REPORT

Report on radiation-and-environmental monitoring in the area of the Belarusian Nuclear Power Plant

2021

CONTENTS

INTRODUCTION

The Radiation and Environmental Monitoring Report for 2021 in the area of the State Enterprise “Belarusian Nuclear Power Plant” (hereinafter - the Belarusian NPP) was developed within the frames of implementation of the Program of the post-project analysis of the Belarusian NPP (approved by the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus on December 23, 2014) in order to fulfill the Espoo Convention obligations by the Republic of Belarus (Article 7). The monitoring has been carried out by specialized Belarusian and foreign organizations.

CHAPTER 1
General description of the Belarusian NPP

The Belarusian NPP is located in the Ostrovets district of the Grodno region of the Republic of Belarus, 18 km northeast of the city of Ostrovets (fig. 1.1).

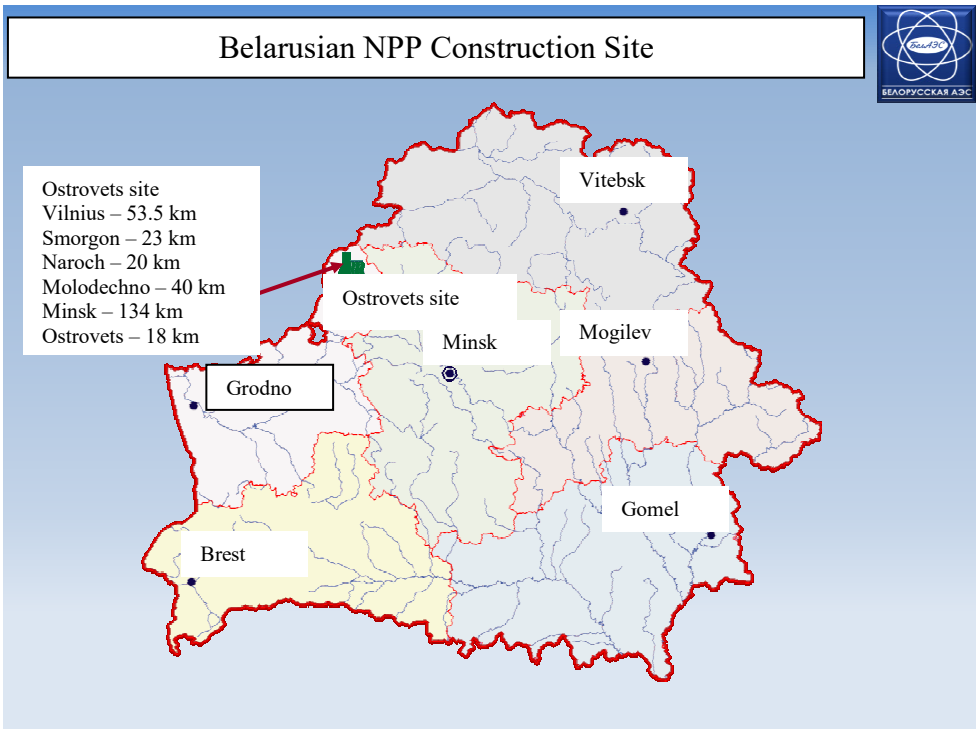


Figure 1.1 - Map of the Belarusian NPP location

The Belarusian NPP, consisting of two power units with a total electrical capacity of up to 2400 MW including VVER-1200 reactors, is being built according to the Russian project “NPP-2006” of 3+ generation near the city of Ostrovets (Grodno region). This project meets the most up-to-date so-called

"post-Fukushima" standards of reliability and safety, which is achieved by the introduction of new "passive safety systems" that are able to function without the operator's intervention even in case of complete blackout of the plant.

Key parameters:

installed nominal capacity – 1200 MW(e);

number of power units - 2;

service life of the power unit - 50 years;

efficiency rating (net) - 33.7%;

plant demand - maximum 7.15% of the rated capacity.

Actual layout of the NPP power unit with VVER-1200 is shown in fig. 1.2.

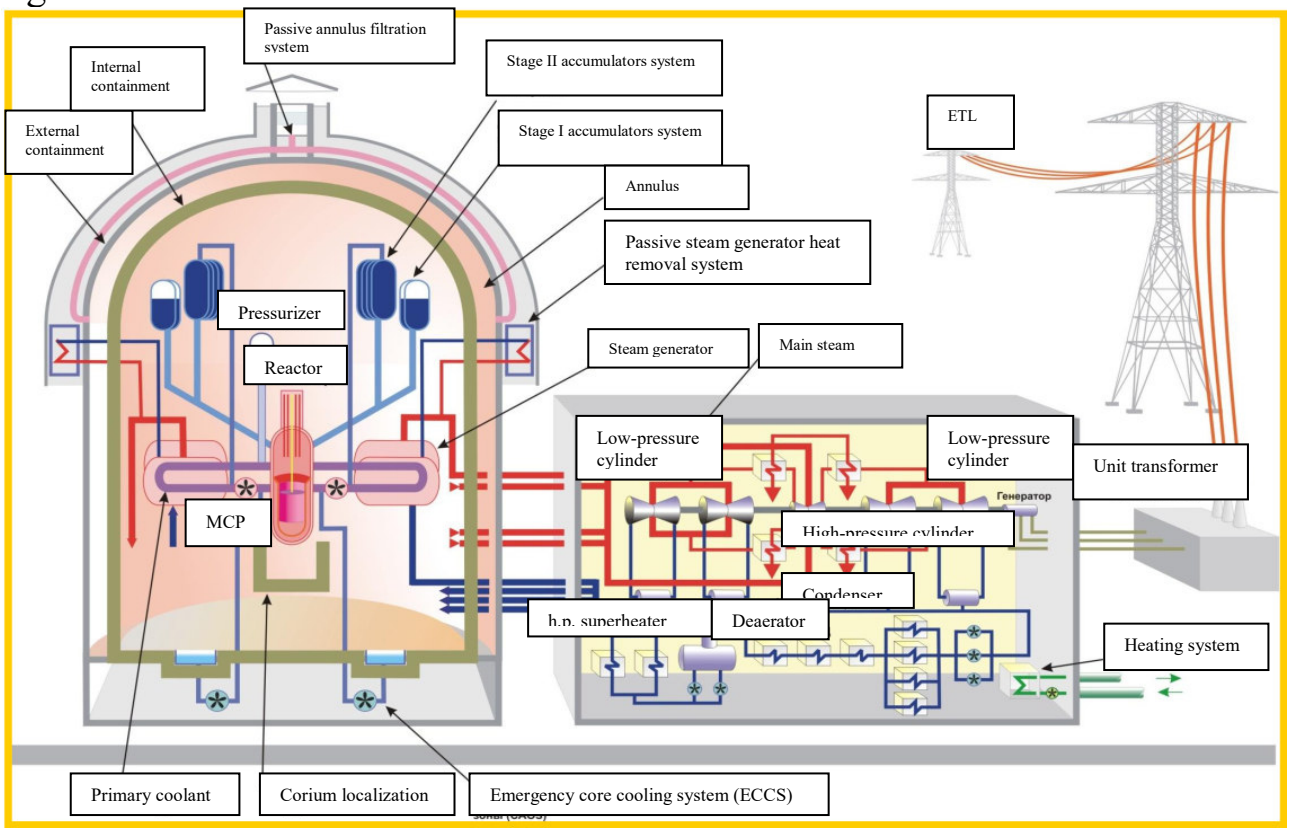


Figure 1.2 - Actual layout of the NPP power unit with VVER-1200

The safety of the Belarusian NPP project is ensured via the defense-in-depth principle - the use of a system of barriers on the way of the ionizing radiation and radioactive substances distribution into the environment.

The barrier system includes:

– a fuel matrix preventing the release of fission products under the fuel element can;

– a fuel element cladding preventing fission products from getting into the coolant of the main circulation circuit;

– the main circulation circuit, preventing the fission products release under the containment;

– a system of containments preventing the fission products release into the environment.

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

The neighboring 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), the Ukraine (distance to the border - 315 km).

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

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

In accordance with the project the territory of the Belarusian NPP site coincides with the boundaries of the sanitary-protection zone (hereinafter referred to as the SPZ), and the observation zone (hereinafter referred to as the OZ) is a circle of 12.9 km radius.

Belarusian NPP uses an indirect service water supply with cooling towers and spray cooling ponds system.

The water intake site for service water supply system is located 7 km to the north of the Belarusian NPP site on the Viliya River near the settlement of Malye Sviryanki. The site of the II elevation structure is located 0.25 km to the north of the settlement of Matskely.

The water intakes for the household water supply system are located 6 km to the south-east of the Belarusian NPP near the settlement of Gaigoli, and the settlement of Popishki. The water intake system includes 4 areas of water intake and a site of the household water treatment plant.

CHAPTER 2
Core activity of the Belarusian NPP

On January 1, 2020 the Belarusian NPP became a part of the State production association of the electric power industry "Belenergo", which made it possible to build and introduce a unified technical policy in the field of electric power generation.

On December 22, 2020 the "Pilot Operation" stage of the power unit No. 1 was started.

This stage included a phased reaching of the power unit capacity from 50 to 100% of the rated one, dynamic tests, tests related to the xenon transient stability analysis, and tests of process equipment. These tests were conducted in accordance with the corresponding programs and, were accompanied by a reactor power cutback from the rated to the minimum controlled power level and disconnection of the power unit from the grid.

On January 12, 2021 the first power unit of the Belarusian NPP was brought to the rated power level.

On April 30, 2021 the Department for Nuclear and Radiation Safety of the Ministry of Emergency Situations of the Republic of Belarus (Gosatomnadzor) held public hearings and after that introduced a new type of activity into the license, which was the operation of power unit No. 1. Taking into account the epidemiological situation these activities were performed in a "hybrid" format via video conferencing. For that purpose 9 active studios located in Ostrovets, Minsk and all regional centers were used, to which citizens and members of the public were invited.

Everyone was given the opportunity to ask questions or make suggestions on the topic of the hearings and receive answers. Email questions from the public were collected from the date of the public hearing announcement on April 23, 2021 until the last day before the event. On the day of the hearing (April 30, 2021), questions were collected also from active studios. In total, the participants of the public hearings asked more than 70 questions.

During the period from May 08, 2021 to May 29, 2021, a comprehensive testing of power unit No. 1 was carried out at nominal capacity for 15 days in the basic mode in order to confirm its readiness for commercial operation.

On June 2, 2021 a new type of activity was added to the license, which was the operation of power unit No. 1, and positive opinion was given by the State supervisory authorities on June 7, 2021.

On June 10, 2021 the State Acceptance Commission signed a Provisional Acceptance Certificate of the release of the power unit No. 1 start-up complex of the Belarusian NPP to commercial operation.

From the date of the first synchronization of the turbine generator of the power unit No. 1 of the Belarusian NPP with the energy system of the Republic of Belarus (November 03, 2020) until the end of 2021 5.8 billion kWh of electricity were generated.

Construction and installation at the power unit No. 2 of the Belarusian NPP approached the final stage by the end of 2021 with installation of the equipment and pipelines, cable laying and commissioning.

On March 24, 2021 operations at phase A-3.1 “Hydraulic tests and circulation flushing” of the stage A “Pre-commissioning alignment activities” were started.

On April 18, 2021 fresh fuel for the power unit No. 2 of the Belarusian NPP was delivered to the site.

On July 6, 2021 works on sub-stage A 2 “Confinement system testing” of stage A “Pre-commissioning alignment activities” were completed at power unit No. 2.

On July 27, 2021 hot functional test (sub-stage A-3.2) at power unit No. 2 was started.

On October 6, 2021 works under the sub-stage “Inspection of the main equipment of the reactor plant” were started at the power unit No. 2. As part of this sub-stage an inspection of the equipment, pre-operational metal control of the main equipment and pipelines have been performed.

On December 21, 2021 in accordance with the phased program works under sub-stage A-4 “Inspection of the main equipment of the reactor plant” at the power unit No. 2 were completed and works under phase B-1.1 of sub-stage B-1 "Reactor fueling and subcritical test" of stage B “Physical start-up of the reactor plant” were started.

On December 27, 2021 nuclear fuel was loaded into the reactor core.

In 2022 the commissioning of the power unit No. 2 will continue.

In 2021 the NPP Decommissioning Financing Fund and the NPP Safety Maintaining and Improving Financing Fund were established by Decree of the President of the Republic of Belarus dated January 26, 2021 No. 32 “On the Funds of the Belarusian Nuclear Power Plant”. These funds are a global practice and is recommended by the IAEA.

On January 26, 2021 the Council of Ministers of the Republic of Belarus approved the National Action Plan to implement the recommendations and proposals of the IAEA mission on the comprehensive evaluation of the national nuclear infrastructure of the Republic of Belarus development (RRI 3 mission). The plan was developed in accordance with the methodology recommended by the IAEA, taking into account the proposals of the Belarusian organizations involved in the implementation of the nuclear energy program.

On February 9-10, 2021 experts from the European Nuclear Safety Regulators Group (ENSREG) visited the Belarusian NPP. The visit was organized as part of a peer review of the National Action Plan as a follow-up to the stress tests of the Belarusian NPP (hereinafter referred to as the National Plan).

European experts visited the facilities with an access to systems and equipment of the Belarusian NPP, which are important to ensure the NPP

resistance to external natural impacts. There was an opportunity to study relevant documentation, discuss their observations regarding the implementation of the National Plan and ENSREG recommendations with representatives of stakeholders. As a result of the visit and other actions the ENSREG experts prepared a draft version of the Peer Review Report.

On March 3-4, 2021 the ENSREG held a plenary session with Gosatomnadzor (Regulator) as an observer. This plenary session was dedicated to topical issues of nuclear safety regulation. The session approved the ENSREG Preliminary Report on the Peer Review of the National Plan.

On April 5-13, 2021 experts from the Moscow Center of the World Association of Nuclear Operators (hereinafter referred to as WANO) held a technical support mission to assess the operational readiness of the power unit No. 2. The experts assessed the effectiveness of the organizational structure and administrative management of the power unit No. 2, analyzed the personnel training conditions, monitored radiation and fire protection, as well as the power unit maintenance system.

On April 26-30, 2021 the WANO experts carried out a technical support mission "Walkaround the workplaces. Works supervision".

An IAEA advisory mission on the physical protection of nuclear facilities (IPPAS mission) worked in Belarus from June 28 to July 9, 2021. On June 30-July 1, 2021, the IPPAS mission visited the Belarusian NPP. The experts reviewed the documents related to the physical protection system operation, also they visited the plant's facilities, including the main control room, fresh nuclear fuel storage, transfer station and others. The mission noted that Belarus had implemented a proper nuclear security regime taking into account all essential elements of the IAEA nuclear security fundamentals manual. The group recommended and proposed to support Belarus in further strengthening and maintaining nuclear security. Best practices have been used which can serve as an example for other IAEA member States in strengthening their nuclear security activities.

Within the period from August 31 till September 2, 2021, ENSREG experts worked at the Belarusian NPP site. This visit was arranged as part of the second stage of the peer review of the National Plan, performed by Gosatomnadzor in cooperation with the European Commission, ENSREG, and other stakeholders.

The experts held three types of stress tests: "External natural impacts", "Loss of power supply and ultimate heat sink", "Severe accidents management".

Members of the delegation visited more than 50 facilities and systems of the Belarusian NPP related to the ability of the plant to withstand adverse

external natural impacts, studied a large number of documentation, held expert discussions with the representatives of the Belarusian NPP, the Russian design office, Gosatomnadzor and other stakeholders.

ENSREG experts noted the progress of the Belarusian party in the implementation of the National Plan by both the regulator - Gosatomnadzor, and the operator - the Belarusian NPP.

A follow-up IAEA mission on operational safety (Pre OSART) visited the Belarusian NPP on October 25-29, 2021. This IAEA experts visit took place as part of the technical cooperation project "Improving the operational safety of the Belarusian NPP during commissioning and operation".

The previous Pre-OSART mission was in August 2019. During the mission, the experts analyzed the implementation by the Republic of Belarus of the recommendations and proposals on operational safety issued in 2019.

Mission experts worked in 11 areas: "Leadership and Safety Management", "Operation", "Maintenance", "Technical Support", "Training and Qualification", "Radiation Safety", "Chemistry", "Operating Experience Exchange", "Accident Management", "Emergency Planning and Response", "Commissioning".

On November 24, 2021 a plenary meeting of ENSREG was held, in which Gosatomnadzor took part as an observer. During the meeting they discussed the nuclear safety regulation, including the ENSREG Report on the Peer Review of the National Plan, which was finally approved.

The ENSREG Report stated that the National Plan contains all ENSREG recommendations of 2018, which were given after the peer review of the National Report on stress tests of the Belarusian NPP.

17 of 22 recommendations set forth in the ENSREG Report 2018 have been fully implemented and completed. Actions on the other 5 recommendations are still being implemented in accordance with the ENSREG recommendations. Gosatomnadzor and the Belarusian NPP have decreased the timing of implementation of several actions as compared to the original schedule.

ENSREG experts believe that significant progress has been achieved in the implementation of the National Plan. Additionally they pointed out that the Belarusian party has published the National Plan in the public domain.

From November 29 to December 10, 2021 experts from the WANO Moscow Center performed a pre-commissioning peer review of the power unit No. 2 of the Belarusian NPP.

On December 5-13, 2021, the IAEA post-mission on an integrated regulatory review of the infrastructure for nuclear and radiation safety (IRRS post-mission) visited Belarus.

The task of the post-mission was to review the implementation of the recommendations and proposals of the IRRS mission, which was in the Republic of Belarus in October 2016. Within the frames of the mission, a group of experts visited the Belarusian NPP as an observer in the inspection performed by Gosatomnadzor.

The Expert Group concluded that Belarus has made progress in developing the regulatory infrastructure for emergency preparedness and response, based on the recommendations of the 2016 IRRS mission.

According to the head of the IRRS post-mission Georg Schwarz, Belarus has implemented most of the recommendations and proposals represented by the IRRS mission in 2016, which is a significant achievement over a five-year period. The Expert Group commended the actions taken by Belarus to implement the recommendations of the 2016 mission, in addition to those related to emergency preparedness and response

CHAPTER 3
Integrated management and radiation safety assurance policies of the Belarusian NPP

In 2020, the enterprise introduced the Integrated Management System Policy (IMS). The environmental management system is part of the IMS.

In 2021 the Integrated Management System Policy (hereinafter referred to as the IMS Policy) was reissued. The management of the enterprise has assumed obligations to implement the IMS Policy, including the environmental protection through the prevention, mitigation and minimization of possible adverse environmental impacts associated with the activities of the enterprise.

The objectives of the Policy in terms of environmental management are as follows:

– production of electricity and heat while ensuring safety, including environmental safety, as the highest priority;

– rational use of natural resources.

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

Awareness of all new employees of the IMS Policy shall be ensured as part ofbasic training on environmental protection

Implementation of the integrated management system policy in 2021 during the construction of the Belarusian NPP was ensured by:

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

– protection of the environment by preventing, mitigating and minimizing possible adverse environmental impacts associated with the operation of the facility.

Observations in accordance with the “Program of Integrated Environmental Monitoring of the Belarusian NPP” were performed and the parameters of the environment status of the Belarusian NPP were evaluated.

In order to perform industrial environmental control and assess facilities having a harmful effect on the environment, the enterprise developed “Measures for environmental protection of the Republican Unitary Enterprise “Belarusian Nuclear Power Plant” in 2021 and implemented in full:

– an early inventory of production waste was carried out, the Manual for the production waste management was updated, changes were made to the permit for the storage and disposal of production waste;

– due to the changes in the water production, the water demand and concentrations of pollutants, discharged with wastewater were calculated, changes were made to the permit for special water use;

– stationary sources of pollutant emission into the air on the territory of the enterprise were recorded;

– research work “Scientific justification of the allowed release of chemical and other substances standards together with the wastewater discharged by the state enterprise “Belarusian NPP” into the river Viliya” was done to justify the of wastewater discharge by the Belarusian NPP into the river Viliya, taking into account the assimilation capacity of this water body.

2. As an operator and in accordance with the local regulations of the Republic of Belarus in the field of atomic energy use, the Belarusian NPP declares that ensuring radiation safety is also one of the priorities in the area of atomic energy.

The radiation safety policy at the enterprise was implemented on April 22, 2019.

The Belarusian NPP uses the atomic energy in accordance with:

– provisions of the international treaties, agreements and conventions related to radiation safety ratified by the Republic of Belarus;

– provisions of the national legislation of the Republic of Belarus related to radiation safety;

- provisions of the local regulations of the Belarusian NPP related to radiation safety;

– recommendations of the IAEA related to radiation safety.

The goal of the radiation safety policy is to protect people now and in future from the harmful effects of ionizing radiation.

The main task of the radiation safety policy implementation is to create the conditions for the most effective policy implementation.

Implementation of the radiation safety policy the Belarusian NPP follows the next three main principles:

- Prohibition of any use of ionizing radiation sources if the benefit does not exceed the risk of possible harm caused by the background exposure, additional to the natural radiation;

– ensuring that the basic radiation limits are not exceeded;

– control of the lowest possible and achievable level of exposure and the number of exposed persons using ionizing radiation sources, taking into account economic and social factors.

The Belarusian NPP declares that it will consider and support any initiatives of employees aimed at maintaining and improving radiation safety.

CHAPTER 4
Environmental and quality management system

1. In 2021, the independent authority for management systems certification, i.e. the Republican unitary enterprise “Belarusian State Institute of Metrology” confirmed that the environmental management system (hereinafter referred to as the EMS) for the production of electricity and heat of the state enterprise “Belarusian NPP” meets the requirements of the STB ISO 14001- 2017, which is equal to to the international standard ISO 14001:2015. The Certificate of conformity was issued, registered under the No. BY/112 05.10. 003.01 00052.


НАЦИОНАЛЬНАЯ СИСТЕМА ПОДТВЕРЖДЕНИЯ СООТВЕТСТВИЯ РЕСПУБЛИКИ БЕЛАРУСЬ

IAF

Орган по сертификации систем менеджмента
Республиканское унитарное предприятие
«Белорусский государственный институт метрологии» (БелГИМ)
Республика Беларусь, 220053, г. Минск, Старовиленский тракт, 93, кор. 2, к. 28, т. 363-82-33

СЕРТИФИКАТ СООТВЕТСТВИЯ

СТБ ISO 14001

Зарегистрирован в реестре № BY/112 05.10. 003.01 00052

Дата регистрации 28 апреля 2021 г.
Действителен до 28 апреля 2024 г.

Настоящий сертификат соответствия выдан Республиканскому унитарному предприятию «Белорусская атомная электростанция»

(УНП 190919639)

Республика Беларусь, 231201,
Гродненская область, г. Островец,
площадка строительства атомной электростанции

и удостоверяет, что система менеджмента окружающей среды
производства электрической и тепловой энергии
соответствует требованиям СТБ ISO 14001-2017

Руководитель
Органа по сертификации В.Л. Гуревич

№ 0270310

To ensure environmental safety the enterprise is guided by the following basic principles:

– ensuring compliance of the operational activities with legislation and international requirements in the field of environmental protection;

– assessment of the envisaged activity impact on the environment by identifying and assessing the environmental aspects of the activity;

– identification of high environmental risks of the enterprise and development of measures aimed at preventing or reducing the harmful impact of the enterprise on the environment and managing high environmental risks;

– minimization of the negative impact of the nuclear power plant on the environment;

– transparency and accessibility of environmental information.

In order to ensure high environmental performance of the enterprise, the following activities were implemented in 2021:

– approved and put into effect the Guidelines for the environmental management system R SMOS-01-OOOS-2021 Version 2;

– approved and put into effect STP 6.1-OOOS-2021 "Management of environmental aspects, risks and opportunities. Version 2";

– updated process certificate PP ISU 04-OOOS-2021 "Environmental Safety Management";

– updated process goals and risks register PP ISU 04-OOOS for 2022;

– post-implementation review of SMOS for 2021 was carried out.

The departments have analyzed their activities aimed at identification of the environmental aspects, which need updating, and related environmental impacts. The environmental aspects have been assessed and the "Register of Environmental Aspects of the State Enterprise "Belarusian NPP" was created.

Significant environmental aspects were identified and their risk level was assessed.

2. The existing and functioning IMS represents a complex of interrelated documented and manageable processes aimed at achieving target indicators that are implemented in compliance with established requirements.

The IMS of the enterprise contains such aspects of safety as nuclear safety, radiation safety, industrial security, fire safety, engineering safety, nuclear security, environmental safety, labor protection by separation of the relevant processes, as well as such elements as quality assurance, human and institutional factors, socio-economic aspects. The highest priority of the enterprise is to ensure safety.

Within the frames of the IMS, the enterprise has implemented, operates, maintains up to date, and certifies in the National System of Conformity Assessment of the Republic of Belarus the following:

– a 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 facilities of 1-4 complexity classes in accordance with the requirements of STB ISO 9001-2015 "Quality

management systems. Requirements" (certificate of conformity No. BY/112 05.01. 003.01.0098 dated June 10, 2021, valid until December 01, 2022);

– a health and safety management system for professional activities in the field of electricity and heat production in accordance with the requirements of STB ISO 45001-2020 "Health and safety management systems for professional activities. Requirements and implementation guidance" (certificate of conformity No. BY/112 05.04. 003.01.00051 dated 28.04.2021, valid until 28.04.2024);

– environmental management system for the production of electricity and heat in accordance with the requirements of STB ISO 14001-2017 "Environmental control (management) systems. Requirements and guidelines for use" (certificate of conformity No. BY/112 05.10. 003.01.00052 of April 28, 2021, valid until April 28, 2024).

The current IMS includes:

– the IMS policy and goals;

– the IMS policy contains the obligations of the top management to maintain and improve the IMS;

- the organizational structure and staffing table;

- the liability of the personnel (fixed in the Regulations on business units, job/work descriptions, organizational and administrative and other documents of the enterprise);

– the IMS Coordinating Council, the main tasks of which are to coordinate the operation of the enterprise within the IMS, maintain and constantly improve the IMS, follow-up the decisions taken at the meetings of the Coordinating Council;

– Decree No. 26-R dated January 26, 2021 appointed authorized IMS representatives to ensure the compliance of the business units with the IMS;

– IMS documents covering different fields of the enterprise's activity (policies, guidelines, enterprise standards, regulations, process certificates, quality assurance programs for NPP (general quality assurance program, quality assurance program to operate the power units of the Belarusian NPP quality assurance program for handling nuclear materials (nuclear fuel), quality assurance program for handling operational nuclear waste, quality assurance program for handling of radiation sources, etc.);

– the development of programs of quality assurance for the General Contractor during the implementation of the Belarusian NPP project, designing the following quality assurance programs: quality assurance program for designing, quality assurance program for construction and installation, quality

assurance program for commissioning of the power units of the Belarusian NPP;

– revision of existing and development of new documents;

– IMS processes identification;

– process owners and their liabilities identification;

– the IMS process risks analysis and assessment, risk registers and processes risk management programs;

– internal audits of the IMS, including control of compliance with the requirements of quality assurance programs, including preparation of relevant documents (programs, plans, reports, corrective action plans);

– external audits of supplier management systems, including control of compliance with the requirements of quality assurance programs, including preparation of relevant documents (programs, plans, reports, corrective action plans);

- control of compliance with regulatory requirements, corrective measures development for identified non-conformities, and control the implementation and effectiveness of corrective actions;

- routine monitoring of the existing IMS processes and the activities of various departments;

- review by management;

- continuous IMS improvement, etc.

CHAPTER 5
Basic documents regulating the environment protection activities of the Belarusian NPP and radiation-and-environmental monitoring activities

1. “Convention on the Environmental Impact Assessment in a Transboundary Context” (Concluded in Espoo on February 25, 1991).

2. Law of the Republic of Belarus dated July 30, 2008 No. 426-3 (Z) “On the use of nuclear power”.

2. Law of the Republic of Belarus dated November 26, 1992 No. 1982-XII “On Environmental Protection”.

3. Law of the Republic of Belarus dated June 18, 2019 No. 198-3 (Z) “On Radiation Safety”.

4. Code of the Republic of Belarus dated April 30, 2014 No. 149-3 (Z) “Water Code of the Republic of Belarus”.

5. Code of the Republic of Belarus dated July 23, 2008 No. 425-3 (Z) “Land Code of the Republic of Belarus”.

6. 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”.

7. Decree of the Council of Ministers of the Republic of Belarus dated April 28, 2004 No. 482 “On approval of the procedure for monitoring surface water, groundwater, ambient air, local environmental monitoring and the use of these monitoring data as part of the National Environmental Monitoring System in the Republic of Belarus”.

8. Decree of the Council of Ministers of the Republic of Belarus dated May 17, 2004 No. 576 “On approval of the procedure for radiation monitoring and using its data as part of the National Environmental Monitoring System in the Republic of Belarus”.

9. Decree 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, rational use of natural resources”.

10. STB ISO 9001-2015 “Quality management systems - Requirements”. International standard.

11. STB ISO 14001-2017 “Environmental Management Systems. Requirements and guidelines for use”.

12. Other regulatory acts of the national environmental legislation.

CHAPTER 6
System for assurance of technical competence and laboratory inspection independence in accordance with GOST ISO/IEC17025-2019

1. The plant supporting systems department of the Belarusian NPP (hereinafter referred to as PSSD), includes an accredited production laboratory (hereinafter referred to as PL PSSD) (Certificate of Accreditation No. BY/112 2.4928 dated May 19, 2017), which meets the criteria of the National Accreditation System of the Republic of Belarus and is accredited for compliance with the requirements of GOST ISO/IEC 17025-2019 “General requirements for testing and calibration laboratories”.

The PL PSSD is accredited to analyze the drinking water quality as follows: sampling (GOST 31862-2012), flavor (GOST 3351-74 п. (p.) 2), taste (GOST 3351-74 п. (p.) 3), color (GOST 31868-2012 (method B), turbidity (GOST 3351-74 п. (p.) 5), pH index (STB ISO 10523-2009), total hardness (GOST 31954-2012 (method A), ferrum (GOST 4011-72 п. (p.) 2), dry residue (GOST 18164-72 п. (p.) 3.1), permanganate index (STB ISO 8467-2009), total

microbial count (MUK RB 11-10-1-2002 п. (p.) 8.1), thermotolerant coliform bacteria (MUK RB 11-10-1 -2002 п. (p.) 8.2), common coliform bacteria (MUK RB 11-10-1-2002 п. (p.) 8.2), sulfite-reducing clostridia spores (MUK RB 11-10-1-2002 п. (p.) 8.4).

Also in 2021, PL PSSD expanded the scope of its accredited activities to analyze the quality of surface and waste water as follows: sampling (GOST 31861-2012, STB 17.13.05-29-2014 / ISO 5667-10:1992, STB 10-2009 / ISO 5667-6:2005), mass concentration of hydroxyethyledene-bisphosphonic 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 D), total ferrum (STB 17.13.05-45-2016), pH index (STB ISO 10523-2009). On-site assessment to expand the scope of accredited activities was performed on November 2021 for the following indicators for waste and surface water: chemical oxygen demand (PND F 14.1:2:4.190-2003), phosphate ion (GOST 18309-2014 method B) , ammonium ion (STB 17.13.05-09-2009 / ISO 7150-1:1984), nitrite ion (STB 17.13.05-38-2015), nitrate ion (STB 17.13.05-43-2015), chloride ion (STB 17.13.05-39-2015), sulfate ion (STB 17.13.05-42-2015), synthetic surfactants (PND F 14.1:2:4.158-2000), oil products (PND F 14.1 :2:4.128-98), temperature (MVI.MN 5350-2015).

The PL PSSD plans to expand the scope of accredited activities for waste and surface water in 2022 for the following three indicators: biochemical oxygen demand, phenols, the Kjeldahl nitrogen.

2. The design documentation of the Belarusian NPP provides for creation of departments to monitor the radiation of the environment in the SPZ and OZ of the Belarusian NPP as part of the radiation monitoring system. These departments include the automated radiation monitoring system (ARMS) and the radiation monitoring laboratory (RML) of the radiation safety division, which is accredited in the National Accreditation System of the Republic of Belarus in compliance with the requirements of GOST ISO/IEC 17025-2019 “General requirements for testing and calibration laboratories” (Certificate of Accreditation No. BY/112 2.5262 dated January 22, 2021 and No. BY/112 1.1824 dated September 10, 2021).

ARMS is intended for continuous monitoring of the radiation in the SPZ and OZ of the Belarusian NPP. The ARMS software and hardware includes 10 radiation control stations, 9 of which are located in the territory of the OZ and 1 at the control point outside the territory of the OZ (settlement of Svir), an automated weather station (settlement of Vornyany), 2 mobile radiometric laboratories, the main central control station (CCS ARMS in the Belarusian NPP site) and the backup central control station (CCS ARMS in Ostrovets).

RML is intended for periodic laboratory monitoring of the radionuclides content in environment (ambient air, atmospheric precipitation, precipitation, soil, groundwater, surface water, bottom sediments, aquatic and ground vegetation) in the SPZ and OZ of the Belarusian NPP, as well as in local agricultural products and food products (vegetables, fruits, milk, meat, fish, etc.).

CHAPTER 7
Industrial ecological observations

On the basis of Article 94 of the Law of the Republic of Belarus "On Environmental Protection" dated November 26, 1992 No. 1982-XII 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 "On approval of procedure for developing and approval of manuals for the industrial ecological observations, rational use of natural resources" all the necessary local documents and monitoring schedules have been developed for the observations in the field of environmental protection:

– Guidelines for the observations in the field of environmental protection, rational use of natural resources at the Belarusian NPP;

– Guidelines for the production waste management at the Belarusian NPP;

– Procedure for radiation control of the Belarusian NPP;

– Program for radiation monitoring of the environment in the sanitary-protection zone and the observation zone of the Belarusian NPP;

– Guidelines on radioactive agents emissions and discharges from the Belarusian NPP;

– Observation schedules for local monitoring;

– Observation schedules for the pollutant emissions into the air from stationary sources;

– Map of the sources of pollutant emission into the air for local monitoring;

– Map of observation wells as part of local groundwater monitoring;

– Map of harmful sources affecting the environment, including the points of testing and sampling.

The main tasks of industrial environmental surveillance at the Belarusian NPP are as follows:

– control the implementation and compliance with the requirements of the environmental legislation of the Republic of Belarus;

– rational use of natural resources;

– control over the state of environment in the area, where it falls under the impact of economic activities connected with the construction of the Belarusian NPP;

– recording the classification and quantity of pollutants released into the environment as a result of economic and other activities;

– provision of up-to-date and reliable information about the environment state and pollution to be submitted to the state environmental control authorities, including the emergencies caused by economic and other activities of the Belarusian NPP;

– participation in the development and implementation of the state (republican, industrial, local and other) programs and activities on the rational use of natural resources and environment protection aimed at preventing and eliminating environmental pollution;

– control over the operation of the environmental protection equipment and structures;

– awareness raising system establishment and development, environmental education and fostering of the ecological culture, as well as training and retraining of specialists in the field of environmental protection.

Certificates of industrial environmental control or Instruction acts (in case there are comments) are made up based on the results of production environmental surveillance.

The facilities of industrial environmental control include:

– construction site of the Belarusian NPP, including utility networks (service water supply, power supply, etc.);

– production facilities, which are in free use by the general contractor JSC “ASE”;

– production facilities, which are in use by the Belarusian NPP;

– housing facilities, which are in free use by the general contractor JSC “ASE”;

– housing facilities, which are in use by the Belarusian NPP;

– water supply sources (underground water supply in the Losha river basin; surface water intake from the Viliya river) and water discharge (surface-water body of the Viliya river; service water body of the Losha river basin - evaporation pond in the territory of military unit 7434);

– production and consumption waste sources: workshops, sites, technological processes and processing pahases;

– emissions of pollutants into the atmospheric air by stationary (auxiliary boiler, block-modular gas boiler house) and mobile pollution sources;

– wastewater discharges into water bodies, including sewerage systems and water discharge networks, wastewater treatment systems;

– surface water in the area of wastewater discharge sources;
– groundwater near identified or potential sources of pollution;
– lands (including soils) near identified or potential sources of pollution;
– vegetation.

Analytical (laboratory) control of environmental protection is established and implemented at the Belarusian NPP by accredited testing laboratories.

The objects of analytical observation zone:

– pollutants emission into the atmospheric air from stationary and mobile emission sources;

- water supply and water discharge system.

In accordance with the supplement to the Decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus dated January 11, 2017 No. 5, the Belarusian NPP has been included in the list of legal entities performing local monitoring since July 22, 2020. Local monitoring objects are:

– pollutant emissions into the atmospheric air from technological and other equipment, technological processes, machines, mechanisms (4 sources of emissions from boiler units);

– wastewater discharged into the surface water bodies and surface water in the area of wastewater discharge sources (the wastewater outlet in the Viliya river, background and monitoring sections on the Viliya river);

- groundwater in the vicinity of identified or potential sources of pollution (3 observation wells on the territory of the enterprise);

– soils (grounds) in the vicinity of identified or potential sources of their pollution (2 test sites on the territory of the enterprise and in its sanitary-protection zone).

CHAPTER 8
Environment impact

1. Air protection

The total volume of pollutant emissions established in the inventory reports and in the emissions permit No. 02120/04/00.1093 dated December 19, 2019 is 85.09 tons/year (excluding the gravitational object of mobile emission sources). The actual gross emission of pollutants released into the atmospheric air from all stationary sources of emissions in 2021 amounted to 9.89 tons, which was 11.6% of the established total value. The ratio of actual pollutant emissions in 2021 against the total permitted volume is shown in fig. 8.1 in tons per year.

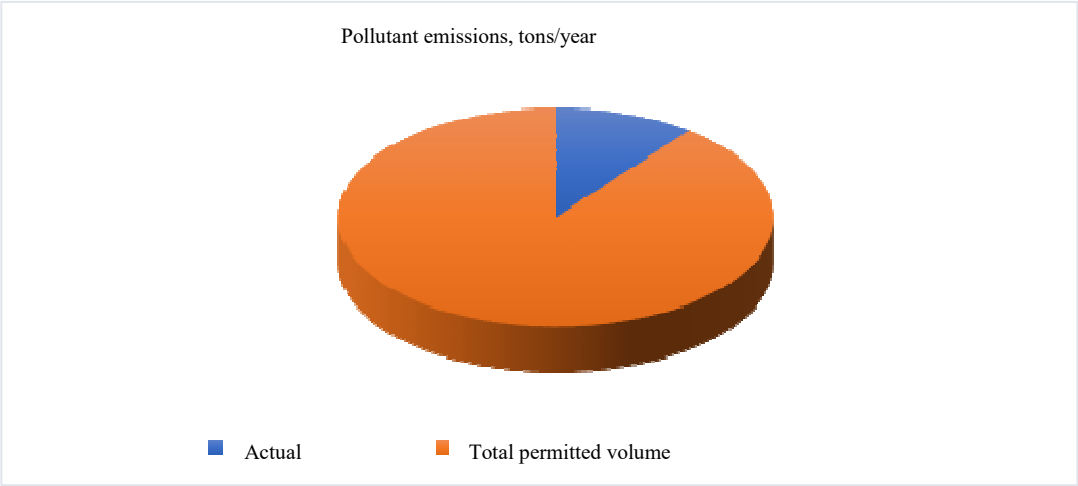


Figure 8.1 - The ratio of actual emissions into the atmosphere in 2021 against the total permitted volume, tons per year

The main sources of actual total pollutant emissions into the atmosphere are the auxiliary boiler (AB) and the block-modular gas boiler house (BMGB).

The dynamics of pollutant emissions from the main sources of the enterprise in comparison with previous years is shown in fig. 8.2.

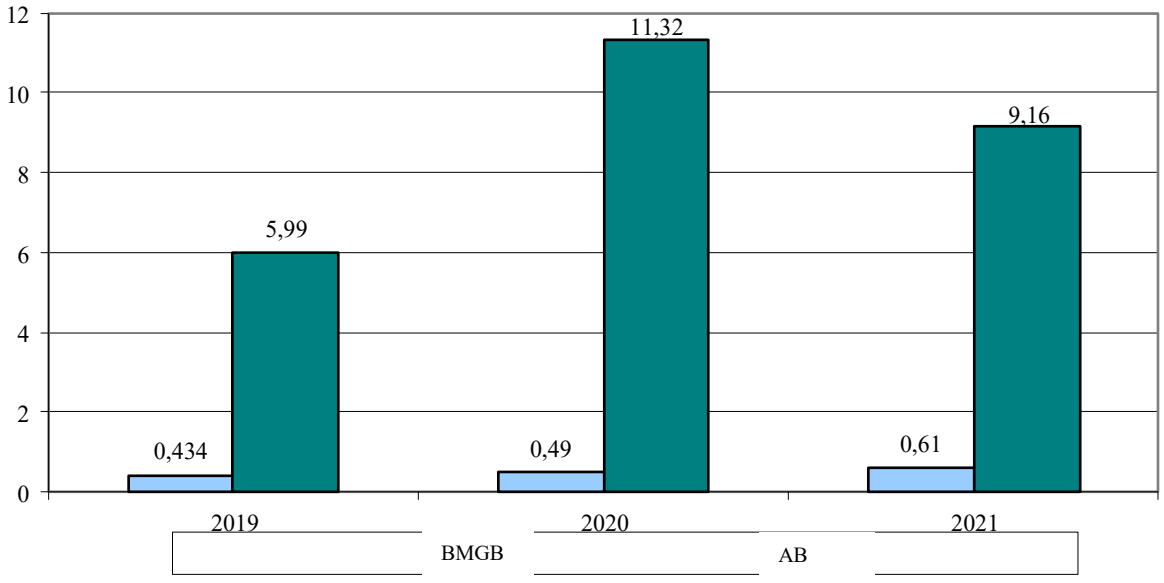


Figure 8.2 - Dynamics of pollutant emissions from the main sources of the enterprise, tons per year

The reduction in emissions in 2021 from the AB compared to the previous year is due to the commissioning of power unit No. 1 and the transfer of the AB to the stand-by condition.

The emissions of the enterprise contain pollutants of 1-4 hazard classes, while the substances of the 1st hazard class amount to 0.00124%, the substances of the 2nd class - 54.9%, the substances of the 3rd class - 17.17%, the substances of 4th class and without hazard class – 27.96%. The break-down of pollutant emissions into the atmosphere by hazard class in 2021 is shown in fig. 8.3.

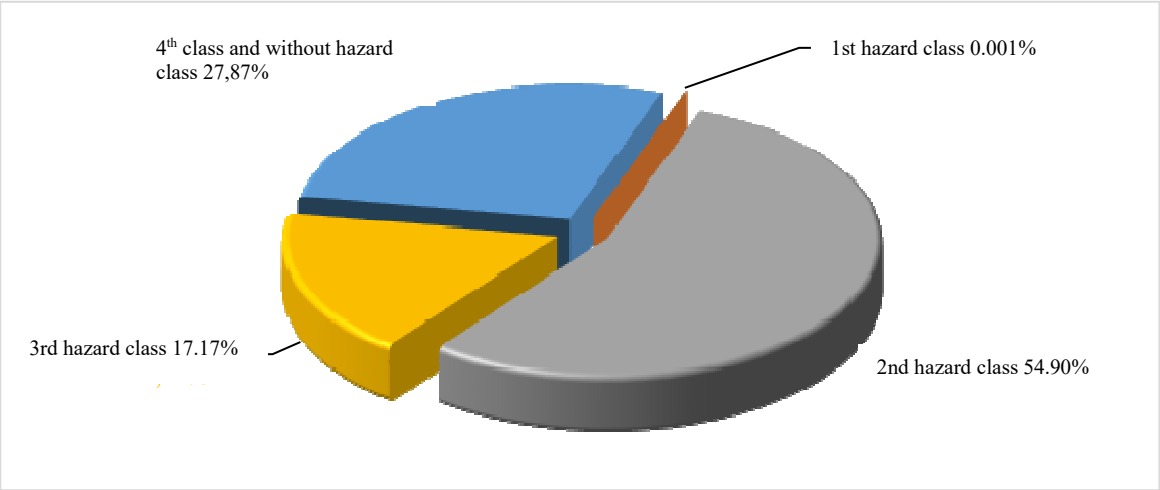


Figure 8.3 - The composition of pollutant emissions into the atmosphere in 2021

In 2021 the state institution “Republican Center for Analytical Control in the Field of Environmental Protection” was contracted to perform an analytical (laboratory) control of pollutant emissions from the following facilities: AB, gas distribution plant and the boiler house of the military station. 8 measurements of pollutant emissions were carried out and 8 protocols of environmental protection measurement were drafted during the reporting period.

The maximum one-time emissions for any of the pollutants were not exceeded in any of the cases.

2. Waste management

At the Belarusian NPP, in accordance with the Law of the Republic of Belarus dated July 20, 2007 No. 271-3 “On Waste Management”, the generated production waste was collected separately.

In 2021 an early inventory of production waste was carried out, standards for the generation of production waste were developed, a new “Guidelines for the management of production waste at the Belarusian NPP” was developed and

changes were made to the Permit for the storage and disposal of production waste.

During the reporting period, the enterprise generated 79.709 tons of production waste (in 2020 - 68.011 tons). 0.756 tons are in interim storage, including mercury-containing waste in the amount of 388 pieces.

The production waste classification by hazard classes for the current year is shown in fig. 8.4.

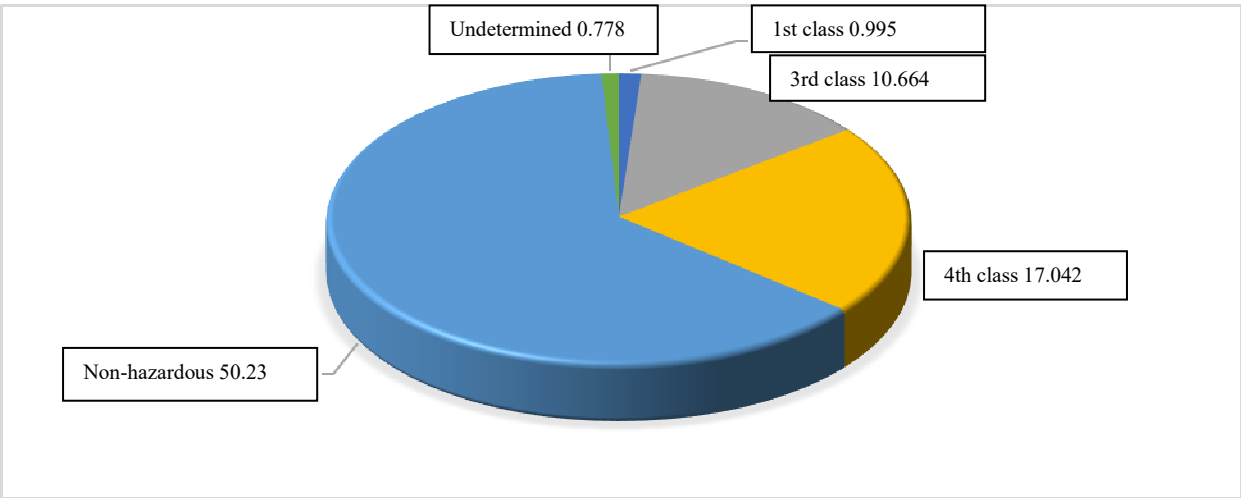


Figure 8.4 - Production waste classification by hazard classes for 2021, tons

In the reporting year, production wastes were transferred to recycling and landfilling facilities in accordance with permits and concluded agreements, as well as to the interim storage sites.

The dynamics of the production waste transfer to the recycling, neutralization and landfilling facilities in comparison with the previous year in tons is shown in fig. 8.5.

The share of secondary raw materials in the total amount of transferred waste amounted to 33% (in 2020 - 46%).

The increase of the waste transferred for disposal is due to an increase in the number of employees of the enterprise.

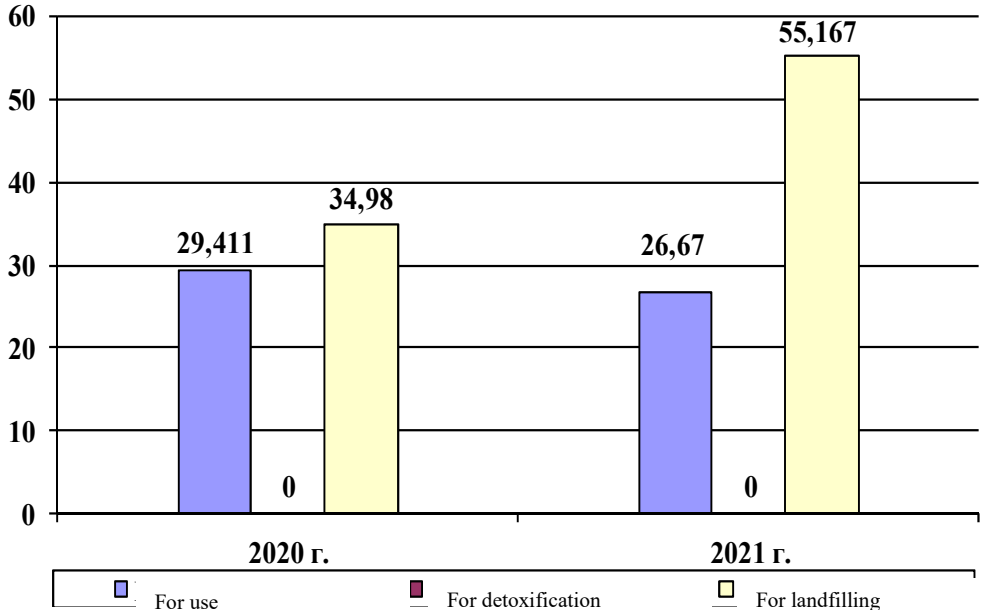


Figure 8.5 - Dynamics of the transfer of production waste to the recycling, neutralization and landfilling facilities, tons

3. Use and protection of water resources

Water consumption and water disposal was carried out in accordance with the limits established in the permit for special water use No. 04.12.0397 dated February 8, 2019, as amended on January 17, 2022 No. 151, and did not exceed the design values.

The water consumption in 2021 compared to previous years is shown in Table 8.1.

Table 8.1 - Water consumption and water discharge in 2021

Indicator	Design value		Amount, thousand m^3		
	m^3/day	thousand m^3/year	2019	2020	2021
1 The volume of produced and received water, total	193,649.8	70,682.2	630.72	5,527.435	29,567.801
including: 1.1 from surface water	188,390.1	68,762.4	329.66	5,203.416	29,228.883
1.2 from groundwater	3500.0	1277.5	180.44	167.357	176.857
1.3 from other sources (drinking water supply system of Ostrovets)	1759.7	642.3	120.62	156.662	162.061
2 Water used for:					
2.1 household needs	29.6	10.8	86.45	152.426	204.947
2.2 production	100.0	36.5	2.92	2.507	15,173.021

(technological) needs					
2.3 other uses (losses and unaccounted water consumption, including during transportation)	0.0	0.0	0.0	0.0	0.0
3 Transferred to other organizations	193520.3	70634.9	541.35	5366.676	14,365.976

In accordance with paragraph 676 of the supplement to the Decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus No. 5 dated January 11, 2017, since July 22, 2020 the Belarusian NPP was included in the list of legal entities to carry out local monitoring at the 3 observation points (the point of wastewater discharge in the Viliya river, background and control sections at the Viliya river)

Analytical quality control of drinking and wastewater was performed by an accredited production laboratory of theplant's supporting systems department (Certificate of Accreditation No. 112 2.4928 dated May 19, 2017 till May 19, 2022). In addition to those third-party accredited laboratories were contracted to perform the full scope of observations.

In the period from January to December 2021, in accordance with agreements with the state institution “Republican Center for Analytical Control in the Field of Environmental Protection” and the state enterprise “SPC for Geology”, 22 studies of waste and surface water samples were performed at 3 local monitoring points and 84 protocols of measurements in the field of environment protection were registered.

During this period the laboratory studies of waste and surface water samples were carried out within the frames of local environmental monitoring for the following water quality indicators: pH value, water salt content, suspended solids, ammonium ion, total ferrum, potassium, calcium, magnesium, sodium, nitrate ion, nitrite ion, total phosphorus, total nitrogen, oil and oil products in dissolved and emulsified state, sulfate ion, phosphate ion, chloride ion, zinc, biochemical oxygen demand BOD_5 , chemical oxygen demand, dichromate oxidizability COD_{Cr} , synthetic anionic surfactants, aluminum, manganese, copper, lead, phenol, 1-hydroxyethylidene diphosphate (4-) zinc disodium salt (hydroxyethylidene diphosphonic acid zinc disodium salt; HEDP-Na_2 Zn; disodium salt of the zinc complex of hydroxyethylidene diphosphonic acid; ethanol-1,1-diphosphonate zinc disodium salt; ethylidene diphosphonic acid zinc disodium salt).

According to the observations no exceeding was identified in the reporting period.

4. Groundwater protection

In 2021 3 observation wells of the enterprise were included in the list of observation points for local environmental monitoring.

Groundwater monitoring in the vicinity of identified or potential sources of pollution includes the following types of work: groundwater level monitoring; groundwater temperature monitoring; groundwater chemical composition. Chemical analysis included the identification of mineralization, water hardness, dry residue, free and aggressive CO_2, O_2 oxidizability, ions Cl^-, SO_4^{2-}, HCO_3^-, CO_3^{2-}, NO_2^-, NO_3^-, NH_4^+, Ca^{2+}, Mg^{2+}, Na^+, K^+, Fe^{2+}, Fe_{total}, pH, SiO_2.

In December 2021 BelHydrotekhproekt Limited Liability Company was contracted to perform one study of groundwater samples from 3 observation wells and one protocol for measurements in the field of environmental protection was drafted.

According to the observations no exceeding was identified in the reporting period.

5. Plant world

In 2021 the General Contractor has developed design solutions for landscaping in the territory within the SPZ.

In the reporting year in accordance with the "Law of the Republic of Belarus dated June 14, 2003 No. 205-3 (Z) On the Flora":

– the order "On those responsible for keeping records of plants and handling them" dated August 24.2021 No. 304-p (r) was issued;

– on the basis of the "Certificate of Inspection of Plants" dated September 10, 2021, trees in poor condition were removed from the territory of the housing stock of the Belarusian NPP, of which Ostrovets District Executive Committee was properly notified. Compensatory measures have been taken: other plants have been planted instead of the removed trees;

– green areas of limited use were accounted for and properly registered. The information about the plants in the territory of the Belarusian NPP was submitted to the national cadastre of flora.

6. Comprehensive environmental monitoring

In 2021, comprehensive environmental monitoring was carried out at the Belarusian NPP site.

Specialized accredited organizations of the Republic of Belarus and the Russian Federation were contracted to perform these works.

According to the program of integrated environmental monitoring of the Belarusian NPP the following types of monitoring were carried out in 2021:

– monitoring of the groundwater dynamics;

– monitoring of atmospheric processes, phenomena and factors, including, weather and microclimate observations;

– aerological monitoring;
– observations of the surface waters dynamics;
– seismological monitoring;
– geodesic monitoring of the modern crustal movements;
– monitoring of ground-level air pollution, terrestrial and aquatic ecosystems, water bodies, the state of aquatic biological resources;
– radiation monitoring.

6.1. Groundwater monitoring

In 2021 the groundwater monitoring included three types of activities: groundwater level monitoring; groundwater temperature monitoring; groundwater chemical composition and its potential pollution. Chemical analysis included the identification of mineralization, water hardness, dry residue, free and aggressive CO_2, O_2 oxidizability, ions Cl^-, SO_4^{2-}, HCO_3^-, CO_3^{2-}, NO_2^-, NO_3^-, NH_4^+, Ca^{2+}, Mg^{2+}, Na^+, K^+, Fe^{2+}, Fe_{total}, pH, SiO_2.

The monitoring was performed on the properly equipped observation wells (piezometric observation network of wells consists of 26 well clusters) (fig. 8.6).

Figure 8.6 - Piezometric well cluster

Groundwater dynamics was determined based on the results of groundwater monitoring in 2021.

The site has been and still remains in the groundwater transit and recharge area. Groundwater flow direction is the same during periods of maximum and minimum levels of. Static (piezometric) levels of the Sozh end-morainic aquifer within the site and near it are established at depths from 14.32 m to 23.15 m, at absolute elevations from 163.91 m to 156.46 m. The difference between the minimum and maximum groundwater levels over all wells in 2021 ranged from

0.10 m to 0.86 m. The average amplitude of groundwater levels in 2021 was 0.49 m, which does not exceed the design value.

The temperature fluctuations in 2021 correspond to the background and range from +7.1°C (February 10, 2021) to +11°C (July 30, 2021). Natural increase during the warm period and a decrease during the cold period confirms the lack of recharge due to the defrosted waters of the water supply communications.

The dependences of groundwater temperature on air temperature demonstrate the synchronism, while the groundwater temperature dynamics is smoother, which is explained by the greater inertia of water as compared to the air and confirms the lack of recharge due to the defrosted waters of the water supply communications (fig. 8.7).

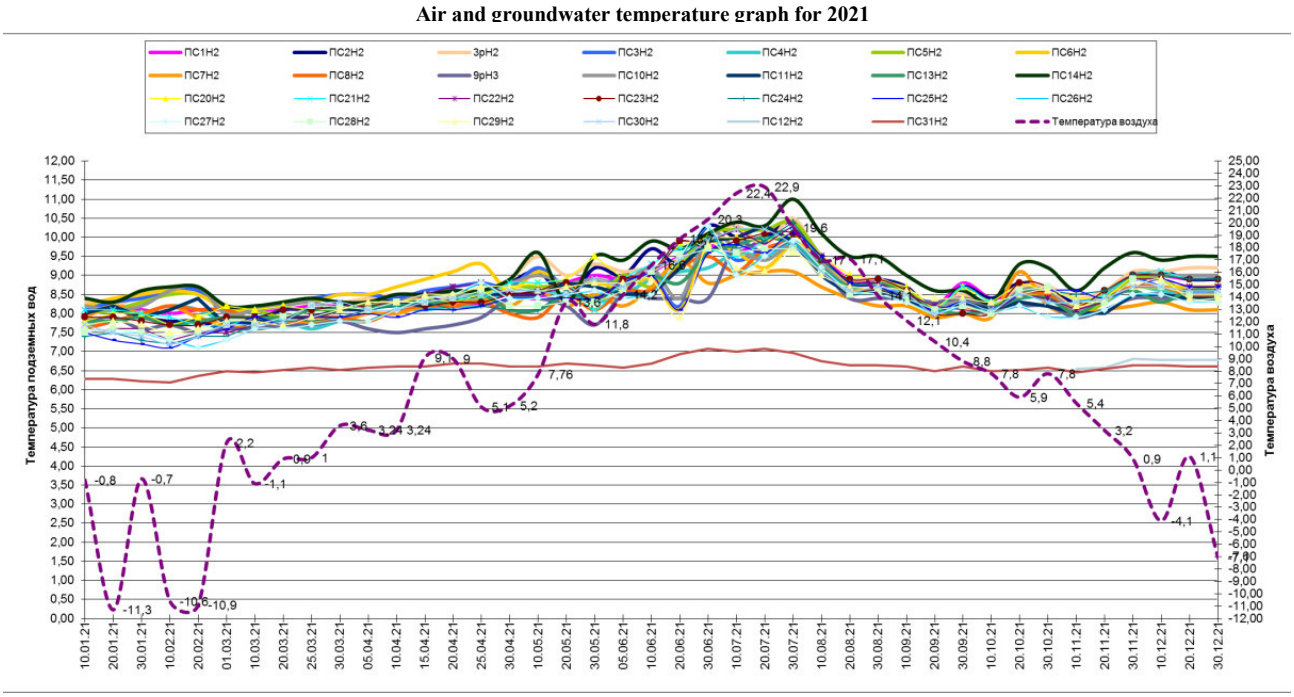


Figure 8.7 – Graph of dependence of groundwater temperature on air temperature

The dependence of groundwater levels on precipitation demonstrates the following (fig. 8.8):

1. during the period of solid atmospheric precipitation, the level of groundwater naturally slightly decreases;

2. the groundwater level rises in May-June, when the two parelle process are observed at the same time: spring snowmelt and maximum liquid precipitation;

3. The dynamics of the groundwater level indicates the absence of “hydrogeological windows” in the site and in the adjacent territory, through which groundwater can be intensively recharged due to atmospheric precipitation infiltration and through which harmful chemicals enter the groundwater.

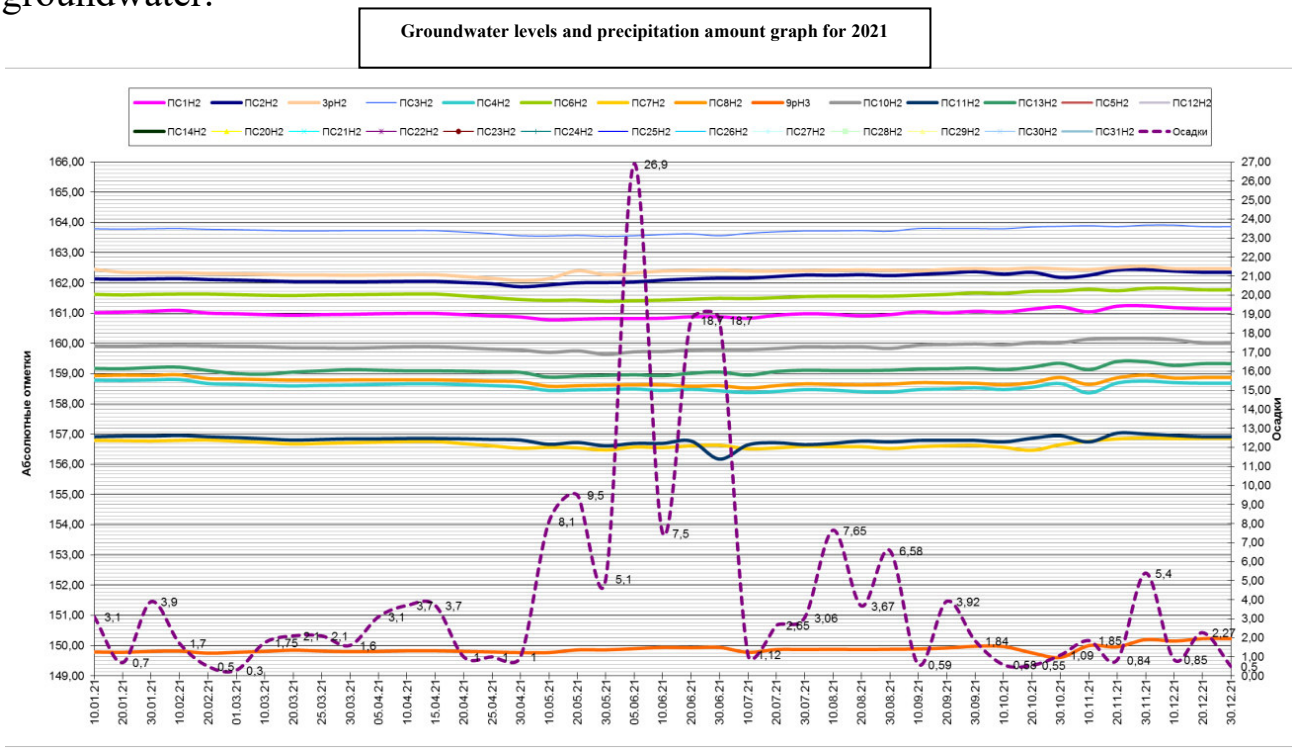


Figure 8.8 - Graph of the dependence of the groundwater level on the amount of precipitation

By the chemical composition the waters are fresh, mainly chloride-hydrocarbonate calcium-magnesium having salinity from 0.055 g/dm^3 to 0.27 g/dm^3, mostly soft and very soft - the total hardness is from 0.80 to 3.70 degrees of hardness, the pH value varies from 6.70 to 9.70, which does not exceed the design values.

The pollution of groundwater with anthropogenic pollutants (NO_3 and Cl) remains at the pre-construction level and is due to agricultural activity in the area near the nuclear power plant. They continue to arrive at the site as transit from adjacent territories.

In general, during the monitoring period, the chemical composition of groundwater remains relatively stable. Surface contamination of groundwater due to the technological cycle of the Belarusian NPP, was not identified. Regular change in the acid-base balance of the horizon waters from season to season remains at the level of background values.

6.2. Monitoring of meteorological processes, phenomena and factors

In 2021 meteorological parameters monitoring were taken 8 times per day by the “Markuny” meteorological station, and a number of other special observations were performed: gradient observations of air temperature and humidity, wind speed at heights of 0.5 and 2 m; observations of ice and frost, measurements of deep soil temperature, observations of evaporation from the water surface (fig. 8.9 and 8.10).

Figure 8.9 - Markuny meteorological station

In 2021 the average air temperature according to the Markuny meteorological station was 6.8°C, and the soil temperature was 8.1°C. The coldest month of 2021 was February with an average monthly air temperature of - 7.1°C, the hottest was July with an average temperature of 21.6°C. The absolute maximum air temperature equal to 34.1°C was noted on July 16, and the absolute minimum was observed on February 19 and amounted to minus 27.1°C.

Relative humidity during the year is 82%. The largest number of days with relative air humidity above 80% within 15 hours was fixed in December and amounted to 26 days.

The average wind speed within a year is 2.6 m/s, the maximum wind speed was 19 m/s. The lowest atmospheric pressure, which is characteristic to hurricanes were not noted, since neither at the Markuny meteorological station nor at similar stations the hurricanes were registered.

During the year precipitation level amounted to 842 mm, the maximum daily precipitation was 59.1 mm. Showers of more than 30 mm/h intensity were not fixed. The amount of intensive solid precipitation exceeding 20 mm per 24 hours was not fixed during the entire observation period. In 2021 ice and frost were fixed at the Markuny meteorological station 21 times, of which 16 were crystal hoarfrost and 4 cases of ice-covered ground.

Figure 8.10 - Measuring tools at the Markuny meteorological station

The available meteorological data from the Markuny station obtained for the short period of 2015-2021 are not sufficient to make conclusions about the climatological conditions in this area, and we can only seek updating the extreme meteorological data.

The average air temperature during seven years at Markuny is slightly higher than the long-term average values at the Oshmyany and Lyntupy meteorological stations. For example, the average annual air temperature at the Markuny meteorological station for the period from 2015 to 2021 was 7.6°C, which is by 1.5 and 1.9°C higher than the long-term average air temperature at the Oshmyany and Lyntupy meteorological stations, respectively.

An air temperature of 34.1°C (2021) was recorded at the Markuny meteorological station, which is very close to the absolute maximum air temperature values recorded at the Oshmyany and Lyntupy stations for the long-term period until 2018.

The relative air humidity at the Markuny station is very close to the long-term values at the Oshmyany and Lyntupy stations.

The average annual precipitation at the Markuny meteorological station was 696 mm, which is inbetween the long-term average annual precipitation at the Oshmyany and Lyntupy stations.

The daily maximum precipitation recorded from 1962 to 2019 at Oshmyany station was 101 mm. The daily maximum precipitation recorded from 1959 to 2018 at Lyntupy station was 80 mm. During the monitoring period from April 2015 to 2021 the maximum daily precipitation registered at Markuny station was 59.1 mm.

The average monthly wind velocity values during five years at the Markuny meteorological station are close to the long-term average values at the Lyntupy station.

The maximum gust at Oshmyany and Lyntupy stations for the period from 1987 to 2018 is 25 m/s and 30 m/s, respectively. The maximum gust at the Markuny meteorological station from 2015 to 2021 was 23 m/s.

6.3. Microclimate monitoring

In 2021 microclimate monitoring was performed in the area of the Belarusian NPP. Microclimate monitoring was carried out at 10 points of the two sections. One section of Chekhi - Bobrovniki is aligned from east to west, the other Mikhalishki - Chekhi is from north to south (fig. 8.11). The monitoring has been performed 2 times a day at 06:00 and 18:00 at 5 points of each section.

Figure 8.11 - Microclimate monitoring point

According to the monitoring results, the combined graphs of the air temperature curves demonstrated that the air temperature at the markers and at the meteorological station (MS) Lyntupy, MS Markuny are almost the same (the difference between the values does not exceed 1.0°C in average).

In the morning hours (from May to December) and in the evening (from March to November) the air temperatures at the MS Lyntupy are slightly colder than at the markers and at the MS Markuny.

The combined curves of the air temperature at the markers showed: that during the monitoring of 2015 - 2021 the lowest air temperatures were fixed in January 2016: - 9.6 °C (morning) and - 7.4 °C (evening); the highest air temperatures were recorded in the evening in July 2021 (25.5 °C) and in the morning in July 2018 and July 2021 (16.5 °C). The winter of 2019-2020 (December 2019 and January, February 2020) can be classified as abnormally warm, since the air temperature had positive values (above 0.0 °C) (fig. 8.12).

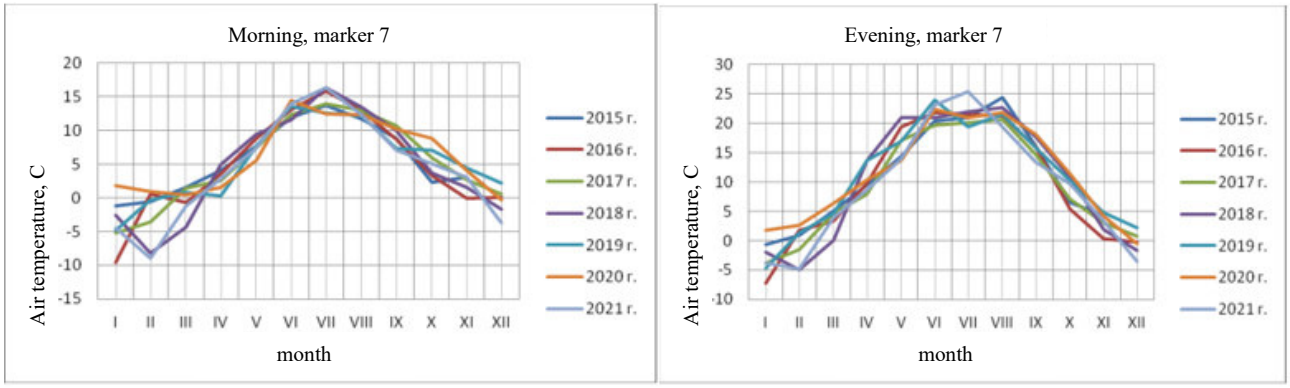


Figure 8.12 - Combined curves of the air temperature at marker 7 during the period of 2015-2021

Combined curves of relative air humidity at the markers during 2015–2021 showed that the driest month in the morning (with the lowest relative humidity) was September 2018 (60% relative humidity). The driest evening values during the entire monitoring period were observed in April 2019 (38% relative humidity). The wettest years (with the highest average annual relative air humidity) were 2020 in the mornings (relative air humidity 91%), and 2017 in the evenings (relative air humidity 77%) (fig. 8.13).

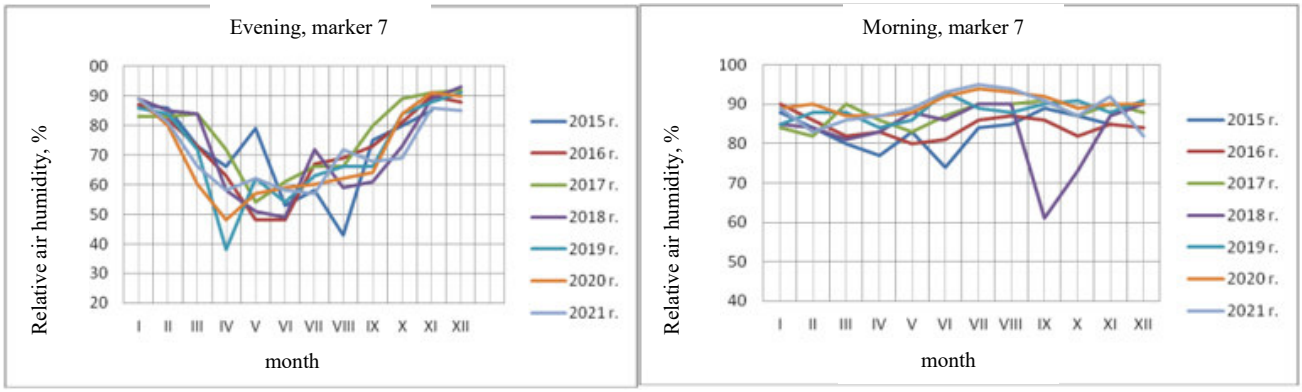


Figure 8.13 - Combined curves of the relative air humidity at marker 7 during 2015-2021

The combined curves of the wind speed at the markers demonstrated: during 2015-2021 the highest wind speeds were fixed in the morning in February 2020 (3.1 m/s) and in the evening in March 2019 (4.3 m/s) (fig. 8.14).

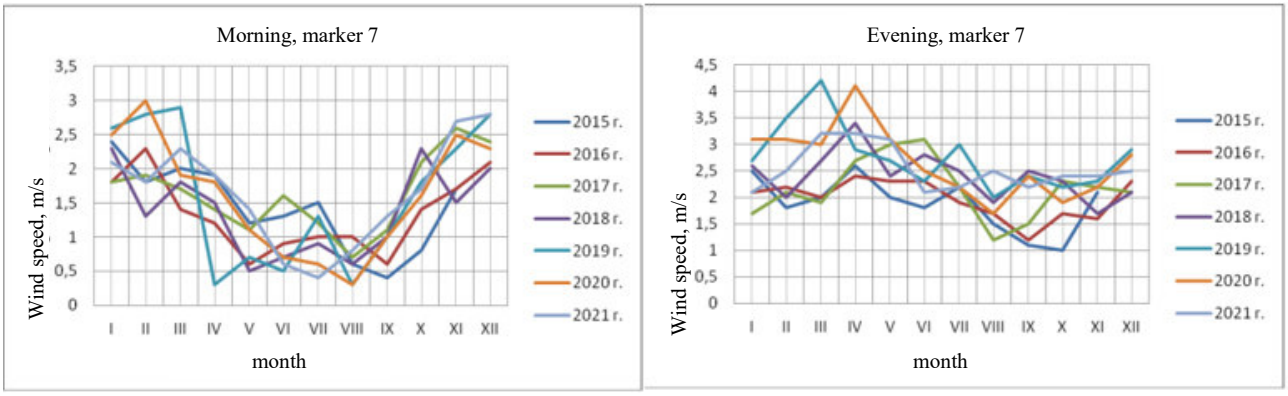


Figure 8.14 - Combined curves of the wind speed at marker 7 during 2015-2021

It ought to be noted that the meteorological information of the MS Lyntupy and Oshmyany have been taken in due account in the design. Comparison and analysis of microclimatic monitoring in the area of the Belarusian NPP was based on the data of surface meteorological observation of the MS Lyntupy, located about 33 km northeast of the NPP, and the MS Markuny located in close proximity to the NPP. It revealed a close connection between the data of microclimatic observations over the two profiles of the MS Markuny (air temperature, relative air humidity, wind speed). Comparative analysis using the MS Lyntupy data revealed a close connection with the profile marker data only in terms of air temperature.

During the construction of the Belarusian NPP the reliable data about the microclimatic patterns of the surrounding area became the basis for the analysis

of impact of the Belarusian NPP in operation. Further microclimatic observations along the routes will make it possible to identify changes being a result of heat and moisture emissions from cooling systems.

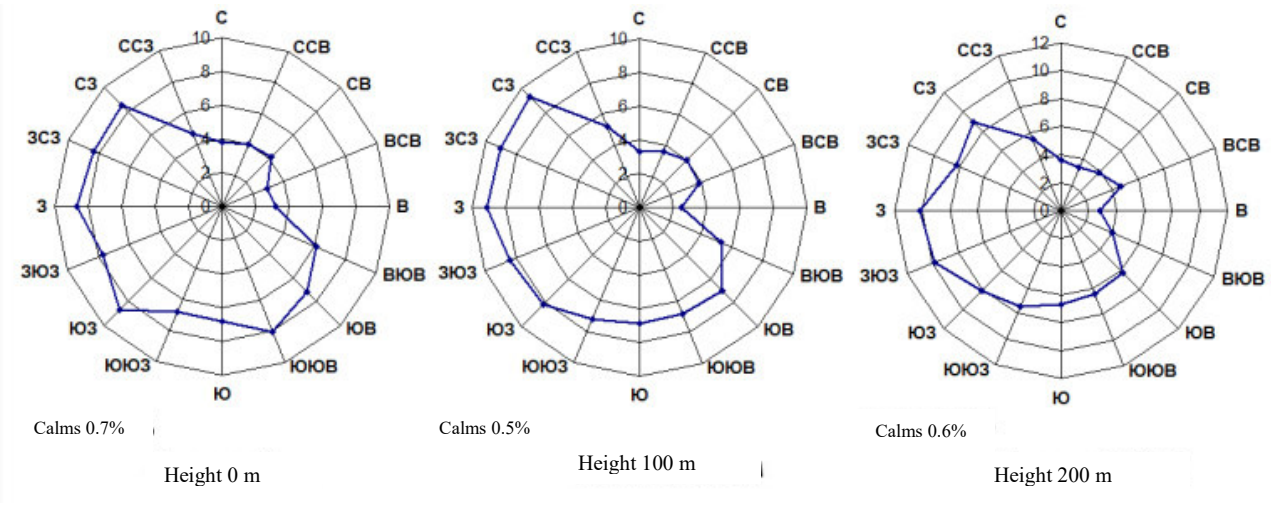
6.4. Aerological monitoring

The aerological monitoring of the atmospheric boundary layer status (hereinafter referred to as the ABL) at the site of the Belarusian NPP was performed in 2021. Observations were carried out using the SODAR / RASS measuring complex (fig. 8.15).

Figure 8.15 – SODAR measuring complex

The results of 2021 observations demonstrated that the temperature lapse rate is positive and varies for layers 0-300, 0-600 and 0-900 m within 0.74 - 1.52°C/100, where raised inversions predominate. The total frequency of the negative stability classes (E and F) is insignificant and in general amounted to only about 7% during a year. The calculated data show that the most negative conditions for the pollutant ventilation in the ABL can affect the environment and the population at all stages of the NPP life cycle in spring and in summer. However, even in these periods the occurrence of the negative stability classes E and F is insignificant. The average wind velocity is moderate and in general

winds of the western and north-western directions prevail throughout the year (fig. 8.16).



С	N
ССВ	NNE
СВ	NE
ВСВ	ENE

В	E
ВЮВ	ESE
ЮВ	SE
ЮЮВ	SSE

Ю	S
ЮЮЗ	SSW
ЮЗ	SW
ЗЮЗ	WSW

З	W
ЗСЗ	WNW
СЗ	NW
ССЗ	NNW

Figure 8.16 – Average wind roses in 2021

Data of remote zoning of the ABL status accumulated over 6 full years makes it possible to identify the patterns of year-to-year changes in the atmospheric dispersion features. According to the data for 2015-2021 it can be stated that the temperature lapse rate is positive and varies within 1.29-1.85 C/100 m. This pattern of temperature lapse rate indicates significant the ABL turbulence, which contributes to intense dispersion of radionuclides. Classes B, C and D prevail during the entire observation period, which confirms favorable conditions for the dispersion of radionuclides. The wind increases strongly on vertical gradient and its speed typical values vary within 1-4 m/s. In the long-term prospective the year-to-year variations of the wind speed are insignificant and commensurate with the accuracy of its measurement. The winds of the west-southwest direction prevail during the entire period of monitoring.

Thus, in general, during the period 2015-2021 there is a relative year-to-year stability of the main average annual atmospheric dispersion features.

6.5. Surface water observations

The level, runoff, ice, thermal regimes and water turbidity was observed in the rivers of Viliya, Stracha, Gozovka and Polpe in 2021. No dangerous hydrological phenomena were observed at all water measuring posts during 2021 (fig. 8.17).

Figure 8.17 - Water gauge station

Based on the level regime monitoring in 2021 it was revealed that the maximum water levels at all water gauge stations were fixed from January 2021 to April 2021 during the spring flood. The minimum water levels at all water gauge stations were fixed from June 2021 to August 2021.

The water level of the Viliya river near the settlement of Malye Sviryanki varies from 202 mBS to 319 mBS. The average water level in 2021 was 245.3 mBS (fig. 8.18).

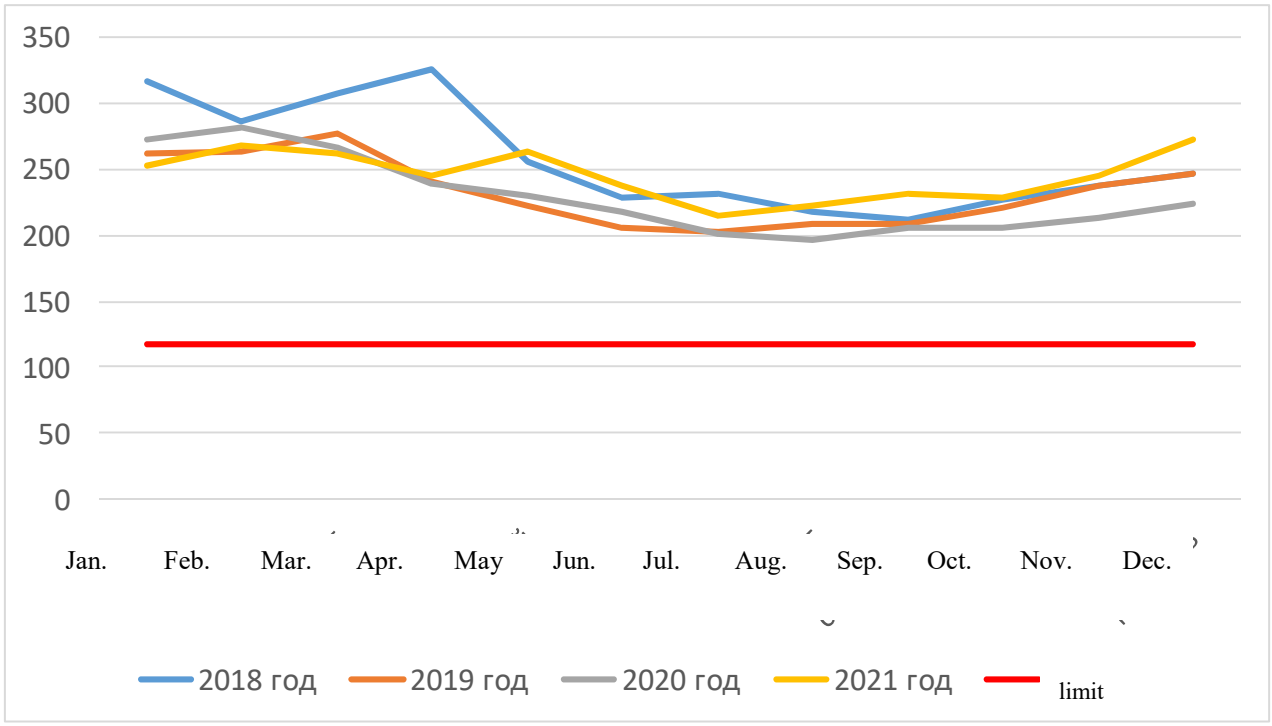


Figure 8.18 - Water level measurement at the water gauge station of the Viliya river (settlement Malye Sviryanki) in 2018-2021, mBS

According to the temperature regime monitoring in 2021 it was revealed that the maximum water temperatures at all water gauge stations were fixed within the period from June 2021 to August 2021, and the minimum values - in February 2021.

The average seasonal water temperature in the Viliya river during “winter-autumn” period varies in the range from 0°C to 26.6°C, at that the maximum observed average daily water temperature was 26.6°C (fig. 8.19).

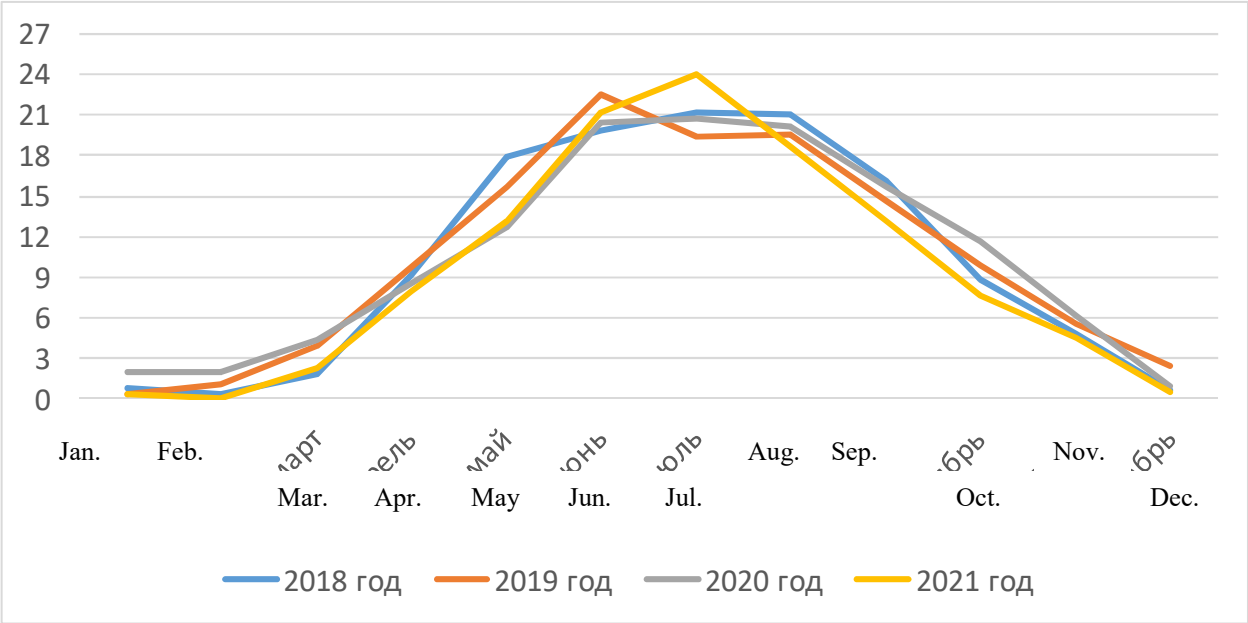


Figure 8.19 - Water temperature measurements at the water gauge station of the Viliya river (settlement Malye Sviryanki) in 2018-2021, °C

The runoff regime observations demonstrated that the water flow in the Viliya river in the settlement of Malye Sviryanki varied from 33.1 m^3/s to 97.5 m^3/s. The fluctuation of water flow data is due to the natural processes (start of the spring flood, meteorological event). The average water consumption in 2021 was 53.26 m^3/s (fig. 8.20).

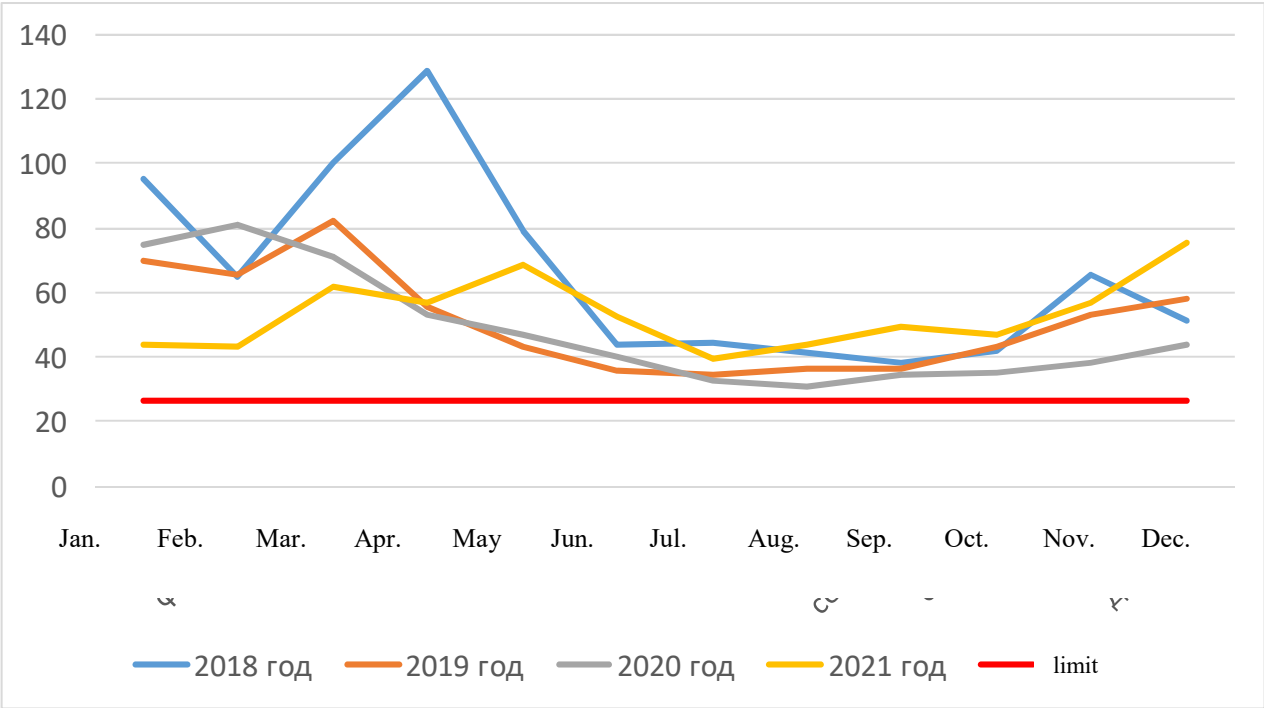


Figure 8.20 - Water consumption measurements at the water gauge station of the Viliya river (settlement Malye Sviryanki) in 2018-2021, m^3/s

According to the observations of the ice regime it should be noted that in the winter of 2020-2021 the unstable ice phenomena (a rare frazil ice drift and unstable shore ice) on the Viliya, Gozovka and Polpa rivers were fixed throughout the entire observation period. Continuous stable freeze-up formed only during the period from February 18 to the middle of the third decade of February. Also at the beginning of winter 2021-2022 there was no stable ice detected at any of hydrological gauges due to the absence of the long-term negative air temperatures.

The Viliya river flow rate near settlement of Malye Sviryanki changed from 33.1 m^3/s to 97.5 m^3/s. The Viliya river average flow rate in 2021 was 0.62 m/s.

At all phases of the hydrological regimen in 2021 the water samples were obtained at four water gauge stations (Viliya river, Stracha river, Gozovka river, Polpe river) to analyze the chemical composition including the following indicators: physical properties of water, suspended solids, hardness, water-dissolved gases, pH, principal ions, biogenic substances, Si, Fe, biochemical oxygen demand (5 days), oil products, synthetic surfactants, phenols, heavy metals, pesticides.

According to the analysis results the river waters are classified as weakly alkaline (based on the A.M. Nikanorov classification), the pH varied in the range from 7.6 to 8.3.

The content of dissolved oxygen met the established quality standards and varied from the minimum in the Gozovka river near the settlement of Goza (5.59 mgO_2/dm^3) to the maximum in the Gozovka river near the settlement of Goza (12.84 mgO_2/dm^3).

The content of easy oxidizable organics (BOD_5 - the amount of oxygen consumed during the biochemical oxidation within 5 days period) did not exceed the quality standards established for watercourses used for breeding, feeding, wintering and migration of salmonids - Viliya, Gozovka and Stracha rivers (3.0 mgO_2/dm^3), as well as for other watercourses - the Polpe river (6.0 mgO_2/dm^3).

The content of organic substances resistant to oxidation (according to COD_{Cr}) met the quality standard in all of the studied watercourses during the summer low water period. The content of the main biogenic substances (nitrogen and phosphorus compounds) met the established quality standards.

6.6. Seismological monitoring

Monitoring of the seismic parameters in the vicinity of the Belarusian NPP is based on a temporary local observation network (7 monitoring 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 emitted by natural and artificial sources of seismic vibrations, registering seismic events in a wide range of epicentral distances and power (fig. 8.21).

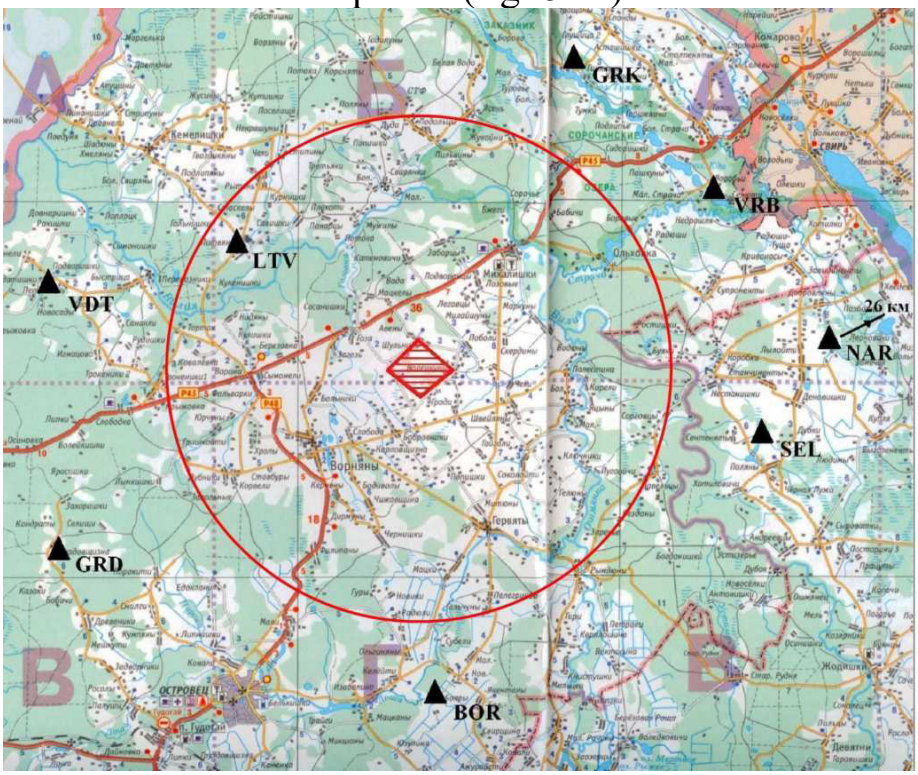


Figure 8.21 - Layout of seismic stations in the vicinity of the Belarusian NPP

Legend:

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

During the reporting period the distant, regional and nearby earthquakes, as well as man-made seismic events (explosions) were recorded based on the data from the network. There were no local events registered within the 30 km area around the NPP site during the reporting period.

The catalog of distant earthquakes contains data of 2,873 earthquakes, of which 183 were earthquakes of magnitude M≥6.0. The catalog of regional earthquakes (R = 301–1000 km) contains data of 95 earthquakes. The catalog of nearby earthquakes (R = 30–300 km) contains data of 59 earthquakes. The catalog of man-made seismic events includes 137 explosions.

Earthquakes in the vicinity of the NPP were registered in the southern part of Belarus (Salihorsk mining area), epicentral distance of which is 200 to 300 km to the site of the Belarusian NPP. These earthquakes epicenters are located in the Pripyat non-linear seismogenic superzone of the earthquake sources. The concentration of earthquake epicenters is observed in the Central

Pripyat seismogenic area (Mmax =3.5; h = 5 km; I = 4-5 score) and in two seismogenic subzones: Luban (Mmax = 4.0; h = 5 km; I = 5–6 score) and Berezinskaya (Mmax = 4.5; h = 10 km; I = 6–7 score). The magnitude range of the registered earthquakes in the vicinity of the NPP is M=1.1–2.9, which does not exceed the seismotectonic potential of the earthquake areas, where their epicenters are located.

The earthquakes that had the greatest seismic impact on the NPP site in 2021 have the following parameters: The maximum acceleration and the maximum intensity data was obtained for a remote earthquake of 6.2 magnitude in Greece on March 3, 2021, which amounted to 0.0511 cm/sec^2 (0.51×10^{-4}g) and 1.0, respectively. As for a regional earthquake in Poland on January 11, 2021 the maximum acceleration and the maximum intensity amounted to 0.0155 cm/sec^2 (0.16×10^{-4}g) and -0.3, respectively. As for an earthquake in Belarus on September 3, 2021 with a magnitude of 2.9, the maximum acceleration and the maximum intensity data was 0.0099 cm/sec^2 (0.01×10^{-4}g) and -1.0, respectively.

Thus, in 2021 the maximum intensity of the seismic impact on the NPP were registered for a remote earthquake that occurred in Greece with a magnitude of 6.2 and amounted to: peak acceleration of 0.0511 cm/s^2 (0.51×10^{-4}g), estimated score 1.0.

The calculations of the intensity of seismic impacts on the Belarusian NPP from remote, regional earthquakes and earthquakes in the vicinity of the NPP recorded by the local seismological network in 2021 showed that they are significantly lower than design values, which are for the design earthquake DE - 6 score, for the maximum design earthquake MDE - 7 score.

In 2021 an additional observation point was established in the Oshmyany area near the epicenter of the 1908 Gudogai earthquake. The new point, as well as the entire local network registered remote, regional earthquakes and earthquakes in the vicinity. There were no local earthquakes registered within the 30 km area of the Belarusian NPP site and within the Oshmyany fault. The seismicity catalog for the area of the Belarusian NPP was updated, which included the study of domestic and foreign materials and materials of international data centers on regional seismicity in the western part of the East European Platform and in the area of the Belarusian NPP. Based on these studies the catalogs of historical, instrumentally recorded earthquakes and technogenic seismic events (explosions) with M≥1.0 were updated for the area of the Belarusian NPP (300 km). The works are still going to create a permanent (stationary) local network of seismological observations for the period of the Belarusian NPP operation. Organizational, technical and design work is currently being carried out.

6.7. Geodetic monitoring of the modern crustal movements

Monitoring of the modern crustal movements includes determination of the horizontal and vertical component of movements.

In 2021 the horizontal crustal movements were monitored on the basis of the GPS technology method. The modern satellite geodetic technologies (GPS measurements) to determine points location in different periods of time made it possible to determine the horizontal shifts with a millimeter accuracy.

The satellite geodetic network was created at 18 points, of which 15 are deep benchmarks, 1 ground benchmark and 2 points with a forced centering device (tours).

Field measurements of the geodynamic area were carried out once a year.

According to the monitoring for 2021 it was revealed that the average annual rate of horizontal crustal movement ranged from 13.7 to 24.6 millimeters per year, where average value of 19.1 millimeters per year does not exceed the accepted tolerance. The average direction of movement is to the northeast along the azimuth of 59°. According to the measurement data in 2021 the horizontal movement velocity gradients ranged from 2×10^{-9} to 4×10^{-7} 1/year.

Calculated for the period 2012-2021 (9.01) the speed of the horizontal crustal movement points are in the range of 24.3 - 25.9 millimeters per year, when average estimated value is 25.2 millimeters per year. The average shifts direction by cycles is to the northeast azimuth from 55° to 69° (fig. 8.22, 8.23).

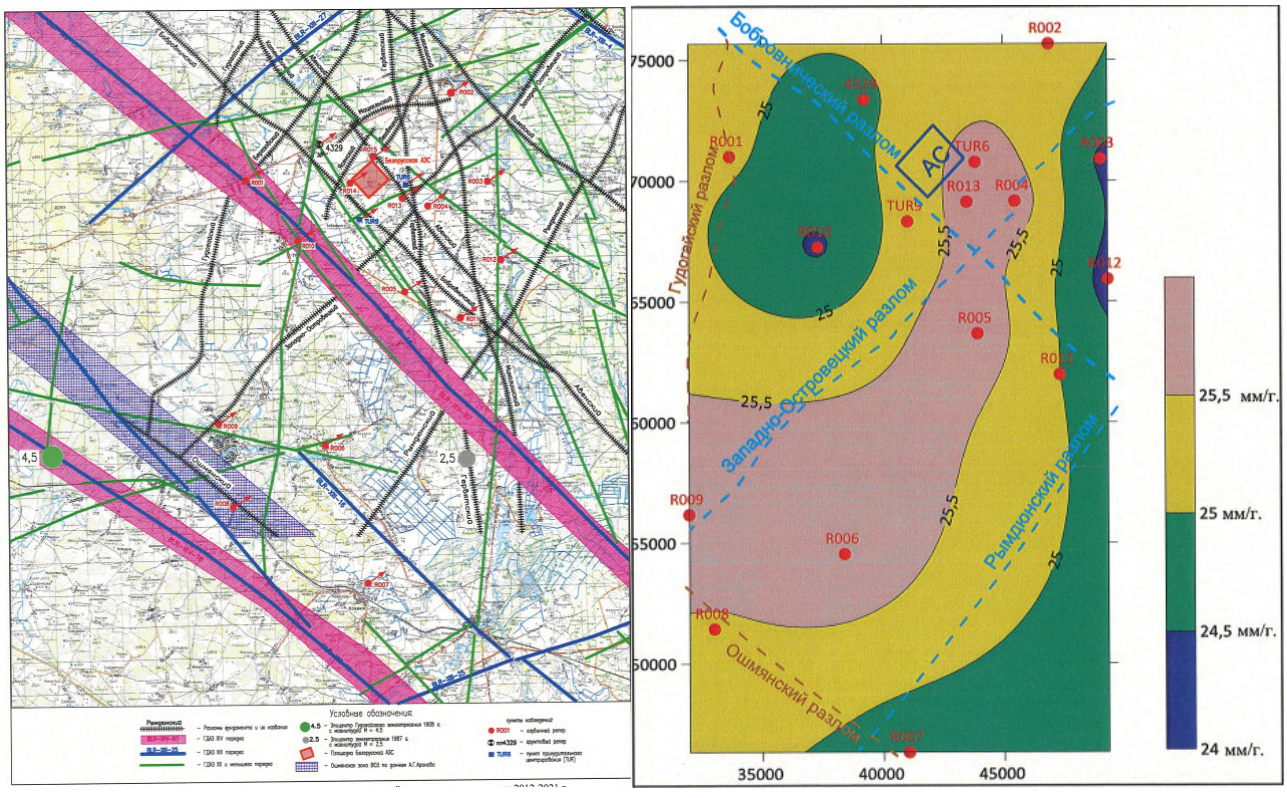


Figure 8.22 - Directions of horizontal crustal movement within the period of 2012-2021

Figure 8.23 - Distribution of the rates of horizontal crustal movement recorded within the period of 2012-2021

Гудогайский разлом	Gudogai fault
Бобровнический разлом	Bobrovniki fault
Западно-Островецкий разлом	West-Ostrovets fault
Рымдюнский разлом	Rumdiuny fault
Ошмянский разлом	Oshmyany fault
АС	Power plant

The design of the Belarusian NPP contains critical thresholds for modern movement, which is 50 millimeters per year for horizontal shifts. The rate of shifts measured in the study area does not exceed these values.

An analysis of the observations of the horizontal crustal movements in 2021 suggests that the values and direction of horizontal movements at the geodynamic area of the Belarusian NPP coincide with the general movements of the East European Platform.

In 2021 the vertical crustal movements were observed using high-precision leveling of the Class I.

Class I leveling was performed in the forward and reverse directions, while observing the equality of distances from the level to the rails along two pairs of transition points, which formed two separate lines. Measurements at observation points were carried out once a year.

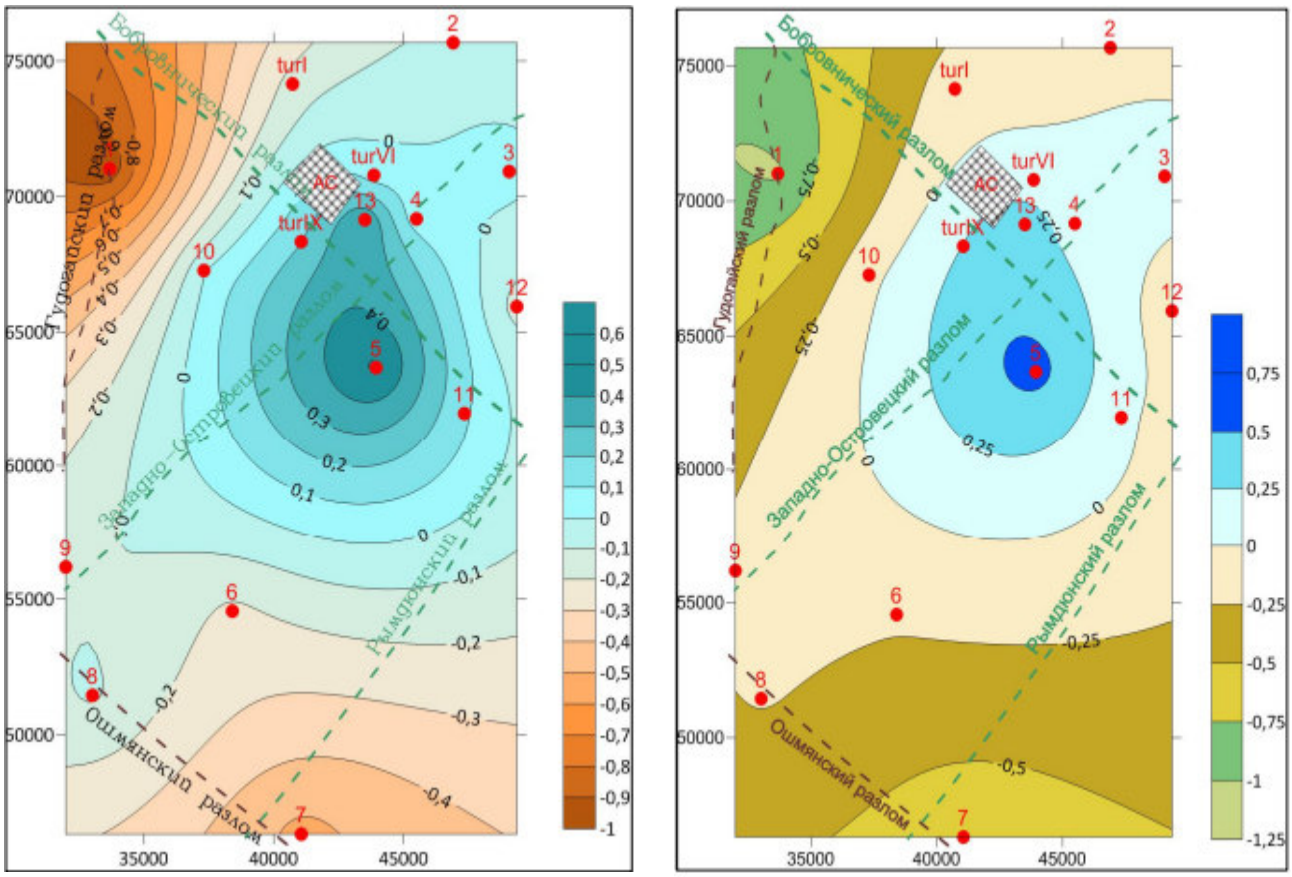
The total length of the network is 141,780 km. There are 73 separate lines between points, which form 6 closed areas, average perimeter of which is 31.1 km (tolerance 40 km). The network is fixed with 13 deep benchmarks, 42 ground benchmarks, 9 wall marks, 3 TUR-type centers and 2 temporary benchmarks. The total number of points is 69.

Analysis and evaluation of the monitoring of vertical crustal movements and velocities for 2021 showed that the velocities of vertical movements of points ranged from (+2.0) to (+3.0) millimeters per year. Consequently, the rates of vertical shifts of the points of the geodynamic area are within acceptable limits (do not exceed 10 millimeters per year).

The vertical movements velocity gradients in the observation area were calculated in 2021 and ranged from 0.0 to 1.8×10^{-7} 1/year. The general gradient of the vertical shifts rate for the entire territory of the geodynamic area for 2021 amounts to 2.6×10^{-8} 1/year, and the general gradient of the shift rate of the geodynamic area ranged from 1.9×10^{-8} to 4.9×10^{-8} 1/year. The direction changes slightly, which indicates the absence of geodynamic processes for the reporting period (2021).

Based on observation data for 2012 - 2021 the general values of the vertical rate of movement of the geodynamic area points ranged from (0.83) to (+0.37) millimeters per year. In the area of the NPP the rate of movement ranged from 0.0 to (+0.2) millimeters per year.

Weighted average values of inter-cycle shifts of the network points range from (+0.59) to (-0.97) millimeters per year (fig. 8.24, 8.25).



a) b)

Figure 8.24 - Distribution of weighted average values of vertical movements of points and velocities in the period of 2012 - 2021

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

Гудогайский разлом	Gudogai fault
Бобровнический разлом	Bobrovniki fault
Западно-Островецкий разлом	West-Ostrovets fault
Рымдюнский разлом	Rumdiuny fault
Ошмянский разлом	Oshmyany fault
АС	Power plant

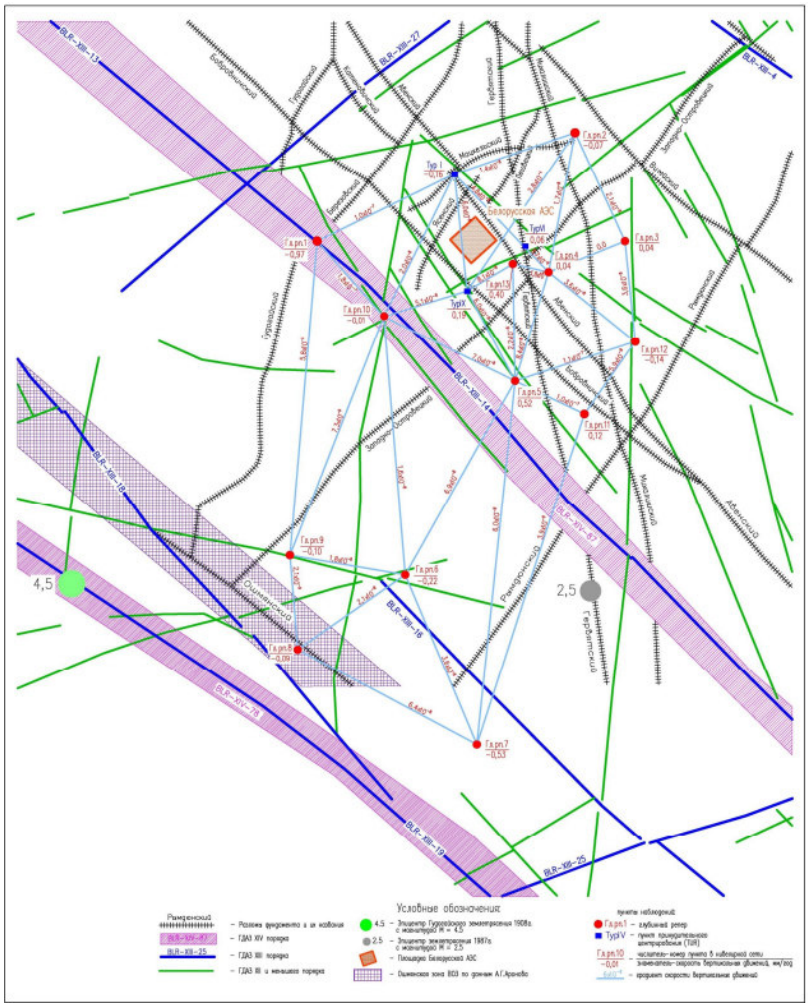


Figure 8.25 - Velocity gradients of vertical movements at the geodynamic area of the Belarusian NPP in the period of 2012 - 2021

Based on the data obtained it should be concluded that the directions, distances and stability criteria of geodynamic monitoring points are stable, the values of partial accelerations do not exceed the criteria and indicate the absence of geodynamic processes in the area of the Belarusian NPP.

6.8. Monitoring of ground-level air pollution, terrestrial and aquatic ecosystems, water bodies pollution, the state of aquatic biological resources

In 2021 the sampling of atmospheric air, soil, water and bottom sediments, lab analysis of pollutants was done; the state and (or) degree of pollution of the atmospheric air, terrestrial and aquatic ecosystems was assessed; the monitoring of flora, fauna and fish fauna in the OZ of the Belarusian NPP was performed.

6.9. Radiation monitoring

The radiation monitoring in the SPZ and OZ of the Belarusian NPP was carried out in 2021 in accordance with the Program for radiation monitoring of

the environment in the sanitary-protection zone and observation zone of the Belarusian NPP and the Procedure for radiation control of the Belarusian NPP.

The main tasks of radiation monitoring include:

– continuous systematic monitoring of the level of radioactive contamination of environment in the SPZ and OZ;

– obtaining the necessary, sufficient and reliable information about the exposure in the SPZ and OZ of the Belarusian NPP;

– assessment of the current status of environmental radiation monitoring in the SPZ and OZ of the Belarusian NPP and analysis of its dynamics;

– assessment of external population exposure residing in the OZ of the Belarusian NPP;

– forecasting radiation changes in the SPZ and OZ.

Local rate of gamma exposure

The results of radiation monitoring in 2021 showed that the exposure rate at the observation points and at the posts of the automated radiation monitoring located near the Belarusian NPP construction site were in the range of 0.05 - 0.12 μSv/h, which corresponds to the background values of this parameter.

Aerosols in the ground-level of atmosphere *(fig. 8.26)*

The values of the total beta activity in the single samples of radioactive aerosols of the ground-level of atmosphere in 2021 were in the range of (3.0 - 33.8) × 10^{-5} Bq/m^3, which corresponds to the background values established during expedition surveys in 2008-2019. The levels of ^{137}Cs in the composite samples of radioactive aerosols taken in 2021 met the previously established background values and were in the range of (0.02 - 0.25) × 10^{-5} Bq/m^3.

In 2021 the content of ^{3}H in the ground-level air did not exceed the values of the minimum detectable activity (MDA) (<0.29 - <0.61 Bq/m^3), the volumetric activity of ^{14}C was in the range of 0.045 - 0.164 Bq/m^3, which corresponds to the natural radiation levels.

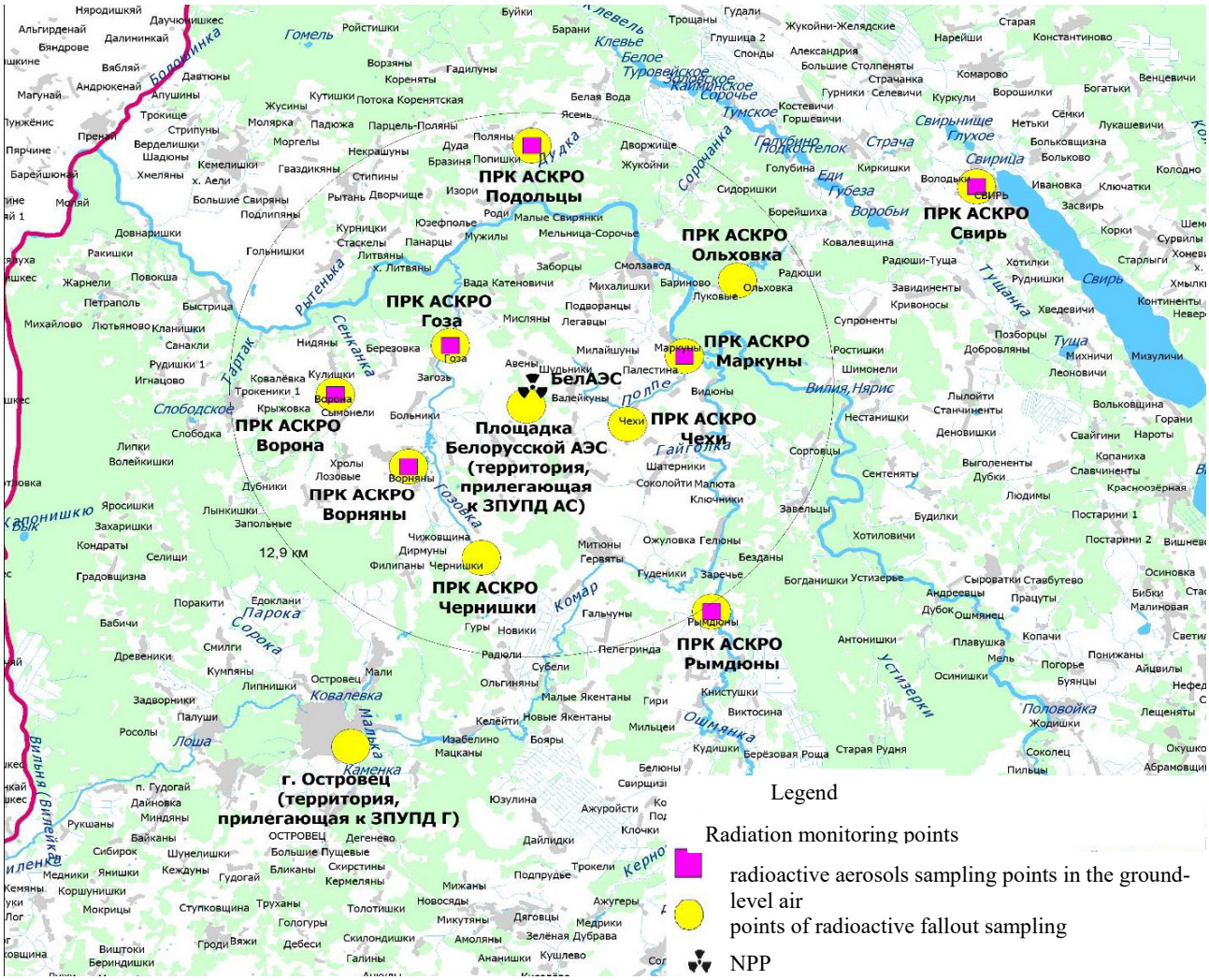


Figure 8.26 - Layout of the air radiation monitoring points near the Belarusian NPP

Radioactive fallout

The total beta activity in atmospheric fallout samples in 2021 corresponded to the average long-term established values for this region and ranged from 0.02 to 0.62 Bq/m^2 a·day.

The content of ^{137}Cs in monthly fallout samples in 2021 was below the MDA (<0.014 - <0.036 Bq/m^2·a day), which corresponds to the previously established background values.

Surface water (fig. 8.27)

The values of total beta activity in surface water samples in 2021 met the background values established during expeditionary surveys in 2008-2019 for this region, and were in the range of 0.05 - 0.22 Bq/dm^3.

The levels of ^{137}Cs, ^{90}Sr and ^{3}H in surface water samples in 2021 were within the previously established values and did not exceed 0.009 Bq/dm^3 for ^{137}Cs and ^{90}Sr, as well as 4.0 Bq/dm^3 for ^{3}H.

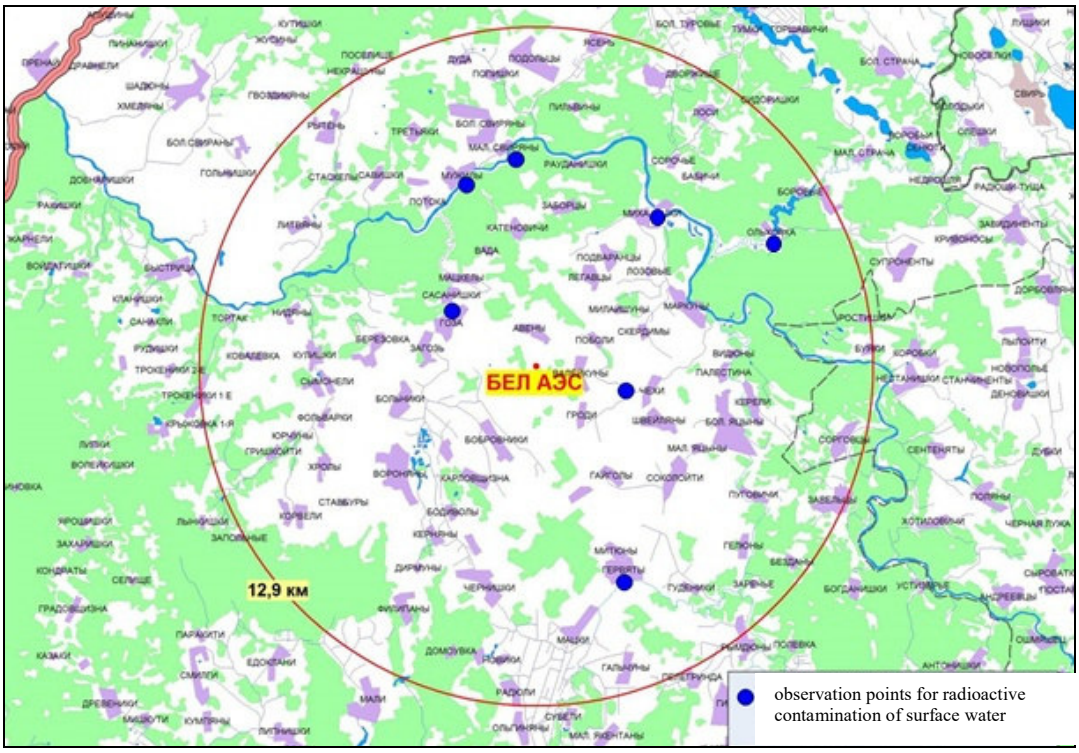


Figure 8.27 - Layout of observation points for radioactive contamination of surface water

Ground and drinking water

Based on the studies in 2021, it was found that the levels of ^{90}Sr in all groundwater samples from observation wells located at the Belarusian NPP site did not exceed the MDA values. The levels of this radionuclide in the samples taken from wells in the settlements of the OZ also did not exceed the MDA in most cases. The volumetric activity of ^{90}Sr exceeding MDA levels were recorded only at two observation points in the settlement of Malye Sviryanki (0.011 Bq/dm^3) and the settlement of Nidyany (0.019 Bq/dm^3) in August 2021.

The content of ^{137}Cs in most of the samples was also below the MDA. The content of ^{3}H in the pits and observation wells did not exceed 4.9 Bq/dm^3 and 6.34 Bq/dm^3 respectively.

Thus, the content of ^{137}Cs, ^{90}Sr and ^{3}H in all groundwater samples from pits and wells was significantly lower than the reference levels of radionuclides in drinking water, established by the Hygienic Standard "Criteria for assessing radiation exposure", approved by the Decree of the Ministry of Health of the Republic of Belarus on December 28, 2012 No. 213.

Hydrological network (bottom sediments, aquatic and coastal-and-aquatic vegetation, fish fauna)

Measuring of the ^{137}Cs content in bottom sediment samples taken in 2021 show that at all observation points the levels of radioactive contamination by this radionuclide correspond to the previously established background values

and do not exceed 1.3 Bq/kg. The content of ^{90}Sr in samples of bottom sediments did not exceed MDA.

Measuring of the radionuclides content in the aquatic and coastal-and-aquatic biogeocenoses in the OZ of the Belarusian NPP in 2021 show that at all observation points the radioactive contamination with technogenic radionuclides almost met the background values established in 2016-2019. The maximum content of ^{137}Cs was 7.9 Bq/kg, ^{90}Sr - 4.0 Bq/kg.

The content of ^{137}Cs in the muscle tissue of the wildfish at the control points of the Viliya river for 2017-2021 was at low level and only spot samples showed values above the MDA. The maximum background values of the ^{137}Cs, ^{90}Sr content in the wild-living fish fillets are 3.8 Bq/kg and 0.53 Bq/kg, respectively. A higher content of 90Sr in samples of bone tissue of wildfish is common to roach.

Soils (fig. 8.28)

The laboratory tests of soil samples taken in 2021 in layers to a depth of 10 cm showed that the content of ^{137}Cs and ^{90}Sr was at the level of global fallout and did not exceed the background values established earlier. The average values of the content of induced radionuclide in the soil of all observation points differ insignificantly and ranges from 2.54 to 3.93 Bq/kg for ^{137}Cs, and from 1.98 to 4.12 Bq/kg for ^{90}Sr. The content of natural radionuclides in soil is typical for soddy-podzolic soils.

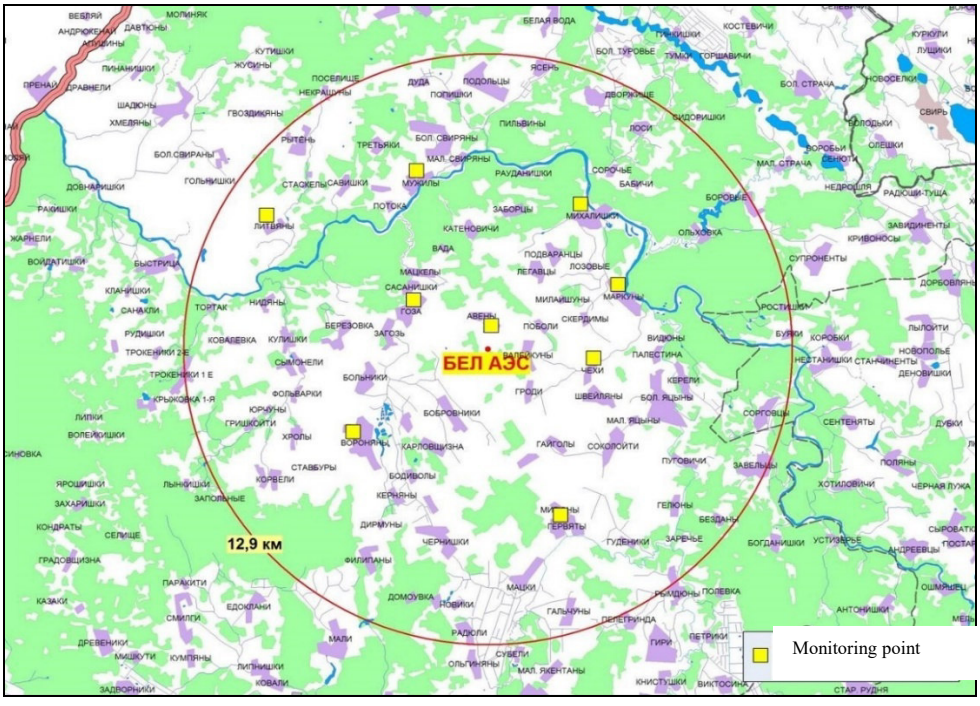


Figure 8.28 - Layout of radioactive contamination of soils in the OZ of the Belarusian NPP

Forest and meadow-boggy vegetation

In 2021 the highest levels of ^{137}Cs in forest biogeocenosis vegetation are specific for forest cover layer and dominant species of the grass-and-bush layer. The maximum content of this radionuclide was registered for the dominant species of the grass-and-bush layer, taken at observation point 8 and amounted to 84.0 Bq/kg. The highest levels of ^{90}Sr content are typical for the forest cover layer of different horizons. The maximum value was recorded in a combined of 8 forest cover layer samples A0L taken at all observation points. The specific activity of ^{90}Sr in moss and lichen was in the range of 3.0 - 8.0 Bq/kg, in other samples it did not exceed 4.0 Bq/kg.

The highest level of ^{137}Cs content in the meadow biogeocenosis vegetation in 2021 was recorded in samples of medicinal plants taken at observation point 10 and amounted to 21.0 Bq/kg. The specific activity of ^{90}Sr was in the range of 2.0 - 5.0 Bq/kg.

The comparative analysis of data for the entire observation period shows that at all observation points at the sites of the forest and meadow-boggy phytocenoses within the OZ of the Belarusian NPP the levels of radioactive contamination with ^{137}Cs and ^{90}Sr in 2021 met the previously established background values.

Agricultural products

The content of radionuclides in the agroecosystems and agricultural products for 2021 showed that the soil contamination with ^{137}Cs varies slightly from 0.77 to 1.36 kBq/m^2 (0.02 - 0.04 Ci/km^2), with ^{90}Sr - from 0.2 to 0.8 kBq/m^2 (0.01 - 0.02 Ci/km^2), which indicates the absence of technogenic contamination with radionuclides.

The evaluation of the monitored parameters within the control plots network for 2021 and their comparison with the previous period showed that there were no significant changes. The values of the monitored parameters in the observation objects are within the tolerance allowed for the methods and measuring equipment used.

The radionuclides content monitoring of the agroecosystems and agricultural products at the livestock observation points for 2021 showed that the specific activity of ^{134}Cs, ^{137}Cs, ^{131}I in milk, meat (beef) and water was at the MDA level.

The content of ^{90}Sr in milk varied from 0.10 to 0.13 Bq/kg, in beef it did not exceed the value of MDA <0.16 Bq/kg, in water drunk by animals - from <0.006 to 0.019 Bq/kg

The specific activity of ^{137}Cs in animal forage was in the range of <2.0 Bq/kg in the green grasses at 6 livestock observation points (Zagoz farm

for cattle raising and fattening, Diary-and-Stock Unit MTK Markuny, Diary-and-Stock Unit MTK Goza, Diary-and-Stock Farm MTF Trokeniki, Diary-and-Stock Farm MTF Malyuta, Diary-and-Stock Farm MTF Supronenty), in feed mixtures of 2 control livestock observation points (Diary-and-Stock Farm MTF Berezovka, Diary-and-Stock Farm MTF Vornyany), in haylage (Diary-and-Stock Unit MTK Berezovka), in corn silage and timothy grass hay (unit for fattening and raising of cattle in Gervyaty), up to <3.3 Bq/kg in cereal haylage (Diary-and-Stock Farm MTF Berezovka, Diary-and-Stock Farm MTF Vornyany, Diary-and-Stock Farm MTF Trokeniki), in corn silage of 3 livestock observation points (Diary-and-Stock Farm MTF Malyuta, Diary-and-Stock Farm MTF Supronenty, Diary-and-Stock Farm MTF Markuny).

The specific activity of ^{90}Sr in forage samples from all 9 livestock observation points ranged from 0.12±0.03 Bq/kg (Diary-and-Stock Unit MTK Markuny), 0.18±0.05 Bq/kg (Diary-and-Stock Farm MTF Supronents), 0.19±0.05 Bq/kg, (MTF Malyuta) in corn silage, up to 1.28±0.31 Bq/kg (Diary-and-Stock Unit MTK Goza), 1.48±0.37 Bq/kg (Zagoz farm for cattle raising and fattening in the orchard grass hay).

The content of ^{137}Cs in the muscle tissue of commercial fish (carp, pike) from the Vornyanskoye lake was at a level below the MDA, in samples of perch muscle tissue it was 2.1 Bq/kg. The specific activity of ^{90}Sr in carp muscle tissue was 0.30 Bq/kg, which is significantly less than the permissible level established by Technical Regulation of Customs Union (TRCU) 021/2011 (100 Bq/kg), in pike muscle tissue it was <0.10 Bq/kg. Fluctuations in accumulation of ^{90}Sr in the fillet of commercial fish can occur due to a change in the fish feeding regime.

The content of ^{90}Sr in bone tissue samples of commercial fish from the Vornyanskoye lake (almost an order of magnitude) exceeds the content of this radionuclide in muscle tissue samples. Commercial carp fish contains the highest level of ^{90}Sr in bone tissue – 0.93 Bq/kg.

Annual ambient dose equivalent on the ground (equivalent dose reflecting the radiation situation)

In 2021 the ambient dose equivalent (ADE) at all observation points varied in quarters in the range of 0.31 - 0.19 mSv. The annual ADE values fluctuated within 0.53 - 0.70 mSv, which corresponds to the values of the "zero" background radiation obtained at the stage of the Belarusian NPP construction.

Thus, the results of radiation monitoring in the OZ of the Belarusian NPP for 2021 indicate that the radiation in the area of the Belarusian NPP remains stable, the technogenic radionuclides contamination of the environment, agroecosystems and agricultural products in the territory in the OZ of the

Belarusian NPP in general meet the global fallout level, which is due to nuclear weapon testing in the 60s of the last century prior to the Chernobyl NPP accident.

The construction and commissioning of the Belarusian NPP does not affect the radiation exposure status in the region; tough environmental issues caused by the radiation have not been revealed.

CHAPTER 9
Radiation-and-environmental monitoring at observation points of the National Environmental Monitoring System of the Republic of Belarus, located outside of the observation zone of the Belarusian NPP

1. Radiation monitoring

The results of radiation monitoring at the observation points of the National Environmental Monitoring System in the Republic of Belarus in the area of the Belarusian NPP, outside of the observation zone, show that the radioactive contamination of environment correspond to the global fallout levels caused by nuclear weapons testings in the middle of the last century and technogenic radiation accidents, taking into account the radionuclides natural decay.

In the area of the Belarusian NPP there are 3 observation points for atmospheric air radiation monitoring (Lyntupy, Naroch and Oshmyany).

Observation parameters and frequency: rate of gamma exposure (1 time per day), in fallout and aerosols in the ground-level air - total beta activity (1 time per day), activity of gamma-emitting radionuclides (1 time per month), activity of ^{90}Sr (1 time per quarter).

Figures 9.1 and 9.2 show the monthly average values of total beta activity in the samples of natural fallout from the atmosphere and aerosols at observation points in the area of the Belarusian NPP for 2021.

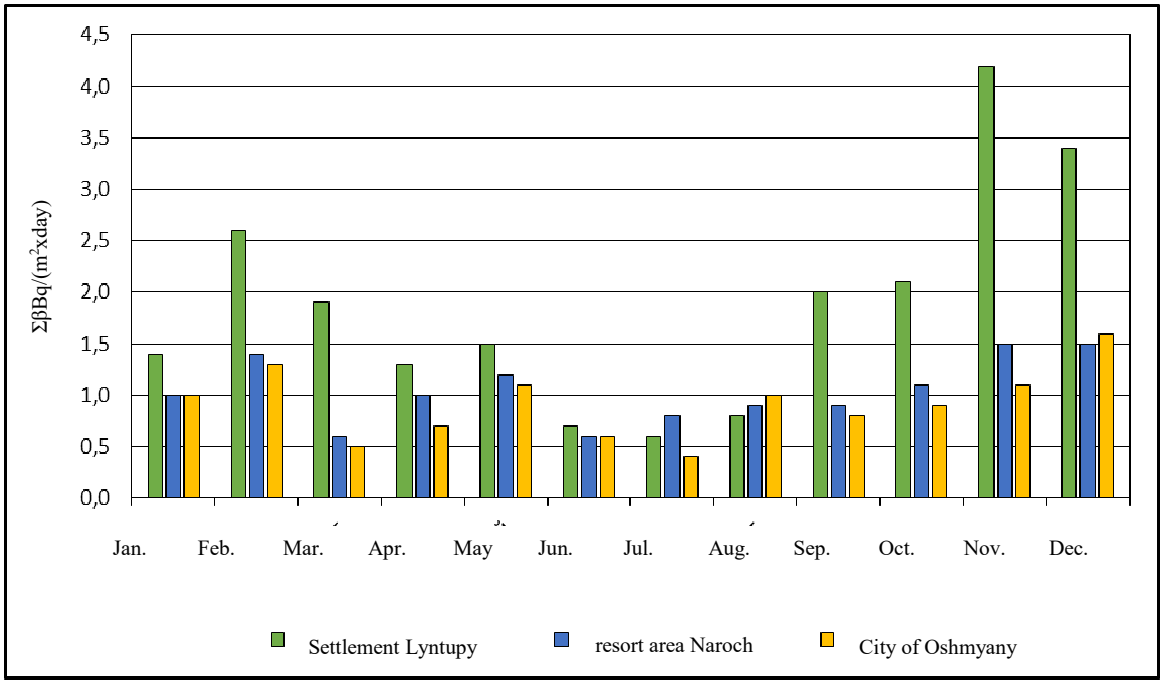


Figure 9.1 - Average monthly values of total beta activity in samples of radioactive atmospheric fallout from the observation points in the area of the Belarusian NPP for 2021

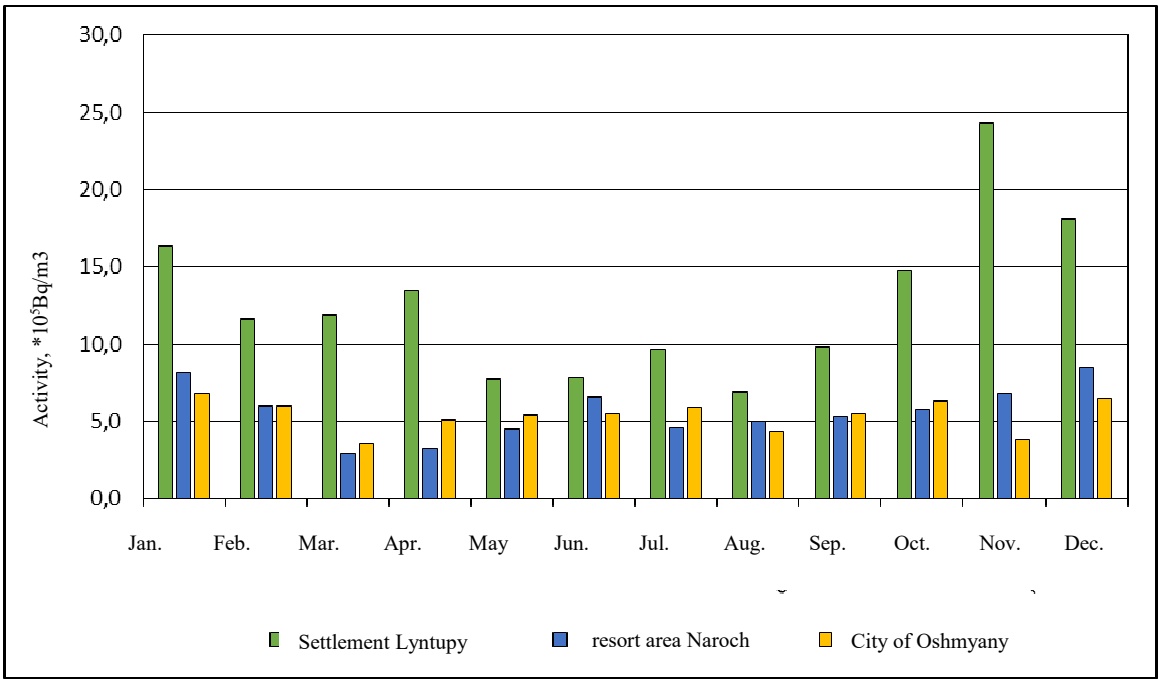


Figure 9.2 - Average monthly values of total beta activity in aerosol samples from the observation points in the area of the Belarusian NPP for 2021

In 2021 the average values of the total beta activity of natural fallout and aerosols in the ground-level air at observation points met the established long-term values and amounted to 0.5 - 1.9 Bq/(m^2 a day) for atmospheric fallout, (6 - 9) 10^{-5} Bq/m^3 - for aerosols.

The content of gamma-emitting radionuclides in the consolidated monthly radioactive fallout samples was below the detection limit (<0.001 Bq/(m^2 a day)), in the monthly aerosols samples it was 10 - 11 μBq/m^3.

Observations are being done lso for the content of natural radionuclides in the ambient air. The monthly average aerosol sample values contained the volumetric activity of ^{7}Be and ^{210}Pb. The natural radionuclides activity in the in the ground-level air also corresponded to the long-term values. The content of ^{7}Be in the ambient air at the observation points in 2021 ranged from 720 × 10^{-6} Bq/m^3 to 5721 × 10^{-6} Bq/m^3, ^{210}Pb - from 24 × 10^{-6} Bq/m^3 to 944 × 10^{-6} Bq/m^3. The highest ^{7}Be activity was recorded in June. The peak of ^{210}Pb volumetric activity at many observation points in 2021 was in January and October.

Radiation monitoring of surface water in 2021 was performed at 3 observation points in the area of the Belarusian NPP: Viliya River (village Bystritsa), Naroch lake (resort area of Naroch) and the Svir lake (Svir village).

Observation parameters included total alpha- and beta activity, activity of ^{137}Cs, ^{90}Sr; activity of ^{137}Cs and ^{90}Sr in the bottom sediments. The radioactive contamination of surface watercourses observation in the area of the BelarusianNPP was performed 5 times a year - Viliya (Bystritsa village), 1 time per quarter - Naroch lake (resort area of Naroch) and the Svir lake (Svir village). The bottom sediments are sampled once a year.

Analysis of the radioactive contamination of surface water dynamics in the controlled rivers and lakes showed that the average annual concentrations of radionuclides in 2021 were below the reference levels of radionuclides in drinking water established by the Hygienic Standard "Criteria for assessing radiation exposure", approved by the Decree of the Ministry of Health of the Republic of Belarus on December 28, 2012 No. 213, which established the quantitative and qualitative parameters which ensure radiation safety.

The analysis of radiation monitoring of surface water in 2021 show that the volumetric activity of ^{137}Cs was in the range from <0.002 Bq/l (less than MDA) to 0.005 Bq/l, the volumetric activity of ^{90}Sr was under 0.009 Bq/l.

The network of observation points for radiation monitoring of soils behind the observation zone of the Belarusian NPP includes 4 landscape-geochemical areas (hereinafter referred to as LGCA): LGCA Bystritsa, LGCA Svir, LGCA Gudogai and LGCA Kemelishki.

The observation parameters included gamma exposure rate, the layer-by-layer distribution of ^{137}Cs and ^{90}Sr activity in the soil at 1 cm intervals and at a depth of 10 cm. The observations are performed once a year. The monitoring results are presented in tables 9.1 - 9.4.

Table 9.1 - Analysis of the radionuclides specific activity in the soil samples from the LGCA Bystritsa on May 26, 2021

Soil layer/depth	Soil layer/mass, kg	Specific activity, Bq/kg	
		^{137}Cs	^{90}Sr
0-1	0.179	<1.0	0.3
1-2	0.228	<1.0	4.0
2-3	0.183	<1.0	5.5
3-4	0.212	<1.0	3.0
4-5	0.293	<1.0	1.8
5-6	0.242	1.2	5.0
6-7	0.268	<1.0	2.5
7-8	0.187	<1.0	2.7
8-9	0.253	<1.0	2.4
9-10	0.328	<1.0	4.5

Table 9.2 - Analysis of the radionuclides specific activity in the soil samples from the LGCA Svir on May 27, 2021

Soil layer/depth	Soil layer/mass, kg	Specific activity, Bq/kg	
		^{137}Cs	^{90}Sr
0-1	0.229	3.5	4.5
1-2	0.161	1.8	7.0
2-3	0.184	1.1	5.9
3-4	0.223	1.4	11.0
4-5	0.269	2.4	5.1
5-6	0.157	1.7	<1.0
6-7	0.222	1.0	1.9
7-8	0.197	1.4	<1.3
8-9	0.224	<1.0	<0.5
9-10	0.322	<1.0	2.5

Table 9.3 - Analysis of the radionuclides specific activity in the soil samples from the LGCA Gudogai on May 28, 2021

Soil layer/depth	Soil layer/mass, kg	Specific activity Bq/kg	
		^{137}Cs	^{90}Sr
0-1	0.251	<1.0	3.9
1-2	0.288	<1.0	<1.7
2.1	0.226	<1.0	1.9
3.6	0.220	1.5	2.4
4-5	0.304	<1.0	<1.6
5-6	0.281	<1.0	4.7
6-7	0.233	<1.0	<0.3
7-8	0.244	<1.0	2.4
8-9	0.262	<1.0	<0.7
9-10	0.270	<1.0	3.9

Table 9.4 - Analysis of the radionuclides specific activity in the soil samples from the LGCA Kemelishki on May 27, 2021

Soil layer/depth	Soil layer/mass, kg	Specific activity, Bq/kg	
		^{137}Cs	^{90}Sr
0-1	0.239	3.1	2.7
1-2	0.314	2.7	4.0
2-3	0.216	3.2	<0.8
3-4	0.294	3.3	2.4
4-5	0.360	2.8	<1.3
5-6	0.275	3.8	<1.7
6-7	0.225	4.4	2.6
7-8	0.268	3.7	2.6
8-9	0.225	3.6	<1.6
9-10	0.326	3.2	2.1

Analysis of the data in tables 9.1 - 9.4 shows that the levels of radioactive contamination of the soil at the observation points, as well as in the entire area of the Belarusian NPP, correspond to the levels of radioactive contamination observed before the accident at the Chernobyl NPP.

The volumetric activity of ^{137}Cs and ^{90}Sr in the rivers' surface waters was significantly below the reference data (10Bq/l).

In 2021 the radiation in the Republic of Belarus remained stable. Based on the atmospheric air radiation monitoring, no exceeding of the power level rate over the established long-term values was identified. The total beta activity and the content of ^{137}Cs, ^{90}Sr in atmospheric air samples was within the established long-term values.

The atmospheric air radiation monitoring data indicates that the launch of the power unit No. 1 of the Belarusian NPP did not worsen the environment radiation status, which is confirmed by the automated radiation status monitoring in the area of the Belarusian NPP.

2. Ecological monitoring

The surface waters monitoring is performed in accordance with the order of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus dated July 19, 2019 No. 180-ОД (OD) "On surface and ground waters monitoring".

The surface waters monitoring is performed in the Viliya river at the observation point of the state observations network 0.3 km to the north-east of the settlement of Bystritsa (10.0 km from the border with the Republic of Lithuania) for the following hydrochemical indicators:

water physical properties and gas composition (temperature, suspended solids, hydrogen index (pH), dissolved oxygen, electrical conductivity), BOD_5, COD_{Cr}, nitrogen-containing (ammonium ion, nitrate ion, nitrite ion, the Kjeldahl nitrogen) and phosphorus-containing (phosphate ion (including hydro- and dihydroforms), total phosphorus) matters, metal content (total iron, manganese, copper, zinc, nickel, chromium, lead, cadmium), oil and oil products in dissolved and emulsified state, synthetic anionic surfactants (including alkyl oxyethylated sulfates, alkyl sulfonates, olefinsulfonates, alkyl benzosulfonates, alkyl sulfates, sodium and potassium salts of fatty acids) - 12 times a year annually;

mineral composition (magnesium, calcium, hydrocarbonate-ion, chloride-ion, sulfate-ion, water salt content) - 7 times a year;

mercury, arsenic - 1 time a year;

DDT and its degradation products, aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, alpha-hexachlorocyclohexane, beta-hexachlorocyclohexane, gamma-hexachlorocyclohexane (lindane), endosulfan, polychlorinated biphenyls (PCB) 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153, PCB 180 - once per every 5 years.

In 2021 Viliya river 0.3 km to the north-east of the settlement of Bystritsa the water quality standard in terms of organic substances exceeding were recorded in 2021, which are determined by COD_{Cr}, up to 39.9 mgO_2/dm^3 (1.6 MAC (maximum permissible concentration)) in May, phosphate ion (0.069 mgP/dm^3, 1.05 MAC) in February.

In 2021 the surface water temperature varied from 0.1°C to 24.8°C, which is higher than the limits established for aquatic life.

The content of dissolved oxygen in the Viliya river used for breeding, feeding, wintering, migration of salmonids remained favorable for the sustainable functioning of aquatic ecosystems throughout 2021 and varied from 9.2 mgO_2/dm^3 to 11.9 mgO_2/dm^3.

Based on the hydrogen index (pH = 7.48 - 8.4) the water of the Viliya river is considered to be neutral and slightly alkaline (according to the classification of A.M. Nikanorov).

The average electrical conductivity was 469.8 μS/cm, the maximum was 826 μS/cm in January.

In 2021 the maximum concentration of total iron in the Viliya river was 0.431 mg/dm^3 (2.2 MAC) in December, of manganese - up to 0.182 mg/dm^3 (6.1 MAC) in December, of copper - up to 0.015 mg/dm^3 (3.5 MAC) in May. The water quality standard for zinc in 2021 was not exceeded (Table 9.5).

The water quality standard exceeding of the mentioned indicators is due to their natural background content and is not caused by the Belarusian NPP activity.

Table 9.5 - Analysis of observations in the Viliya river 0.3 km to the north-east of the settlement of Bystritsa in 2021

Parameter of	MPC for the Viliya river	Average	Maximum	Minimum
Temperature (°C)		10.1	24.8	0.1
Suspended solids (mg/dm^3)	maximum 25 mg/dm^3	8.3	9.15	7.2
Hydrogen index (pH)	should be within 6.5-8.5	8.1	8.4	7.48
Dissolved oxygen (mgO_2/dm^3)	In the ice-cover period there should be at least 6 mgO_2/dm^3, open – 8 mgO_2/dm^3	10.5	11.9	9.2
Magnesium (mg/dm^3)	40 mg/dm^3	24.6	38	15
Chloride ion (mg/dm^3)	300 mg/dm^3	16.5	19.9	14.1
Sulfate ion (mg/dm^3)	100 mg/dm^3	23.6	26.5	19.6
Hydrocarbonate ion (mg/dm^3)		184.9	210	166
Calcium (mg/dm^3)	180 mg/dm^3	54.9	72	38
Mineralization of water (mg/dm^3)	maximum 1000 mg/dm^3	264.6	304.5	235
COD_{Cr} (mgO_2/dm^3)	25 mgO_2/dm^3	28.6	39.9	16.9
COD5 (mgO_2/dm^3)	3 mgO_2/dm^3	2.4	3	1.5
Ammonium ion (mgN/dm^3)	0.39 mgN/dm^3	0.095	0.196	0.023
Nitrite ion (mgN/dm^3)	0.024 mgN/dm^3	0.015	0.023	0.011
Nitrate ion (mgN/dm^3)	9.03 mgN/dm^3	1.2	2.4	0.47
Phosphate ion (mgP/dm^3)	0.066 mgP/dm^3	0.041	0.069	0.008
Electrical conductivity (μS/cm)		469.8	826	381
Phosphorus total (mg/dm^3)	0.2 mg/dm^3	0.07	0.11	0.018
the Kjeldahl total nitrogen (mg/dm^3)	5 mg/dm^3	1.46	1.83	1.12
Iron total (mg/dm^3)	0.195 mg/dm^3	0.222	0.431	0.182
Copper (mg/dm^3)	0.0043 mg/dm^3	0.002	0.015	<0.001
Zinc (mg/dm^3)	0.030 mg/dm^3	0.01	0.028	0.003
Nickel (μg/dm^3)	34 μg/dm^3	<5	<5	<3
Chromium (mg/dm^3)	0.005 mg/dm^3	<0.002	<0.002	<0.001

Plumbum (μg/dm^3)	14 μg/dm^3	<5	<5	<0.01
Cadmium (mg/dm^3)	0.005 mg/dm^3	<0.0005	<0.0005	<0.0001
Manganum (mg/dm^3)	0.030 mg/dm^3	0.069	0.182	0.032
Oil products (mg/dm^3)	0.05 mg/dm^3	0.020	0.048	0.009
Anionic surfactants (mg/dm^3)	0.1 mg/dm^3	<0.025	<0.025	<0.025
Hydrargyrum (μg/dm^3)	0.07 μg/dm^3	<0.02	<0.02	<0.02
Arsenicum (mg/dm^3)	0.05 mg/dm^3	<0.001	<0.001	<0.001

CHAPTER 10
Awareness raising on radiation-and-environmental monitoring

Since 2009 the Nuclear Power Plant Information Center in the city of Ostrovets has been operating as part of the Belarusian NPP. The center is designed to inform the population on the nuclear power issues and on the progress of the Belarusian NPP construction.

Specialists of the Information and Public Relations Department of the Information Center and other employees of the Belarusian NPP share information on the development of the global nuclear industry, about the implemented project, about modern and reliable technologies used during the Belarusian NPP construction, and EIA materials of the Belarusian NPP.

The Information Center offers it services (activities for visitors, excursions to the construction site of the Belarusian NPP) is carried out exclusively on a gratuitous basis.

In November 2020 the Information Center created an exposition in the show room of the Belarusian NPP training center.

In 2021 the NPP Information Center was visited by 2,584 people, since the opening - more than 24 thousand people (fig. 10.1), including students of the Academy of Public Administration under the President of the Republic of Belarus, cadets of the Academy of the Ministry of Internal Affairs and the University of Civil Protection, the Prime Minister of the Republic of Belarus , students of various schools and gymnasiums, teachers and students of Polotsk State University, representatives of the Turkish Red Crescent. The radiation and environmental monitoring seminars were held for visitors. Also specialists of the Information and Public Relations Department hold lectures on the environmental safety, visiting educational institutions and enterprises.

Information booklets and brochures are published annually in Russian and English in more than 3,000 copies total.

Figure 10.1 - NPP Information Center

Since 2015 the Information Center for Atomic Energy (hereinafter referred to as ICAE) has been operating in Minsk. It is equipped with a modern multimedia movie theater, educational models “Universal radiometer”, “Key safety systems of the nuclear power plant”, “The principle of the nuclear power plant operation on the example of household appliances”, an interactive model of the Belarusian NPP (made using the augmented reality method), as well as a touch screen panel with special programs (fig. 10.2). ICAE organizes educational and career guidance events, creative work exhibitions, scientific and technical conferences, etc. (fig. 10.3).

Figure 10.2 - Information Center for Atomic Energy

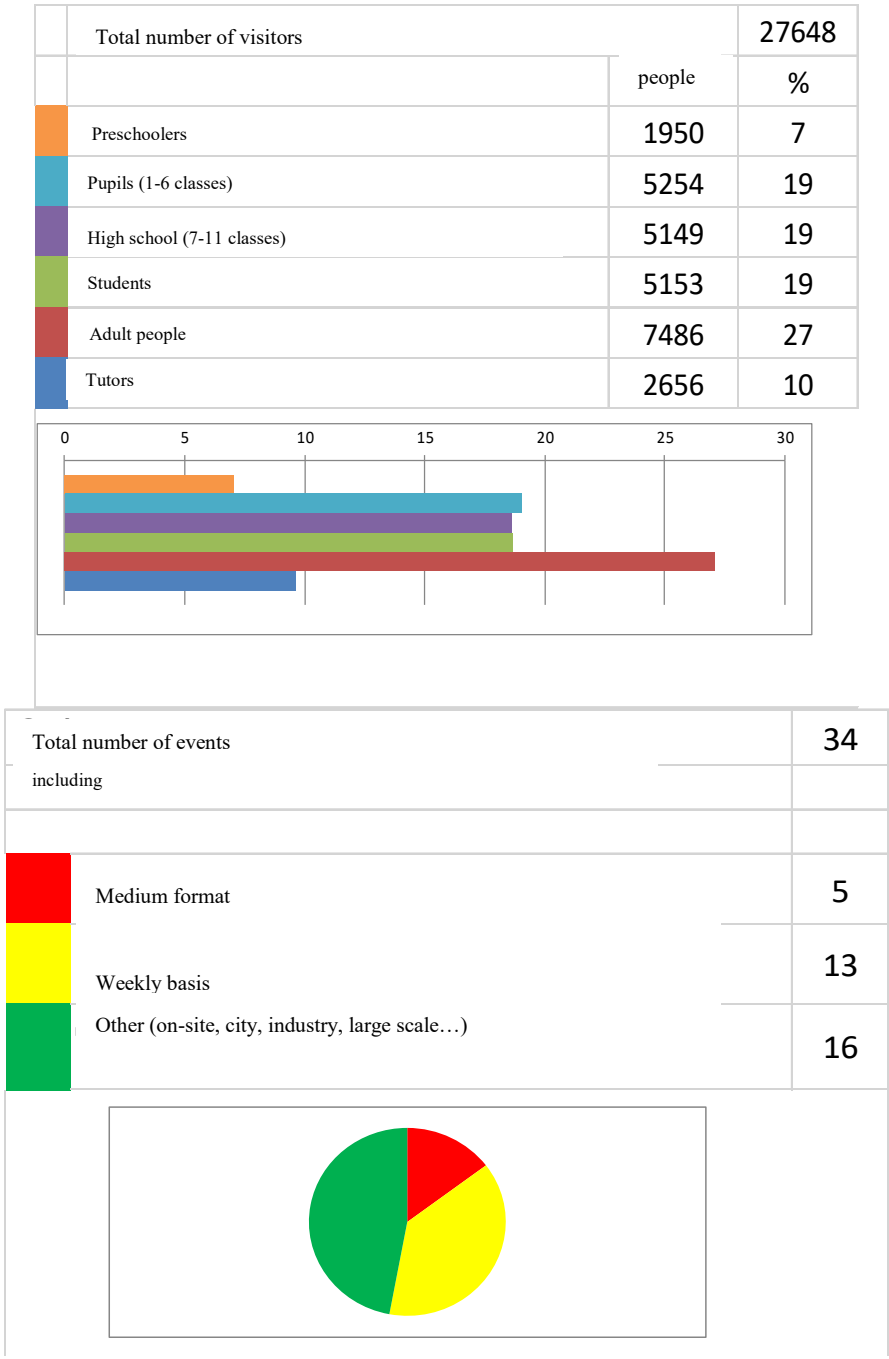


Figure 10.3 - ICAE operation in 2021

Information about the Belarusian NPP construction, the latest news about nuclear power is posted in Belarusian, Russian and English on the official website of the enterprise http://belaes.by, as well as in popular social networks: Facebook, VKontakte, Odnoklassniki. Radiation data in the area of the Belarusian NPP is updated daily on the official website, it is received from 10 points of the automatic radiation monitoring system - ARMS, located around the Belarusian NPP.

The issues of the nuclear power development in the Republic of Belarus, the progress of the Belarusian NPP construction, training of specialists for the

industry are covered on the pages and websites of the leading national media. Information materials and videos prepared together with the employees of the enterprise are placed on the pages of newspapers and magazines, in information and information-analytical television programs on TV channels Belarus-1, Belarus-3, ONT, STV.

Since 2018 a joint monthly information project of the Ministry of Energy of the Republic of Belarus, the Belarusian NPP and the newspaper “Respublika” “Energy of the Future” has been implemented, and it reflects the most important issues of the nuclear power plant construction in the Republic of Belarus.