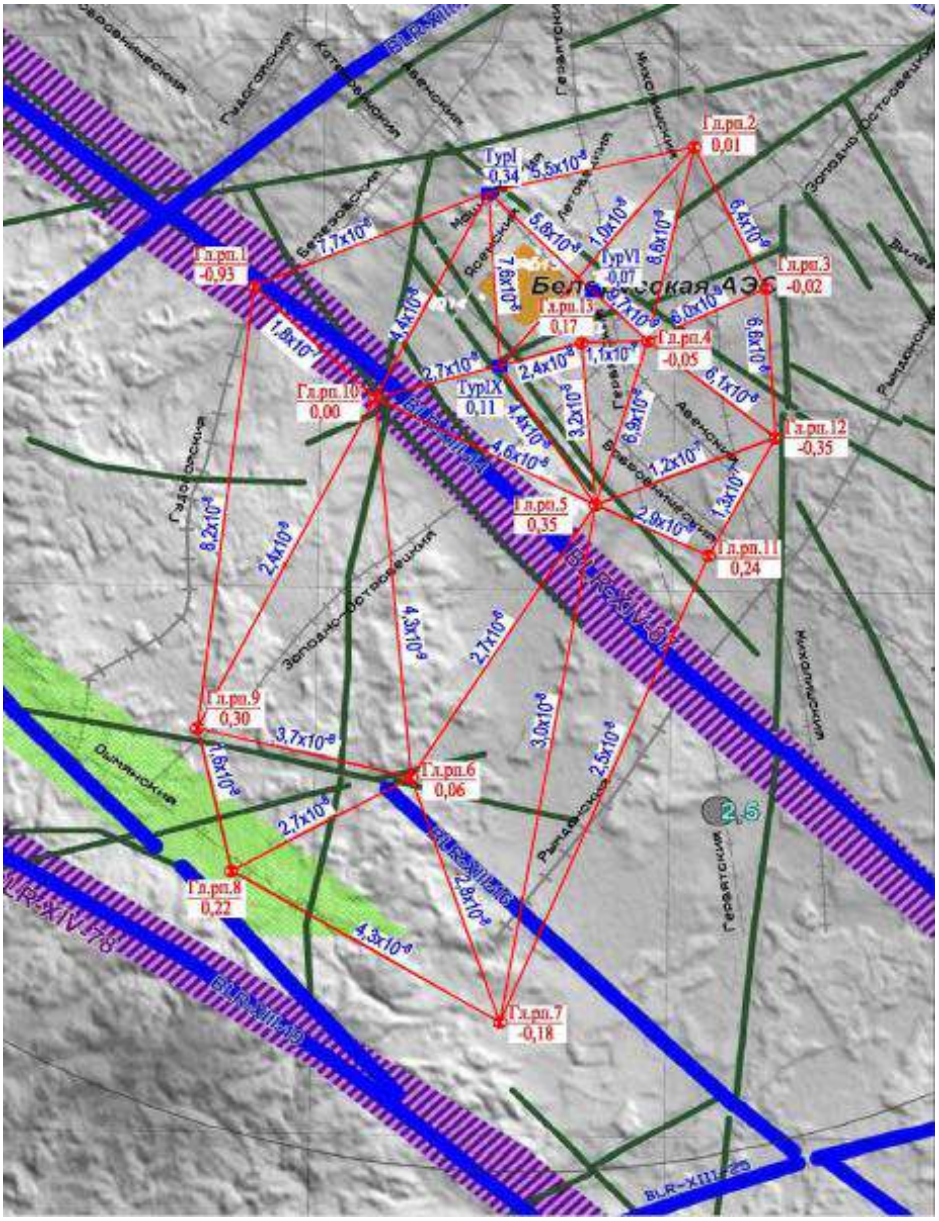
Vertical motion velocity gradients in the observation area ranged from 4.3×10^{-9} to 1.8×10^{-7} 1/year. The total values of the velocity gradient of the geodynamic polygon points ranged from 1.7×10^{-8} to 4.9×10^{-8} 1/year. The direction changes insignificantly that is indicative of the absence of geodynamic processes signs (Fig. 8.39).



a) b)

a) point vertical motions b) annual average motion velocities

Figure 8.38 Distribution of weighted average vertical motions of points and velocities in 2012-2024



Legend:
Гл. рп Deep benchmark
Typ IV Forced centring point (TUR)
$3.7x10^{-8}$ Vertical motion velocity gradient
Гл. рп.7 Numerator – levelling network number
-0.18 Denominator- vertical motion velocity mm/y

Figure 8.39 Vertical motion velocity gradients at the Belarusian NPP geodynamic polygon in 2012-2024

The obtained data allow for a conclusion that the directions, distances and stability criteria of the geodynamic monitoring points are stable, the values of partial accelerations are not in excess of the criteria and indicate the absence of signs of geodynamic processes in the Belarusian NPP location area.

8.5.8 Monitoring contamination of the surface layer of the atmosphere, land and aquatic ecosystems, contamination load of water bodies and condition of aquatic biological resources

In 2024, a yearly observation cycle was completed as part of environmental monitoring in the Belarusian NPP BA and RCA. Samples of atmospheric air, soil, water and bottom sediments were collected; the condition and/or extent of contamination of atmospheric air, land and aquatic ecosystems was assessed.

The results of route surveys in the warm period of 2024 (April-October) are indicative of a moderate anthropogenic load on atmospheric air in the area of the Belarusian NPP. No exceedances of maximum permissible concentrations were recorded in 100% of cases. The quality of atmospheric air in the neighbouring settlements remains high.

The ecological condition of the soil cover within the surveyed area boundaries is satisfactory. The threshold values of the gross content of chemical elements at the sampling sites in the Belarusian NPP observation zone are not in excess of the "low contamination degree" category.

Comparative analysis of surface water quality throughout the observation period allows for a conclusion that stations are characterised by good and satisfactory environmental condition (status). Deterioration of the condition of the studied watercourses at the observation points for hydrobiological and hydrochemical indicators in 2024 is not observed, accordingly, no negative impact of the nuclear power plant on the watercourses was detected

Analysis of the obtained results of chemical composition of bottom sediments at the observation stations showed that the obtained values are significantly lower than the MAC as compared to the established MAC for soils, which indicates the absence of chemical contamination in the bottom sediments of the watercourses under survey at the Belarusian NPP observation stations.

Based on the results of the fauna studies at six monitoring stations during the 2024 field season, insignificant radiation-biological fluctuations within the reaction norms were found, mainly due to natural and climatic variations within the composition of fauna and natural environment complexes.

To date, the environmental situation in the Belarusian NPP monitoring zone remains stable, and the NPP is environmentally safe.

8.5.9 Radiation monitoring

In 2024, radiation monitoring in the Belarusian NPP BA and RCA was conducted subject to the Programme of Environmental Radiation Monitoring in the Buffer Area and Radiation Control Area of Belarusian NPP and the Regulations on Radiation Monitoring of Belarusian NPP.

The main tasks of radiation monitoring include as follows:

continuously systematically controlling the level of radioactive environmental contamination in the BA and RCA;

acquiring necessary, sufficient and reliable data on the radiation situation in the BA and RCA;

assessing the current state of environmental radiation monitoring in the BA and RCA of Belarusian NPP and analysing its trends;

assessing radiation doses to the population residing in the RCA;

forecasting changes in the radiation situation in the BA and RCA;

collecting, compiling and transmitting information on radiation situation and environment condition in the BA and RCA to the authorities and agencies concerned and on forecasting their trends.

Radiation control of emissions and discharges from the Belarusian NPP

In 2024, the values of emissions and discharges of radioactive substances from the Belarusian NPP power units No. 1 and No. 2 were not in excess of the values of the maximum permissible limits of emissions/discharges of radioactive substances from the Belarusian NPP into the environment approved by the Nuclear Power Plant Chief Engineer-issued Order No. 278 of 20.06.2022 and approved by Gosatomnadzor, State Institution "Grodno Oblast Centre of Hygiene, Epidemiology and Public Health" and the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus.

Data on discharges of radioactive substances from the Belarusian NPP power units Nos. 1 and 2 over the period from 01.01.2024 to 31.12.2024 are provided in Table 8.3.

Table 8.3 Discharges of radioactive substances from the Belarusian NPP power units Nos. 1 and 2 in 2024

Specified radionuclide	for 12 months of 2024 Power unit No. 1, No. 2				
	Annual discharge, Bq	PD for year, Bq	PD index, %	MPD for year, Bq	MPD index, %
^{3}H	2.75E+12	7.00E+12	39.29	3.50E+13	7.86
^{60}Co	1.02E+08	1.08E+09	9.44	5.42E+09	1.88
^{131}I	9.78E+07	7.46E+09	1.31	3.73E+10	0.26
^{134}Cs	1.04E+08	8.39E+08	12.40	4.20E+09	2.48
^{137}Cs	1.12E+08	1.15E+09	9.74	5.73E+09	1.95

Note: MPD – maximum permissible discharge, PD – permissible discharge.

Data on emissions of radioactive substances from the Belarusian NPP power units Nos. 1 and 2 over the period from 01.01.2024 to 31.12.2024 provided in Table 8.4.

Table 8.4 Radioactive substance emissions from the Belarusian NPP power units Nos. 1 and 2 in 2024

Radionuclide	Total volumetric emission activity for 2024, Bq	PE (year), Bq	PE index, %	MPE (year), Bq	MPE index,%
Power unit No. 1					
^{3}H	4.64E+11	6.78E+13	0.68	3.39E+14	0.14
^{14}C	1.28E+10	5.08E+12	0.25	2.54E+13	0.05
^{60}Co	6.05E+06	3.62E+09	0.17	1.81E+10	0.03
^{131}I	8.29E+06	1.41E+09	0.59	7.03E+09	0.12
^{133}I	4.12E+06	2.54E+09	0.16	1.27E+10	0.03
^{134}Cs	4.89E+06	3.72E+08	1.31	1.86E+09	0.26
^{137}Cs	5.41E+06	5.60E+08	0.97	2.80E+09	0.19
RIG	7.75E+12	2.04E+13	37.99	1.02E+14	7.60
Power unit No. 2					
^{3}H	2.55E+11	6.78E+13	0.38	3.39E+14	0.08
^{14}C	2.24E+10	5.08E+12	0.44	2.54E+13	0.09
^{60}Co	5.07E+06	3.62E+09	0.14	1.81E+10	0.03
^{131}I	8.05E+06	1.41E+09	0.57	7.03E+09	0.11

Radionuclide	Total volumetric emission activity for 2024, Bq	PE (year), Bq	PE index, %	MPE (year), Bq	MPE index,%
^{133}I	3.78E+06	2.54E+09	0.15	1.27E+10	0.03
^{134}Cs	3.88E+06	3.72E+08	1.04	1.86E+09	0.21
^{137}Cs	4.26E+06	5.60E+08	0.76	2.80E+09	0.15
RIG	2.93E+12	2.04E+13	14.36	1.02E+14	2.87

Note: RIG – radioactive inert gases; MPE – maximum permissible emissions; PE – permissible emissions.

Gamma radiation dose rate in the territory

The layout of the Belarusian NPP radiation monitoring posts of the automated control system of radiation situation (hereinafter referred to as the "ACSRS") is shown in Figure 8.40.

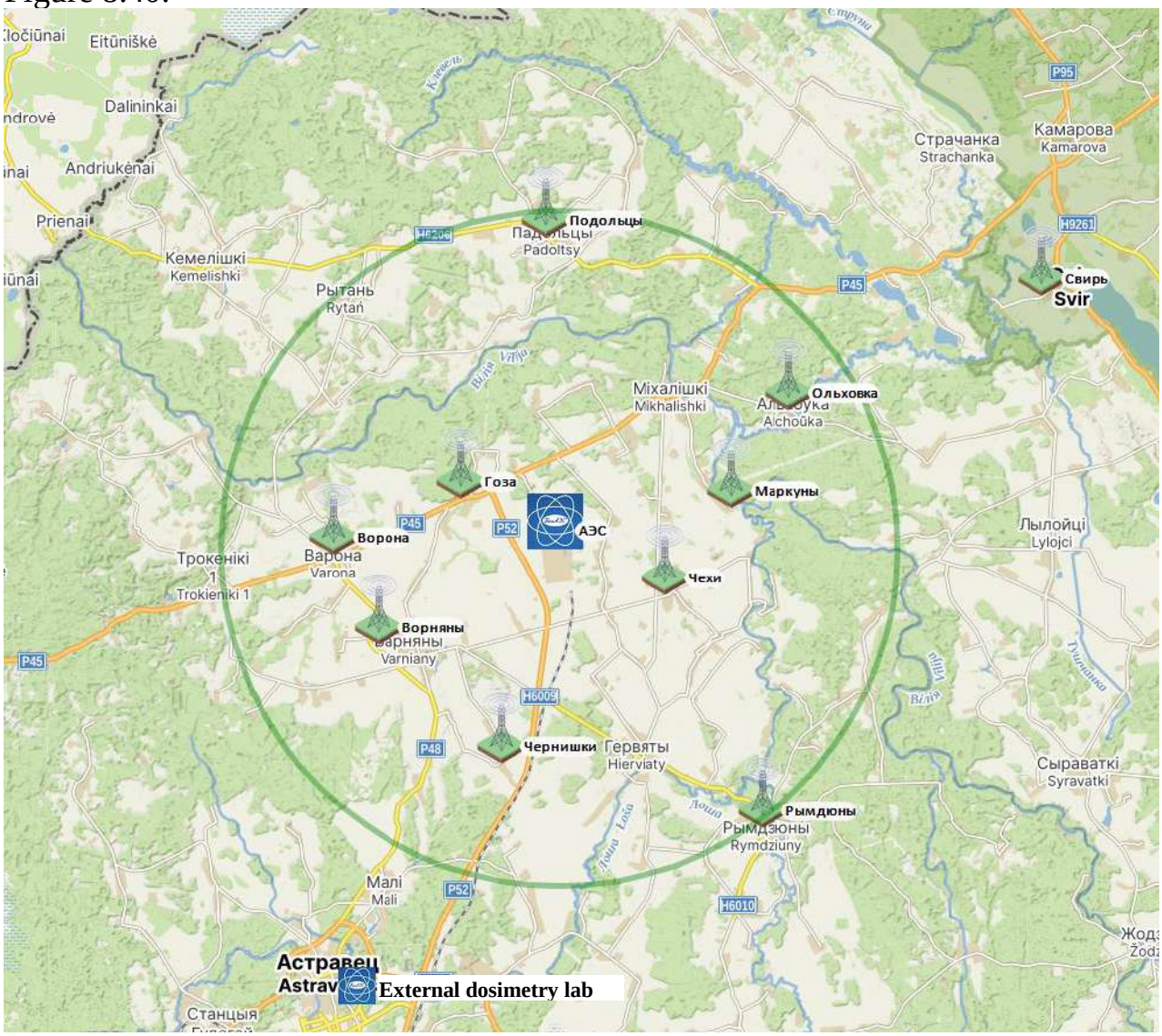


Figure 8.40 Belarusian NPP ACSRS RCP layout

In 2024, the levels of ambient dose equivalent of gamma radiation (ADE) in the Belarusian NPP RCA were in the range of 0.059-0.066 μSv/h, which corresponds to the determined long-term values for this region of the Republic of Belarus.

Aerosols in the surface layer of the atmosphere

Figure 8.41 shows the layout of the atmospheric air control and radiation monitoring points in the Belarusian NPP RCA.

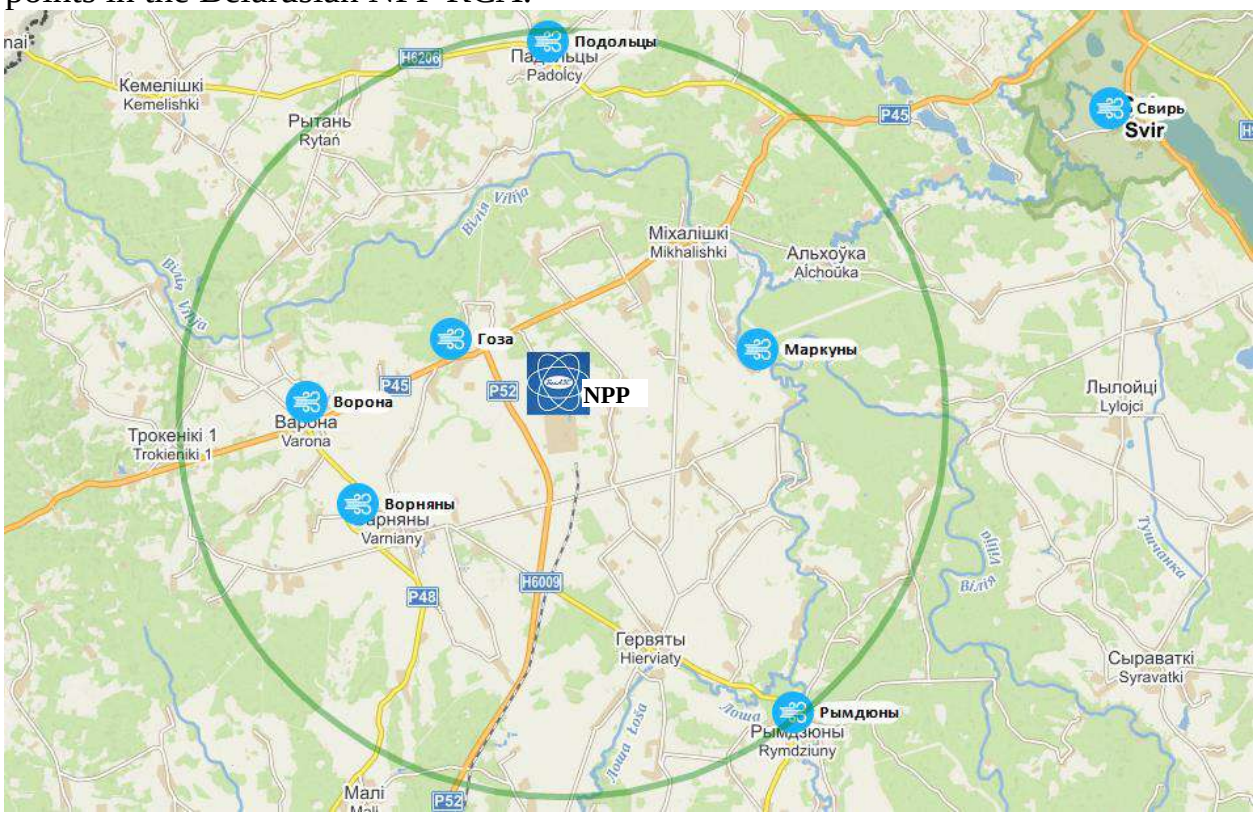


Figure 8.41 Layout of atmospheric air control and radiation monitoring points in the Belarusian NPP RCA

The mean monthly values of total beta activity in the atmospheric surface layer aerosol samples in 2024 were in the range of (6.6-28.3)×10^{-5} Bq/m³, which corresponds to the background values established during the 2008-2019 expedition surveys (1-34×10^{-5} Bq/m³).

In 2024, the average annual value of ^{137}Cs volumetric activity in atmospheric surface layer aerosols was 0.03 ×10^{-5} Bq/m³, which correlates with data previously obtained at the Belarusian NPP construction site and since the power unit No. 1 physical startup (<2.0 ×10^{-5} Bq/m³).

The ^{90}Sr content in the collected aerosol samples was not in excess of the lower limit of the measuring range of the applied method (hereinafter referred to as the "LLMR"), which is <0.09×10^{-5} Bq/m^3.

The values of ^{3}H and ^{14}C volumetric activity in atmospheric air were lower than MDA (<0.5 Bq/m^3).

Atmospheric fall-out

The layout of atmospheric fall-out control and radiation monitoring points in the Belarusian NPP RCA of is shown in Figure 8.42.

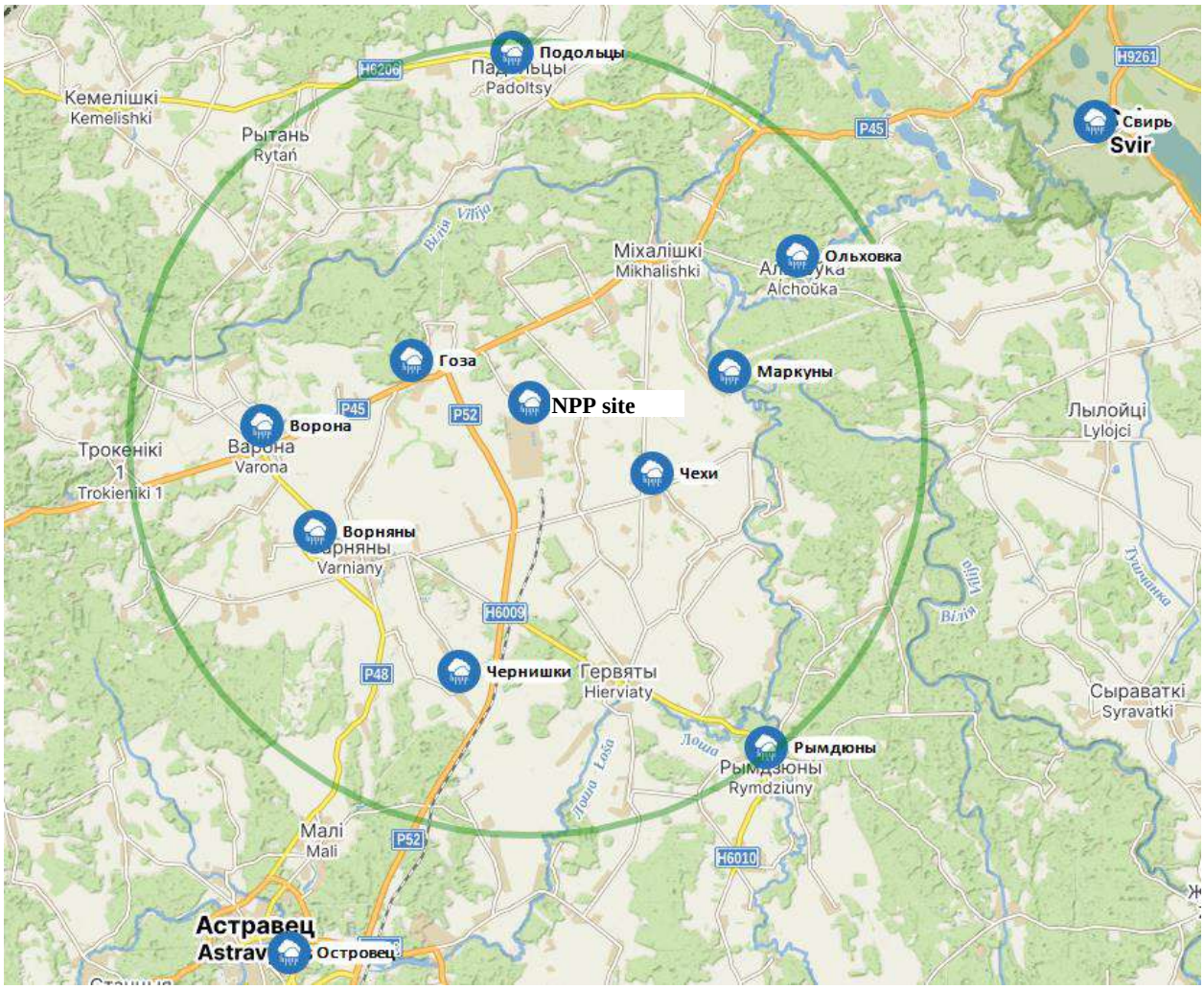


Figure 8.42 Layout of atmospheric fall-out control and radiation monitoring points in the Belarusian NPP RCA

The values of total beta activity in atmospheric fall-out samples in 2024 correlate with the average determined long-term values for this region and were in the range of 0.043-0.503 Bq/m²×day.

In 2024, the ^{137}Cs content in monthly fall-out samples was in the range of <0.0007-0.017 Bq/m²×day, which correlates with the previously determined background values of this parameter. The ^{90}Sr content in all collected atmospheric fall-out samples were lower than LLMR <0.019 Bq/m²×day.

Surface waters

The layout of surface water radioactive contamination surveillance points is shown in Figure 8.43.

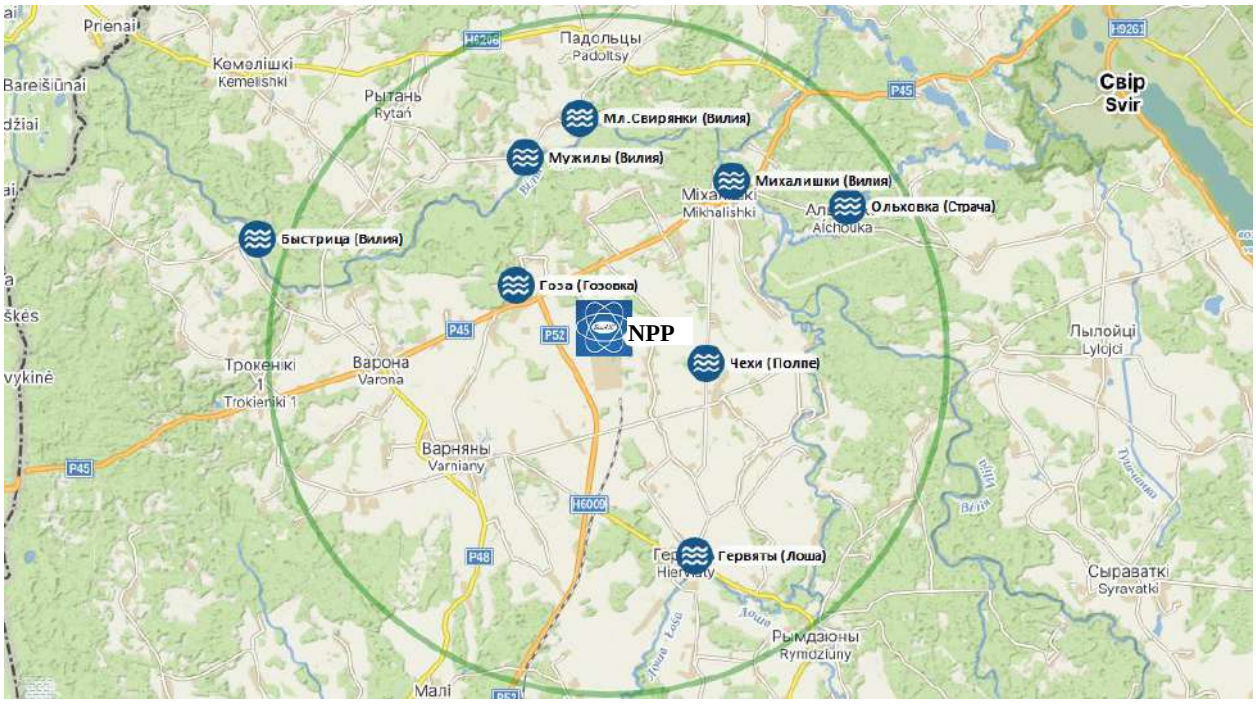


Figure 8.43 Layout of surface water radioactive contamination surveillance points

In 2024, the values of total beta activity in surface water samples were consistent with the background values found during the 2008-2019 expedition surveys for this region and were in the range of <0.14 - 0.16 Bq/dm³.

The ^{137}Cs content in the collected surface water samples ranged from <0.0008-0.0029 Bq/dm³. The ^{90}Sr content in surface water samples was below the LLMR (<0.3 Bq/dm³). The ^{3}H content was lower than the previously measured background values and ranged from <0.2 to 3.1 Bq/dm³.

Groundwater and drinking water

The location of drinking water radioactive contamination surveillance points is shown in Fig. 8.44.

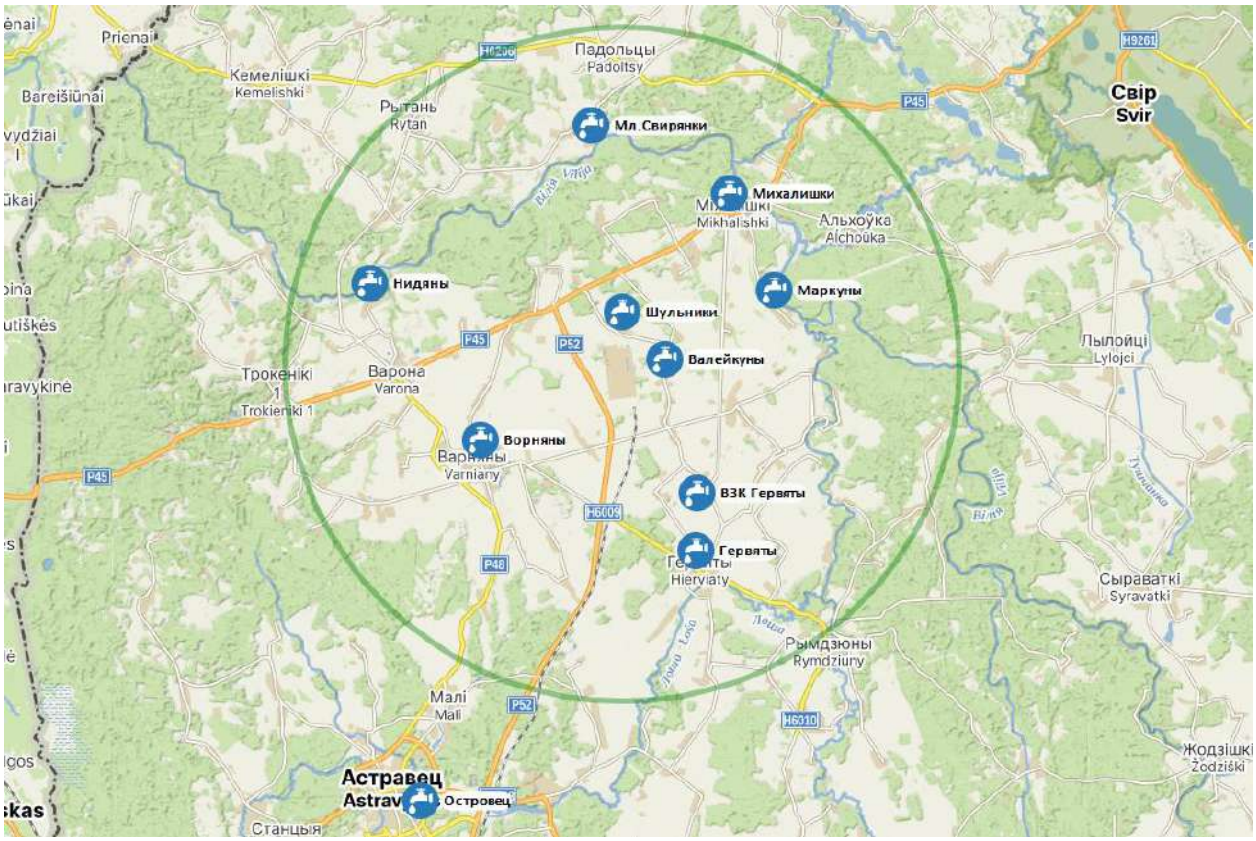


Figure 8.44 Layout of drinking water radioactive contamination surveillance points

The values of total alpha activity in drinking water samples collected in 2024 from wells in RCA ranged from <0.02-0.09 Bq/dm³. The values of total beta activity in drinking water samples ranged from <0.10-1.82 Bq/dm³.

The ^{137}Cs content in drinking water samples collected from wells in settlements located in the radiation control area was below the MDA (<0.0008 Bq/dm³).

Levels of ^{90}Sr volumetric activity in drinking water samples collected from wells in RCA were below the LLMR <0.3 Bq/dm³.

The values of the drinking water controlled parameters in 2024 in the RCA corresponded to the determined long-term values and were below the permissible level standards (RDU-99) for drinking water (^{137}Cs - 10 Bq/dm³, ^{90}Sr - 0.37).

The determined in 2024 values of total beta-activity in drinking water samples collected from wells in the settlements within the Belarusian NPP radiation-control area were lower than the values obtained at the Belarusian NPP construction site within the integrated environmental monitoring (“zero” radiation background). However, in specific samples the values of total volumetric beta-activity are higher than those of the established standard (1 Bq/l, in accordance with the hygienic standard “Criteria for Assessment of Radiation Exposure” approved by the Decree of the Council of Ministers of the Republic of Belarus dated 25.01.2021, No. 37), and those values observed both at the Belarusian NPP construction site and upon commissioning were due to the increased content of natural radionuclide ^{40}K in drinking water (the maximum recorded level of this radionuclide in drinking water is 3.32 Bq/l).

The layout of groundwater surveillance points is shown in Fig. 8.45.

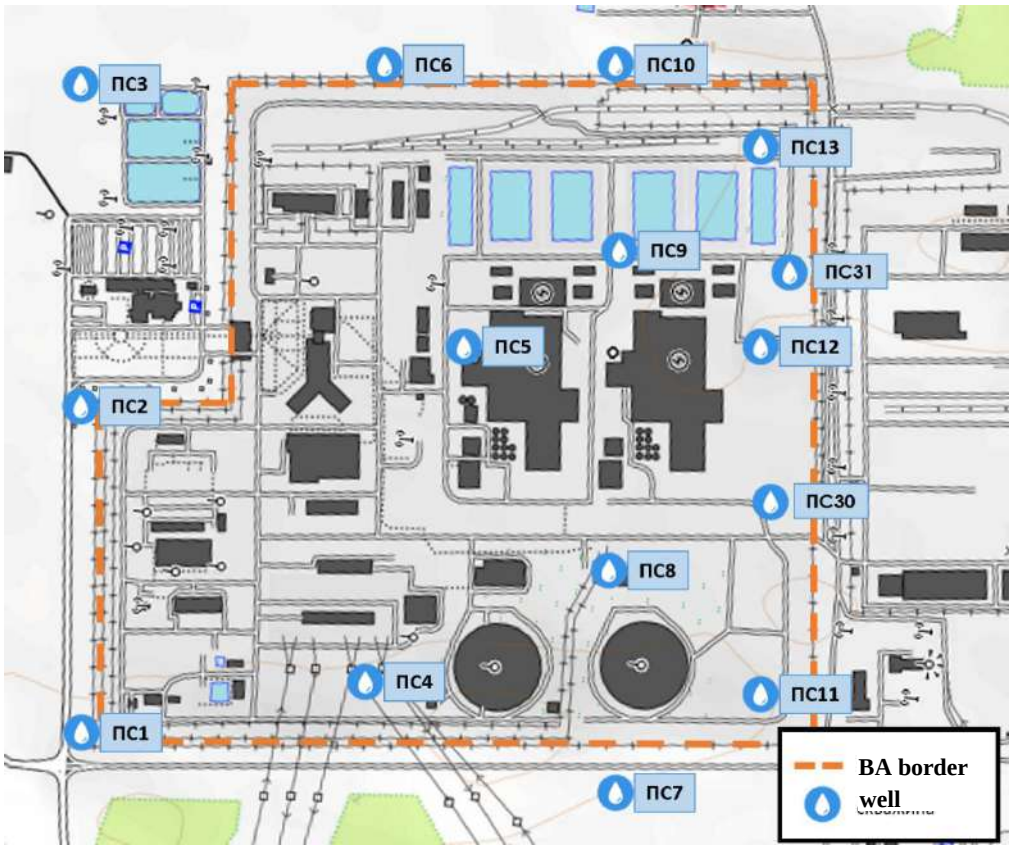


Figure 8.45 Layout of groundwater surveillance points

Values of total alpha activity in groundwater samples collected in 2024 from the monitoring well network at the Belarusian NPP site were <0.02-0.06 Bq/dm³. The values of total beta-activity in groundwater samples were less than LLMR <0.10 Bq/dm³.

Levels of ^{90}Sr volumetric activity in groundwater samples collected from the monitoring well network at the Belarusian NPP site were below the LLMR <0.3 Bq/dm³.

The levels of ^{137}Cs volumetric activity in groundwater samples collected from the monitoring well network at the Belarusian NPP site were in the range of <0.0008-0.005 Bq/dm³.

Hydronetwork water bodies (bottom sediments, aquatic and shore side-aquatic vegetation, ichthyofauna)

In 2024, the levels of ^{137}Cs and ^{90}Sr in bottom sediment samples at all observation points were in the range of 0.59-8.90 Bq/kg and <1.0-1.53 Bq/kg, respectively, and correspond to previously determined background values (0.4-13.76 Bq/kg - ^{137}Cs and 0.6-7.1 Bq/kg - ^{90}Sr).

In 2024, the results of measurement of radionuclide content in components of aquatic and shore side-aquatic biogeocenoses in the Belarusian NPP RCA showed that in all surveillance points the levels of radioactive contamination with anthropogenic radionuclides (2024) were for ^{137}Cs <0.8 - 2.1 Bq/kg, for ^{90}Sr - <0.1-2.0 Bq/kg and corresponded to background values (up to 21.6 Bq/kg - ^{137}Cs, up to 4 Bq/kg - ^{90}Sr).

The measured values of ^{137}Cs specific activity in ichthyofauna at the surveillance points of the Viliya river in 2024 ranged from 0.6 to 41.8 Bq/kg. The maximum level of ^{137}Cs activity in ichthyofauna was determined in one pike sample and was 41.8 Bq/kg (at the surveillance point located upstream of the Belarusian NPP wastewater discharge point in the area of Markuny settlement).

The values of ^{90}Sr specific activity in all ichthyofauna collected samples were in the range of <0.1-2.59 Bq/kg.

The obtained values of the ^{137}Cs and ^{90}Sr content level in ichthyofauna were significantly lower than the reference levels established by the Hygienic Standard "Criteria for Assessment of Radiation Exposure", approved by the Resolution of the Council of Ministers of the Republic of Belarus dated 25.01.2021, No. 37 (the content of ^{137}Cs in fish should not exceed 130 Bq/kg, ^{90}Sr - 10 Bq/kg).

Soils

The radionuclide content in soils and agricultural land is monitored at permanent surveillance points (Fig. 8.46). 9 points of radiation monitoring of soils and 13 points of radiation monitoring of agricultural lands were established in the Belarusian NPP RCA.

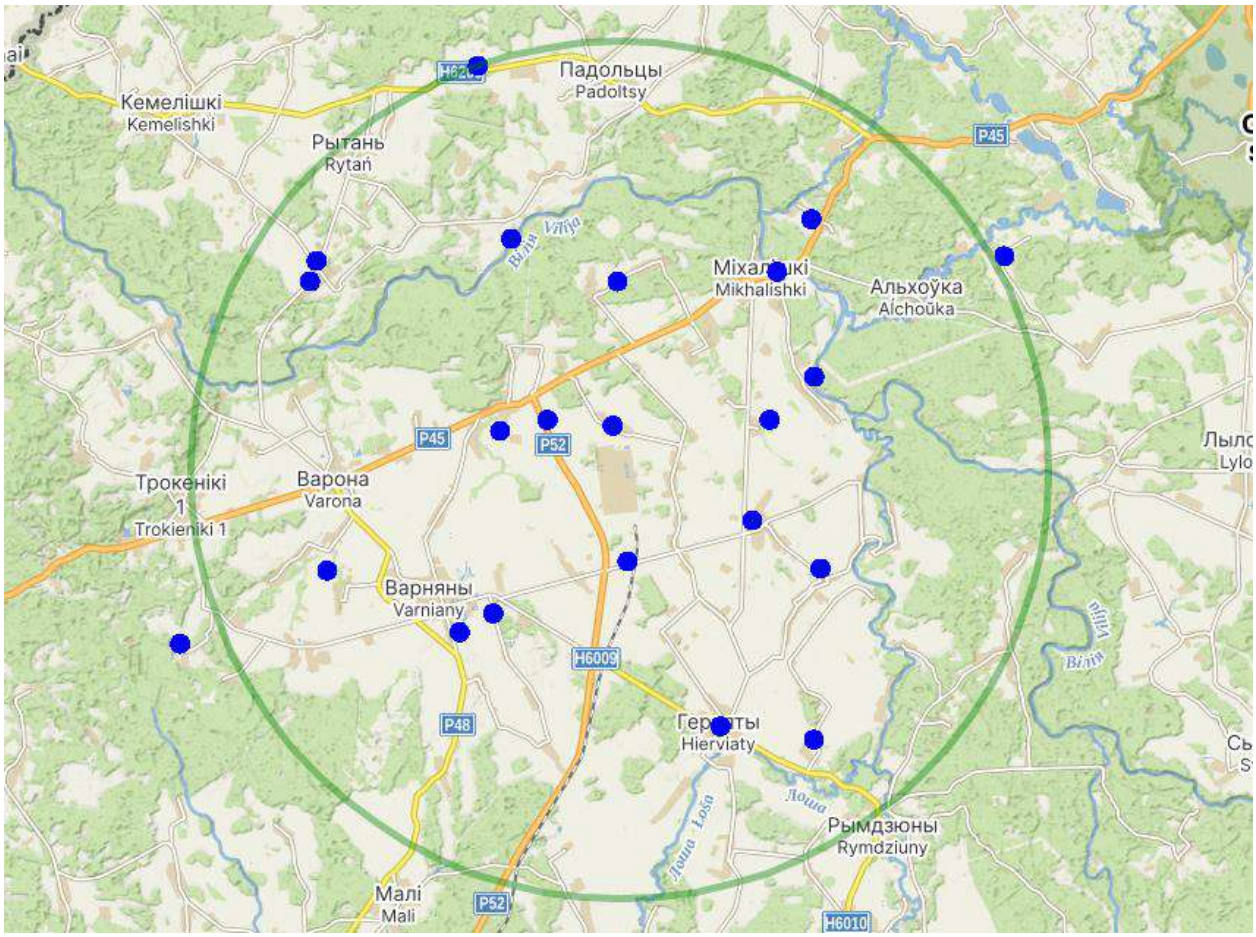


Figure 8.46 Layout of observation points for monitoring radioactive contamination of soils and agricultural lands in the Belarusian NPP RCA

The results of laboratory tests of samples collected in 2024 showed that the values of ^{137}Cs specific activity were in the range from <0.26 to 7.9 Bq/kg, ^{90}Sr - from <1.0 to 2.0 Bq/kg.

ADE at radiation monitoring points of soils and agricultural lands measured at a height of 1 m above the soil surface were lower than 0.1 μSv/h.

According to the results of assessment of 2024 radioecological parameter data and comparing them with the previous 2023 data, no significant changes were found.

Ground Vegetation

Levels of ^{137}Cs content in samples of vegetation of meadow biogeocenosis were lower than MDA (<0.5 Bq/kg) with the maximum background value of 24.6 Bq/kg obtained at the Belarusian NPP construction site. The specific activity of ^{90}Sr in the vegetation of meadow biocenosis was in the range of <0.1-0.1 Bq/kg (maximum background value - 5.0 Bq/kg).

The highest levels of ^{137}Cs content in forest biogeocenosis samples were found in the following plants: grass-subshrub layer - 9.5 Bq/kg (maximum value of "zero background" - 400.0 Bq/kg), forest stand components - 8.2 Bq/kg (maximum value of "zero background" - 173, 0 Bq/kg), wild berries - 6.8 Bq/kg (maximum value of "zero background" - 115.4 Bq/kg), mushrooms - 160 Bq/kg (maximum value of "zero background" - 2348.65 Bq/kg).

^{90}Sr specific activity in samples of forest biocenosis plants was in the range of 1.31 - 5.02 Bq/kg (maximum value of "zero background" - 4.0 Bq/kg), in mushrooms - <0.1 - 10 Bq/kg (maximum value of "zero background": for mushrooms - 16.0 Bq/kg).

The results of data comparative analysis show that the levels of radioactive contamination with ^{137}Cs and ^{90}Sr radionuclides in 2024 correspond to the previously established background values in all surveillance points for components of forest and meadow phytocenoses of the Belarusian NPP radiation control area.

Agricultural Produces

The specific activity of ^{134}Cs, ^{137}Cs and ^{131}I in milk samples collected at 7 livestock farms were lower than MDA levels (<0.1; <0.15 and <0.12 Bq/dm³, respectively). The ^{90}Sr specific activity in milk ranged from <0.1 to 0.34 Bq/dm³.

The obtained values of ^{137}Cs and ^{90}Sr content in milk are significantly lower than the reference levels established by the Hygienic Standard "Criteria for Assessment of Radiation Exposure" approved by the Decree of the Council of Ministers of the Republic of Belarus of 29.11.2022, No. 829 (^{137}Cs content must not exceed 100 Bq/l, ^{90}Sr - 5 Bq/l).

Meat (beef) samples were collected at 2 livestock farms (Gervyaty cattle breeding and fattening complex, Chekhi cattle breeding and fattening farm). The ^{137}Cs specific activity in beef was lower than MDA levels (<0.07; <0.11 Bq/kg, respectively). The ^{90}Sr specific activity in beef ranged from <0.1 to 0.21 Bq/kg. "Background" levels of radionuclides in meat were as follows: ^{137}Cs - up to 1.1 Bq/kg, ^{90}Sr - up to 0.44 Bq/kg).

The obtained values of ^{137}Cs content in meat are significantly lower than the reference level established by the Hygienic Standard "Criteria for Assessment of Radiation Exposure" approved by the Decree of the Council of Ministers of the Republic of Belarus dated 25.01.2021, No. 37 (^{137}Cs content must not exceed 200 Bq/kg).

The ranges of values of controlled parameters in 2024 were as follows for cereals: ^{137}Cs: <0.08-0.05 Bq/kg, ^{90}Sr: <0.1-0.26 Bq/kg; for vegetables: ^{137}Cs: <0.08 Bq/kg, ^{90}Sr: <0.1 Bq/kg; for fruits: ^{137}Cs: <0.08 Bq/kg, ^{90}Sr: <0.5 Bq/kg; for agricultural fodder (green mass): ^{137}Cs: <0.08 Bq/kg, ^{90}Sr: <0.1-1.9 Bq/kg. The obtained values were not in excess of the values of "zero" radiation background obtained at the Belarusian NPP construction stage.

Annual Ambient Dose Equivalent (ADE) on the ground (dose equivalent characterising the radiation situation)

Analysis of the obtained data shows that in 2024 quarterly values of the ambient radiation dose equivalent at all surveillance points (Vornyany, Svir, Vorona, Podoltsy, Rymdyuny, Goza, Chekhi, Markuny, Chernishki, Olkhovka) varied in the range of 0.15 - 0.22 mSv. In 2024, annual ADE values fluctuated within the range from 0.62 to 0.87 mSv, that corresponds to the stationary values of "zero" background radiation for this region of the Republic of Belarus.

The results of radiation monitoring in the Belarusian NPP RCA obtained in 2024 indicate that the radiation situation in the area of the Belarusian NPP location remains stable, the levels of contamination of components of natural environment, agroecosystems and agricultural produces with technogenic radionuclides in general correspond to "zero" background radiation levels recorded at the Belarusian NPP construction and commissioning stage.

CHAPTER 9
OUTREACH ACTIVITIES IN THE FIELD OF RADIATION AND ENVIRONMENTAL MONITORING

In 2024, 5,486 persons visited the NPP Information Centre as members of 234 delegations. The number of visitors increased by 7% compared to 2023.

Lectures, excursions, workshops were held for the Information Centre visitors related to the issues of the Belarusian NPP safety, NPP-2006 project specifics, Belarusian NPP efficiency, its role in national economy, the NPP impact on the ecology of the region and other issues.

Figure 9.1 Students of the National Children's Technopark at the Belarusian NPP

Detailed mockups of the NPP production site and NPP power unit were made for more informatory filling of the Information Centre exposition.

Practical assistance was provided to representatives of local and foreign mass media (hereinafter referred to "MM") in preparing TV spots, coverages and interviews related to the operation of the Belarusian NPP and its best employees.

A media tour for local and foreign MM to cover the visit of Director General Rafael Mariano Grossi, a media tour for the Kazakhstan MM and expert community representatives, a media tour at the Belarusian NPP and Ostrovets facilities for representatives of Belarusian, Russian and the Union State MM.

Coverages on the Belarusian NPP operation were prepared for the regional socio-political newspaper "Astravetskaya Prauda". Information materials were prepared for the publishing house "SB. Belarus Today".

Assistance is provided in preparation of special coverages by Stolichnoe Televidenie CJSC, Second National TV Channel CJSC and others.

The information support is provided in preparing the reports related to the Belarusian NPP operation for industry mass media: Energy Strategy, Energy of Belarus. Information support was provided for preparing reports on the NPP operation.

Together with the editorial office of the newspaper "Astravetskaya Pravda", the monthly publication of the thematic page "Belarusian NPP" has been resumed.

The "NPP in Persons" project implementation continued jointly with "Energetika Belarusy" newspaper.

In total, more than 120 representatives of local and foreign mass media visited the Belarusian NPP during the reporting period.

One of the priority areas of the awareness-building effort is participation in specialised forums and exhibitions.

In 2024, the Enterprise's stand was presented at the 28th Belarusian Energy and Environmental Forum "Energy Expo 2024", at the 2nd International Security Industry Exhibition "NATIONAL SECURITY. BELARUS - 2024", International Forum 'Atomexpo 2024' in Sochi and 68th Session of the IAEA General Conference. At the end of 2024 - beginning of 2025, Belarusian NPP participated in the exhibition of achievements of sovereign Belarus "My Belarus" as part of the joint stand of the Ministry of Energy.

To provide prompt and comprehensive coverage of the most important events at the Belarusian NPP, to more actively and in more detail inform youth audience about nuclear power, the Enterprise maintains official pages in popular social networks, such as Telegram, Facebook, Vkontakte, Odnoklassniki and Instagram. Compared to 2023, the number of subscribers in the official accounts increased by more than 5%.

The Enterprise website content is regularly updated. Since 2022, the Enterprise's website section "Radiation Situation" has been highlighting in the on-line mode the relevant information on the radiation background in the Belarusian NPP RCA, with the update frequency being 30 minutes.