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General Directorate for Environmental Protection of Poland

REPORT ON IMPLEMENTATION OF THE POST-PROJECT ANALYSIS PROGRAMME FOR THE NEW INSTALLATIONS OF IGNALINA NUCLEAR POWER PLANT

With this letter we are sending you Transboundary Impact Monitoring Report for year 2023 (the Report on the Implementation of the Post-Project Analysis Programme) for the new INPP Nuclear Installations:

- Interim Spent Nuclear Fuel Storage Facility (ISFSF, B1 Project);
- Solid Waste Management and Storage Facilities (SWMSF, B2/3/4 Project) consisting of Solid Waste Retrieval Facility (SWRF, B2 Project) and Solid Waste Treatment and Storage Facility (SWTSF, B3/4 Project);
- Landfill Disposal Facility for Short-Lived Very Low-Level Waste (Landfill Repository, B19 Project).

We sincerely hope you find this information useful and we would like to take this opportunity to express our gratitude for your constructive cooperation.

Vice-minister Justas Ruškys

Annex enclosed. The Report on Implementation of the Post-Project Analysis Programme for the New INPP Nuclear Installations, 36 pages.

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STATE ENTERPRISE
IGNALINA NUCLEAR POWER PLANT

TRANSBOUNDARY IMPACT MONITORING REPORT FOR YEAR 2023.

NEW INPP NUCLEAR INSTALLATIONS:
INTERIM SPENT FUEL STORAGE FACILITY (B1 PROJECT), SOLID RADIOACTIVE WASTE RETRIEVAL FACILITY (B2-1 AND B2-2 PROJECTS), SOLID RADIOACTIVE WASTE TREATMENT AND STORAGE FACILITY (B3/4 PROJECT) AND LANDFILL DISPOSAL MODULES (B19-2 PROJECT)

2024

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1 INTRODUCTION

The purpose of the present document is to provide the information on the implementation of the Transboundary Impact Monitoring Programme for the new Ignalina NPP nuclear installations for which transboundary environmental impact assessment has been carried out pursuant to the Convention on Environmental Impact Assessment in a Transboundary Context of the United Nations Economic Commission for Europe (Espoo, 1991), in order to ascertain that operation of nuclear installations newly constructed on the Ignalina NPP site and the overall decommissioning activities carried out on the INPP site do not have and will not have significant adverse transboundary impact and is in line with the assessments and safety substantiations made during the environmental impact assessment and safety justification stage.

The following newly constructed on the INPP site spent nuclear fuel and radioactive waste management facilities include:

- Dry Type Interim Spent Nuclear Fuel Storage Facility (ISFSF, B1 Project);
- Solid Waste Management and Storage Facilities (SWMSF, B2/3/4 Project) consisting of Solid Waste Retrieval Facility (SWRF, B2 Project) and Solid Waste Treatment and Storage Facility (SWTSF, B3/4 Project);
- Landfill Disposal Facility for Short-Lived Very Low-Level Waste (Landfill Repository, B19 Project).

Therefore, for the transparent implementation of the Post-Project Analysis Programme for the New Ignalina NPP Nuclear Installations [1], the Ignalina NPP made a compilation of the annually conducted monitoring results with the purpose to demonstrate that the objectives of the transboundary impact monitoring as set in the Espoo Convention:

- ➢ Monitoring of the compliance with the safe operation conditions and limits as set out in the design of the installation approved in the established manner and assessment of the effectiveness of the impact mitigation measures;
- ➢ Review of a potential impact for proper implementation of appropriate measures and to prepare to take actions for coping with uncertainties;
- ➢ Verification of previously made predictions in order to transfer the gained experience to implement the future activities of the same type,

are fully fulfilled and the obtained monitoring results have not indicated any negative impact to the health of the population and the environment of the neighbouring countries.

By continuously and systematically carrying out the environmental radiological monitoring both during the normal operation conditions and in case of potential emergency situations, the INPP seeks:

- ➢ to limit radionuclide pathways into the environmental components, thus protecting the INPP personnel, the population, and the environment against hazardous radionuclide impact, as well as to forecast contamination effects;
- ➢ to prove conformity with the discharge limits set for airborne and waterborne discharges;
- ➢ to demonstrate that the determined exposure doses of the personnel and the population do not exceed the limit dose values set in the normative documents;
- ➢ to analyse and assess efficiency of the implemented environmental protection measures;
- ➢ to accumulate, analyse and submit to the state institutions and the population the information on the environment condition on the INPP territory and the sanitary protection zone, including the interested neighbouring countries in implementing the provisions of the Espoo Convention.

The present report contains a brief overview of the operation of the following already commissioned nuclear installations that have started their commercial operation:

- The Interim Spent Fuel Storage Facility (B1 Project);
- The Solid Radioactive Waste Retrieval Facility, RU-1 (B2-1 Project) and the Solid Radioactive Waste Retrieval Facility, RU-2, RU-3 (B2-2 Project);
- Solid Radioactive Waste Treatment and Storage Facility (B3/4 Project);
- Landfill Disposal Facility for Short-Lived Very Low-Level Waste (B19 Project),

and the potential impact to the population and the environment due to their operation, including assessment of the results of the cumulative impact to the population and the environment as a result of operation of all the INPP nuclear installations located on the INPP site.

1.1 Abbreviations

BOD	Biochemical Oxygen Demand;
COC	Chemical Oxygen Consumption;
FIBC	Flexible Intermediate Bulk Container;
ISO container	Standard 20ft half height ISO container (1CX);
ISFSF	Interim Spent Fuel Storage Facility;
MPC	Maximum permissible concentrations;
NI	Nuclear Installation;
RU	Retrieval Unit;
RW	Radioactive waste;
SE INPP	State Enterprise Ignalina Nuclear Power Plant;
SPZ	Sanitary Protection Zone;
SSC	Structures, system and components important to safety;
SWRF	Solid Radioactive Waste Retrieval Facility;
SWMSF	Solid Radioactive Waste Management and Storage Facility;
SWTSF	Solid Radioactive Waste Treatment and Storage Facility;
TPC	Transport Packaging Container.

1.2 Interim Spent Nuclear Fuel Storage Facility, ISFSF (B1 Project)

The ISFSF is located within approximately 0.5 km to the south of the INPP Units. The territory of the ISFSF occupies 5.93 ha. The ISFSF site is connected to the INPP via railway as well as the road connection. The transfer of the casks to the ISFSF was performed by the rail transport. In total 190 casks are temporary stored at the ISFSF, 22 casks out of the total number of casks contain damaged and experimental fuel bundles.

Three basic areas are distinguished at the main ISFSF storage building: Reception Hall, Storage Hall, and Fuel Inspection Hot Cell. The building and all the structures were designed taking into consideration the seismic loads and explosion impact. The structures of the ISFSF building are designed in such a way as to protect the objects inside the building against consequences of external meteorological and seismic phenomena, as well as human activity (e.g., external fire, transportation accidents, etc.). The building stability calculations were performed in compliance with the requirements of valid normative documents considering the initial impact data of the seismic loads and explosion wave. For more detailed information regarding the seismic safety and measures taken to ensure it for all the new NI, as well as the technical surveillance measures of the new NI building structures, see the Post-Project Analysis Programme for the New Ignalina NPP Nuclear Installations [1].

CONSTOR® RBMK1500/M2 casks are designed as dual-purpose casks for storage and transport after expiration of the storage period. They meet the ISFSF requirements for storage period of not less than 50 years from the scheduled completion of transfer of all SNF into the ISFSF without any need for scheduled intervention during the entire storage period plus an allowance of 5 years for the subsequent transport of the fuel to the final storage site. The storage configuration of the cask CONSTOR®RBMK1500/M2 loaded with 91 Spent Fuel Assembles or 182 Fuel Bundles is 102 FB in the 32M Basket and 80 FB in the Ring Basket.

Main information related to the SNF removal from the Units and SNF transportation to the ISFSF:

- By 13 August 2020 only leaktight fuel assemblies were loaded into storage casks and transported for storage to the ISFSF.
- In September 2020 handling and transportation for storage of the damaged fuel was started at Unit 1 by using the Special Damage Fuel Handling System designed for damaged and experimental nuclear fuel removal from the cooling pools, their processing in pools and insertion of the individual fuel bundles into cartridges for subsequent loading into the CONSTOR® RBMK1500/M2 casks. The safety justification and design documents of the equipment for handling of the damaged and experimental fuel assemblies including all aspects related to the risk assessment during the handling process were performed within the scope of the safety case development and were approved by the regulatory body, including performance of the "Hot" trial of the Special Damage Fuel Handling System in accordance with the Commissioning Program and approval of the Report and the Final Safety Analysis Report.
- Handling of damaged fuel at Unit 1 was completed on 11 May 2021.
- On 5 May 2021 handling of the damaged fuel at Unit 2 started by using the same damaged fuel handling equipment that was used for handling operations at Unit 1 which was transported to Unit 2 and assembled for the similar work performance.
- In total, 182 damaged fuel assemblies were stored at Unit 1, and 185 – at Unit 2. The total number of damaged fuel assemblies stored in both Units is relatively small in comparison with the total number of spent fuel assemblies and constitutes only 1.7%. All damaged fuel was placed into 22 containers out of the total number of 190 storage casks transported to the ISFSF.
- The last cask with the spent nuclear fuel from the storage pool of Unit 2 was removed on 21 April 2022.
- The total number of casks transported from Unit 1 is 88 casks, including 11 casks with the damaged fuel.
- The total number of casks transported from Unit 2 is 102 casks, including 11 casks with the damaged fuel.
- In total 190 CONSTOR®RBMK1500/M2 type casks containing 15555 of spent fuel assemblies and 1 cartridge with the collected fuel debris from the bottom of spent fuel storage pools are stored at the ISFSF.

- In total 21571 fuel assemblies were used during the INPP operation; 6016 spent fuel assemblies loaded into 118 casks are stored at the old Dry-Type Interim Spent Fuel Storage Facility operated since 1999 until 2010, and 15555 spent fuel assemblies are stored at the ISFSF.

No nuclear fuel either spent or fresh is left at the INPP Units and on the INPP site. Within the scope of the separate modification MOD-20-00-1747 on 29-30 December 2022 all fresh nuclear fuel (75 fresh fuel assemblies) were transported from the Fresh Nuclear Fuel Store (Bld. 165) to the ISFSF for further interim storage. Safety of the fresh fuel storage at the ISFSF was analysed and justified in the Critically Safety Analysis Report of Storage of Fresh Nuclear Fuel in the Interim Spent Nuclear Fuel Storage Facility [2] and the Safety Analysis Report of Fresh Fuel Storage at the ISFSF (Addendum to the ISFSF Final SAR) [3] which were approved by the regulatory body.

The amount of nuclear material placed in appropriate containers and transported from Bld. 165 to the ISFSF for storage is as follows:

1. Transport Packaging Container (TPCs) (TK-C6 type) – 8 pcs.;
2. Fresh fuel assembly (max. 10 assemblies per TPC) – 74 pcs.;
3. Experimental fuel assembly – 1 pc.;
4. Packaging can with fresh fuel pellets – 3 pcs.;
5. Packaging can with fresh fuel pellets – 1 pc.

Information related to the operation of the ISFSF:

- The ISFSF is operated strictly following the requirements of the Interim Spent Nuclear Fuel Storage Facility Operation Technical Specification [4].
- The nuclear fuel storage norms and conditions are established in the INPP Instruction on Safety Assurance during Nuclear Fuel Storage and Transportation [5] developed on the basis of the regulatory requirements.
- SNF accounting procedure is established in the Instruction on Nuclear Fuel Accounting at the ISFSF [6].
- Technical maintenance, monitoring, testing and inspections of the ISFSF process equipment is carried out at the established periodicity and in accordance with the established procedures and schedules developed in compliance with the requirements of the Nuclear Safety Requirements BSR-3.1.1-2016 “Spent Nuclear Fuel Handling at the Dry Type Spent Nuclear Fuel Storage Facility” [7] by the qualified and appropriately trained and certified staff undergoing training in accordance with annual training programs.
- The SSC important to the ISFSF safety are included into the List of Systems Important to Safety of Units 1, 2 and General Power Plant Facilities after 9 September 2022 [8]. Periodicity of inspections and testing of SSC important to safety, their maintenance is carried out in compliance with the INPP Equipment and Facilities Technical Maintenance Regulations [9].
- During the SNF handling nuclear safety and radiological protection of workers, the public and the environment is always maintained following the ALARA principle.
- The cask storage safety at the ISFSF is ensured by consistent realisation of the “defence in depth” principle based on a system of barriers preventing or hindering migration of radionuclides or other substances from the ISFSF to the environment and by applying

technical and organisational measures protecting those barriers and maintaining their efficiency during the ISFSF operation, thus directly protecting employees and the public from harmful effects of ionising radiation.

- Mandatory monitoring of the surface temperature of each cask with the spent nuclear fuel is performed. The measured temperature of all the casks was below the established limit. During the storage period the cask body (internal side) temperature is monitored once per month. Radiological monitoring of the casks is performed in compliance with the INPP Instruction on Performance of Radiological Monitoring during Handling of the Cask CONSTOR®RBMK1500/M2 [10] providing the detailed description of the composition and volumes of to be performed radiological measurements while handling casks at different stages of its handling, including measurement of the gamma and neutron radiation dose rate from the cask surface (after its loading with SNF and transfer to the ISFSF) and radiological monitoring of the working places at different stages of the cask handling.
- No breach of the normal operation conditions and operational limits were identified during the ISFSF operation in 2023. All systems and components of the storage facility were operated without failures. No changes to the safety features of the ISFSF site have been identified. No initiating events of either natural or man induced origin as provided for in the ISFSF Safety Analysis Report have been identified.

More detailed information on the description of the ISFSF and the operations performed therein is provided in the Post-Project Analysis Programme for the New INPP Nuclear Installations [1].

Information related to the successful completion of the final clean-up of the fuel debris from the bottom of the SNF storage pools of Units 1 and 2:

- In September 2021 fuel debris collection and removal equipment was installed at Unit 1 and the work related to the underwater video inspection, removal of 10-15 cm thick layer of sludge organic matter / dust / metal particles formed during the many years of operation of the Storage Pools, large-size objects (long rods, parts of radioactive special tooling, different forks, graphite rings, lead sheets and other miscellaneous scrap materials) from the bottom of the storage pools started, including coarse fraction pumping through the separator.
- In September 2022 the clean-up works were completed at Unit 1.
- The clean-up activities of the SNF Storage Pools of Unit 2 commenced in July 2022 and were completed in December 2022.
- No fuel debris was identified or was found in either Unit 1 or Unit 2 SNF Storage Pools.
- The Final Underwater Survey Reports for Unit 1 and Unit 2 identify the reasons for absence of fuel debris:
  - Storage of defective fuel assemblies in special cases;
  - Heavily damaged fuel assemblies handled in the working tray and their debris contained within these cases already recovered with the appropriate Fuel Debris Recovery System vacuum equipment;
  - The analysis of patterns (collation map) of dose rate and neutron radiation measurements at SNF storage pools of Units 1 and 2 showed no presence of neutron flux that is a typical indicator for a significant amount of nuclear fuel debris.

- On 9 January 2023 VATESI agreed Unit 2 SNF Storage Pools visual inspection report and the project was fully completed.

1.3 Solid Radioactive Waste Management and Storage Facility, SWMSF (B2/3/4 Project)

The Solid Radioactive Waste Management and Storage Facility (SWMSF, B2/3/4 Project) consists of separate facilities located on two different sites:

- Solid Waste Retrieval Facility (SWRF, B2 Project) constructed within the boundary of the INPP site close to the existing solid waste storage buildings 155, 155/1, 157 and 157/1;
- Solid Waste Treatment and Storage Facility (SWTSF, B3/4 Project) constructed on a separate site located approximately 0.6 km to the south from the Ignalina NPP adjacent to the Interim Spent Fuel Storage Facility.

The main objectives of the SWMSF are as follows:

- Waste retrieval from the existing storage buildings 155, 155/1, 157 and 157/1;
- Sorting, preliminary treatment and packaging of waste retrieved from the storage buildings;
- Waste processing (fragmentation, incineration, compaction);
- Loading of processed and dedicated for interim storage waste into appropriate containers subject to the generated waste class;
- 50-years interim storage of RW packages.

1.4 Solid Radioactive Waste Retrieval Facility, SWRF (Retrieval Unit 1, B2-1 Project and Retrieval Units 2,3, B2-2 Project)

The purpose of the SWRF is to retrieve waste from its present storage location, i.e. buildings 155, 155/1, 157 and 157/1, pre-sort and package this waste. The SWRF consists of three Retrieval Units (RU), the Landfill Separation Facility and the Control Building.

The Retrieval Unit 1 (RU1) is used to retrieve radioactive waste from buildings 155 and 155/1, to receive Group 1 waste retrieved from buildings 157 and 157/1 (RU2), to receive class A operational RW, to perform pre-sorting, processing and radiological characterization of the waste; to transfer pre-sorted RW either to the LSF sorting area or to SWTF for further treatment.

Waste is retrieved by using remotely operated vehicles which enter the waste storage compartments of buildings 155 and 155/1 via access apertures cut in the side of the waste buildings. The remote control of all operations is carried out from the control room arranged in the control building.

The Retrieval Unit 2 (RU2) is used to retrieve, pre-sort and pack Group 1 and Group 2 radioactive waste from buildings 157 and 157/1. RU2 is a mobile unit located on the top of the waste storage building. The unit can move in two directions due to rail system mounted on the top of the waste storage building. The Unit can move to the required position above the waste storage compartment opening by means of the rail system. Waste retrieval is performed from the top of the waste storage compartments, after removal of closure panels. Waste is retrieved remotely with a girder crane equipped with specific grabs, which is lowered through an existing aperture of the roof slab of the waste compartment. Then the waste is loaded into appropriate waste transport containers for transfer to corresponding waste sorting and processing sites. When no retrieval operations are run, the sliding hatch that completely close the compartment aperture and the sealing skirt in rubber, fixed on frames due to rubber moulding, together with the sliding hatch ensure radiological protection to the personnel in order to permit maintenance operations inside the unit.

The Retrieval Unit 3 (RU3) is used to retrieve Group 3 radioactive waste from compartments 1 and 4 of building 157. Like the RU2, the RU3 is a mobile framed metal structure located on the top of the storage building. The waste retrieval is performed from the top of the compartments of building 157 after removing plugs from waste compartment roofs. All waste retrieval and packaging operations are performed inside the Unit with a remote tool carrier arm (manipulator). Operations are remotely controlled from the Control Building.

The confinement of the radioactive waste during the solid radioactive waste retrieval from the existing INPP solid waste storage buildings is ensured by the Retrieval Units construction and the safety systems. The RU1 is designed as a concrete structure with separate monolithic structural elements providing appropriate sealing between the RU1 and the INPP solid waste storage buildings. The RU2 and RU3 are sealed to the solid waste storage building roofs. The exhaust ventilation of the radioactive waste treatment areas (retrieval, sorting, treatment, etc.) is maintained at a depression in comparison to the outside environment. Fine cleaning and high efficiency particulate air (HEPA) filtering systems are installed for cleaning the exhaust air.

Retrieval Unit 1 (RU1, B2-1 Project)

Information related to the SWRF (B2-1 Project) operation:

- 203.1 m^3 of radioactive waste of class A (very low-level waste, short-lived) was retrieved from RU1(Bld. 155/1) during 2023 and in total 2212.8 m^3 of radioactive waste was retrieved from the beginning of the waste retrieval process.
- The waste originating due to the equipment dismantling and transported from Bld. 101/1,2; 130/2, 159B, as well as industrial waste retrieved from Bld. 155/1 was treated at the Landfill Separation Facility of RU1.
- The SWRF is operated strictly following the requirements of the Solid Radioactive Waste Retrieval Facility Operation Technical Specification, B2-1 Project [11] establishing the safe operation limits and conditions, requirements for operation, monitoring of the functioning of the systems important to safety, as well as other general requirements for safe organising of works related to radioactive waste retrieval and management till their transfer for further processing or storage, including other operational instructions and procedures dedicated for assurance of the safe radioactive waste retrieval, processing and transportation to other INPP on-site radioactive waste management facilities for further processing or storage.
- In case of emergency situations, the operating personnel will act in compliance with the Instruction on Elimination of Emergencies at the SE INPP Facilities during Radioactive Waste Treatment and Transportation [12].
- The systems important to the SWRF safety are included into the List of Systems Important to Safety of Units 1, 2 and General Power Plant Facilities after 9 September 2022 [8]. Periodicity of inspections and testing of systems important to safety, their maintenance is conducted in compliance with the Regulations of Inspections and Tests of SWRF Systems Important to Safety [13].
- Technical supervision of building structures is conducted at the periodicity and following the requirements and the procedure established in the Instruction on the Technical Supervision of the INPP Buildings and the Territory [14].

- All the procedures related to the SWRF operation, radioactive waste retrieval and initial processing is carried out in compliance with the requirements stated in the Nuclear Safety Requirements BSR-3.1.2-2017 "Pre-disposal Management of Radioactive Waste at Nuclear Installations" [15].

More detailed information on the description of RU-1 and the operations performed therein is provided in the Post-Project Analysis Programme for the New INPP Nuclear Installations [1].

Retrieval Units 2,3 (RU2, RU3, B2-2 Project)

Find below the main facts related to the construction of the Retrieval Units 2,3 (B2-2 Project):

Information related to the Retrieval Units 2,3 operation:

- 1269.12 m^3 of radioactive waste of classes A, B, C (very low, low and intermediate level waste, short-lived) was retrieved from Bld. 157/1 during 2023 and in total 1764.82 m^3 of radioactive waste was retrieved from the beginning of the waste retrieval process from this building.
- 93.3 m^3 of radioactive waste of classes D and E (low and intermediate level waste, long-lived) was retrieved from Bld. 157 during 2023 and in total 210.5 m^3 of radioactive waste was retrieved from the beginning of the waste retrieval process from Bld. 157.
- The SWRF (RU2, RU3) is operated strictly following the requirements of the Solid Radioactive Waste Retrieval Facility Operation Specification, B2-2 Project [16] establishing the safe operation limits and conditions, requirements for operation, monitoring of the functioning of the systems important to safety, as well as other general requirements for safe organising of works related to radioactive waste retrieval and handling till their transfer for further processing, including other operational instructions and procedures dedicated for assurance of the safe radioactive waste retrieval, processing and transportation to other INPP on-site radioactive waste management facilities for further processing.

1.5 Solid Radioactive Waste Treatment and Storage Facility, SWTSF (B3/4 Project)

The SWTSF consists of the Solid Waste Treatment Facility (SWTF) and the Solid Waste Storage Facility (SWSF).

Solid Waste Treatment Facility (SWTF)

The primary function of the SWTF is to treat Group 2 and Group 3 radioactive waste. For this purpose, the following operations are performed at the SWTF:

- Reception of the solid radioactive waste from the SWRF as well as decommissioning solid waste originating due to dismantling of the INPP equipment;
- Sorting and assessment of the waste according to radiological and physical characteristics;
- Size reduction, where necessary;
- Incineration, where applicable;
- High pressure compaction, where applicable;
- Waste loading into storage containers (optimum capacity);
- Grouting (i.e., filling of containers with grouted waste);
- Waste characterization;
- Waste transfer to the dedicated interim storage facility.

The SWTF includes the following main waste handling facilities:

- Waste Reception Facility;
- G2 Sorting Cell;
- G3 Sorting Cell;
- Incineration Facility;
- High Force Compaction Facility;
- Grouting Facility.

The SWTF consists of two different sorting cells and sorted waste further processing facilities. In the sorting cells, named after the incoming waste type (G2 and G3 sorting cells, respectively), the waste is processed in parallel streams considering its respective radiological properties. In the G2 Sorting Cell and the G3 Sorting Cell the waste is sorted by the remotely operated equipment. After the sorting procedure the size reduction and other preparatory actions take place prior to incineration, high force compaction, grouting and / or loading into containers.

Prior to loading the waste into containers, the waste is repeatedly characterized (weight, radionuclide content, dose rate, physical and chemical condition, etc.). Consideration is also given to the waste further technological treatment characteristics, i.e. further interim storage type: in the short-lived waste (SLW) or long-lived waste (LLW) storage facilities.

Solid Waste Storage Facility, SWSF

The SWSF comprises two separate stores directly connected to the SWTF: intermediate short-lived waste storage facility and intermediate long-lived waste storage facility which are directly connected to the SWTF. This ensures transportation of waste containers within the enclosed area.

The SLW waste storage facility can accommodate ~2500 m^3 of treated short-lived waste and allows the waste packages to be stored for a period of 50 years. The LLW storage facility can accommodate ~2000 m^3 of treated long-lived waste and allows the waste packages to be stored for a period of 50 years.

The LLW waste storage is dedicated for storage of waste packages containing waste of classes D (low level waste, long-lived), E (intermediate level waste, long-lived) and F (spent sealed sources). The storage is provided with separate compartments for spent sealed sources. Besides, the LLW storage is designed so that it can be extended by addition of additional modules.

Information related to the SWTSF operation:

- During 2023 the following operational solid radioactive waste volumes were treated at the SWTSF:
  - Group 1 (class A) combustible waste – 202.9 m^3;
  - Group 2 (classes B and C) non-combustible compactable waste –71.9 m^3;
  - Group 3 (classes D and E) metal waste – 134 m^3;
  - Group 3 (class F), spent sealed sources – 0.17 m^3;
- The number of formed packages for transfer to the appropriate storage facility is as follows:
  - Short-lived waste packages – 35 pieces;
  - Long-lived waste (class E) packages – 46 pieces;

  - Long-lived waste (class F) packages – 0.

- During 2023 four radioactive waste incineration campaigns were conducted. 71.5 t of solid radioactive waste and 1500 litres of combustible liquid radioactive waste (oil) was incinerated during these incineration campaigns.
- Acceptance and treatment of the radioactive waste at the SWTSF and the SWTSF operation is conducted strictly following the requirements of the Solid Radioactive Waste Treatment and Storage Facility Operation Technical Specification, B3/4 Project [17] establishing the safe operation limits and conditions, requirements for operation, monitoring of the functioning of the systems important to safety, as well as other general requirements for safe organising of works related to radioactive waste treatment and storage, including other operational instructions and procedures dedicated for assurance of the safe radioactive waste transportation, treatment and storage.
- In case of emergency situations, the operating personnel will act in compliance with the Instruction on Elimination of Emergencies at the SE INPP Facilities during Radioactive Waste Treatment and Transportation [12].
- The systems important to the SWTSF safety are included into the List of Systems Important to Safety of Unit 2 and General Power Plant Facilities [8]. Periodicity of inspections and testing of systems important to safety, their maintenance is carried out in compliance with the INPP Equipment and Facilities Technical Maintenance Regulations [9].
- Technical supervision of the SWTSF building structures is carried out at the periodicity and following the requirements and the procedure established in the Instruction on the Technical Supervision of the INPP Buildings and the Territory [14].
- All the procedures related to the SWTSF operation, radioactive waste treatment and storage is carried out in compliance with the requirements stated in the Nuclear Safety Requirements BSR-3.1.2-2017 “Pre-disposal Management of Radioactive Waste at Nuclear Installations” [15].

More detailed information on the description of SWTSF and the operations performed therein is provided in the Post-Project Analysis Programme for the New INPP Nuclear Installations [1].

1.6 Landfill Disposal Facility for Short-Lived Very Low-Level Radioactive Waste (B19-2 Project)

The Landfill Disposal Facility consists of two separate facilities:

- 4000 m^3 capacity Buffer Storage Facility built on the INPP site;
- Three Disposal Modules with the capacity of 20000 m^3 of packed radioactive waste each. The Modules are planned to be constructed and their operation will be started in sequence, one after another, approximately every 10 years.

The Landfill Disposal Facility is constructed in the vicinity of the INPP, to the south (~50 m) of the ISFSF and the SWTSF sites. The Buffer Storage Facility is built on the INPP territory and is dedicated for accumulation of the waste packages in the amount necessary for performing of the first waste disposal campaign.

The purpose of the Landfill Disposal Facility is to dispose of very low-level radioactive waste (class A) in compliance with the safety and environmental protection requirements providing the necessary protection level of the environment against both the radiological and nonradiological impact.

The Disposal Modules are the above-ground structure, where the waste is placed in the standard half height ISO containers, compacted waste plastic bales, and flexible plastic containers (FIBC package) serving also as barriers protecting against radionuclide discharge into the environment. The waste is loaded in several tiers on the supporting concrete foundation to roughly form a “hill shape” and is fully isolated from the environment by several layers of natural and artificial material layers (engineered barriers) by achieving a smooth, hill-shaped form. Finally, hydro-isolation, drainage and protective layers will be laid on top to prevent water penetration into the waste stack and washout of radionuclides from the waste to the environment. Modules will occupy the area of 4.4 ha.

The radioactive waste is loaded into the Landfill Disposal Facility with no intention of its retrieval in the future. It is planned to operate the Disposal Modules until the termination of the INPP equipment and buildings dismantling projects. Subsequently the repository will be closed, and the surveillance of the repository will be performed in compliance with the Nuclear Safety Requirements BSR-3.2.2-2016 “Radioactive Waste Repositories” [18]. The active surveillance continues for not less than 30 years and the passive surveillance continues for not less than 70 years. Upon termination of both surveillance periods, monitoring of the Landfill Disposal Facility surrounding environment will be carried out.

More detailed information on the description of the Landfill Disposal Modules is provided in the Post-Project Analysis Programme for the New INPP Nuclear Installations [1].

Main facts related to the Landfill Disposal Modules first radioactive waste loading campaign:

- The first campaign of the radioactive waste packages stacking on the Landfill Disposal Facility site (“Hot” trials) was carried out from 20 July to 30 August 2022;
- The final works of the first campaign (completion of formation of the drainage layer, placing of geotextile, formation of the local ground and soil layer, planting of the grass) were completed during the period of 15 May to 23 June 2023.
- The second (regular) campaign of the radioactive waste packages stacking on the Landfill Disposal Facility site within the scope of the “Hot” trials was carried out from 1 July to 15 August 2023. Construction of the engineering barriers was completed on 13 November 2023.
- The “Hot” trials Report and the Report on the Implementation of the Monitoring Program of the Ignalina NPP Landfill Disposal Facility for Short-Lived Very Low-Level Radioactive Waste during the 1-st Waste Disposal Campaign were developed and submitted to the regulatory body;
- The total weight of the waste stacked in the 1-st waste disposal module during the first and the second campaigns (“Hot” trials) is 6508.9 t and the volume of the disposed of waste is 7651.576 m^3.
- The Landfill Disposal Modules are operated strictly following the requirements of the Ignalina NPP Short-lived Very Low Level Radioactive Waste Disposal Facility Operation Technical Specification, B19-2 Project [19] establishing the safe operation limits and conditions, the safe operation procedure of the Disposal Modules, requirements for operation, monitoring of the functioning of the systems important to safety, including other operational instructions and procedures dedicated for assurance of the safe operation of the Landfill Disposal Modules.

- In case of emergency situations, the operating personnel will act in compliance with the Instruction on Elimination of Emergencies at the SE INPP Facilities during Radioactive Waste Treatment and Transportation [12].
- The systems important to the Landfill Disposal Modules safety are included into the List of Systems Important to Safety of Unit 2 and General Power Plant Facilities [8]. Periodicity of inspections and testing of systems important to safety, their maintenance is carried out in compliance with the INPP Equipment and Facilities Technical Maintenance Regulations [9].
- Technical supervision of the Landfill Disposal Modules foundation plate and the structures is carried out at the periodicity and following the requirements and the procedure established in the Instruction on the Technical Supervision of the INPP Buildings and the Territory [14], B19/2 Facility Sedimentation Monitoring Programme [20] and the Monitoring Programme of the Ignalina NPP Landfill Disposal Facility for Short-Lived Very Low-Level Radioactive Waste during the First Waste Disposal Campaign [21].
- The purpose of the Monitoring Programme [21] is to set the types, volumes and frequency of monitoring of the condition of engineering barriers and other operational parameters during and after the first waste disposal campaign until the decision is made to recognize the repository as fit for purpose.
- The radionuclide content in the atmospheric air is controlled at the permanent monitoring post close to the ISFSF and SWTSF. Samples of atmospheric precipitation are taken near the Landfill Disposal Facility site. Monitoring of the radionuclides transfer from the Landfill Disposal Facility site into the surface groundwater is carried out based on the water sampling results from the surveillance wells located around the Landfill Disposal Facility site. Soil samples are taken from four sides of the Landfill Disposal Facility site.
- Based on the conclusions of the Report [22] on the implementation of the above-mentioned Monitoring Programme [21]:
  - Parameters of the radiological situation at the Landfill Disposal Facility site during the first campaign and after its completion do not exceed the values set in the normative documents and the technical design;
  - Radioactive contamination and gamma radiation equivalent dose rate in the controlled area of the Landfill Disposal Facility and radioactive waste transportation routes after the end of the campaign does not exceed the values established for the supervised area;
  - During the 1st campaign no radioactive discharges into the environment was detected (activity less than MDA). Radiological state of the environmental components since the construction and operation of the Landfill Disposal Facility has not changed;
  - The main dose-forming radionuclides in environmental components are natural radionuclides K-40, Be-7 and globally distributed in the atmosphere Cs-137;
  - The settlements of the foundation slab of the Landfill Disposal Facility are acceptable for its further operation in compliance with the design requirements and the Program [20];
- All the procedures related to the Landfill Disposal Modules operation is carried out in compliance with the requirements stated in the Nuclear Safety Requirements BSR-3.2.2-2016 “Radioactive Waste Repositories” [18].

1.7 Definition of the Representative Person

Representative person is assumed as a representative person, a member of a representative public group who is subject to significant exposure due to airborne and waterborne discharges. The exposure dose of a representative person is evaluated taking into consideration all exposure pathways from the radiation source.

The following public groups that potentially may be close to the sanitary protection zone, such as farmers, gardeners, fishermen, hunters, mushroom pickers, berry, herbs pickers, tourists, holidaymakers have been analysed for screening of the representative persons characteristic for the INPP region by evaluating all exposure pathways and exposure duration.

In calculating the exposure doses of a representative person the radionuclide dispersion models into the environment as provided in the IAEA Safety Reports Series No. 19 “Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment” [23] and the International Commission on Radiological Protection [24] and recommended by the national regulatory requirements Nuclear Safety Requirements BSR-1.9.1-2017 “Standards of Release of Radionuclide from Nuclear Installations and Requirements for the Plan on Release of Radionuclides” [25] were applied, considering the radiation protection optimisation results, realistic life-style and food chains of the representative person, as well as the realistic airborne discharges into the atmosphere and waterborne discharges into lake Drūkšiai.

The performed analysis of all the external and internal exposure pathways considering the life-style and food chains of all the public groups that potentially may be close to the INPP sanitary protection zone due to residing or performing their daily activity on the boarder of the INPP sanitary protection zone and the surveillance zone and the estimation of the contribution of airborne and waterborne discharges into the exposure dose, it was identified that the farmers, gardeners and fishermen may experience the highest exposure due to airborne and waterborne discharges:

- In case of fishermen the exposure dose will consist of the following exposure doses: to all the body, to the skin, due to aerosol inhalation from immersion in the plume, from ground depositions and shore sediments, due to consumption of fish;
- In the case of farmers, the exposure dose will consist of the following exposure doses: to all the body, to the skin, due to aerosol inhalation from immersion in the plume, from ground depositions, due to consumption of milk, meat, drinking water;
- In the case of gardeners, the exposure dose will consist of the following exposure doses: to all the body, to the skin, due to aerosol inhalation from immersion in the plume, from ground depositions, due to consumption of terrestrial foodstuffs.

The Lithuanian Hygiene Standard HN 73:2018 “Basic Standards of Radiation Protection” [26] establishes the dose constraint of annual effective dose -0.2 mSv for the general public due to exposure resulting from airborne and waterborne discharges from the nuclear installation and the exposure resulting directly from the NI.

This dose constraint is applied for design, operation and decommissioning of nuclear installations during the normal operation conditions and anticipated operational occurrences. If radionuclides are released from several NI and in different ways (into the air and water), the dose constraint is distributed for each NI and each radionuclide pathway insomuch that the dose constraint would not be exceeded for the representative persons exposed by several NI situated in the same territory, irrespective if the impact is incurred by the same or different representative person.

In limiting discharge of radionuclides, internal and external exposure determining the annual effective dose of the representative person is considered. The cumulative annual effective dose (due to released radionuclides and direct external exposure) of the representative person shall not exceed the dose constraint of the annual effective dose - 0.2 mSv.

Based on the analysis performed in the INPP Report on Establishment of Data Required for Assessment of Exposure Doses due to Airborne and Waterborne Discharges, At-2371(3.166) [27], it was determined that the contribution of the airborne and waterborne discharges to the exposure dose of the representative person is of the same order of magnitude, thus, the annual effective dose due to each radionuclide discharge pathway (airborne and waterborne discharges) constitutes 0.1 mSv per year, i.e. half of the dose constraint of the annual effective dose - 0.2 mSv.

2 ENVIRONMENTAL MONITORING RESULTS

2.1 Radiological Monitoring Results

Radiological condition of the environmental components and the radiological situation within the Ignalina NPP sanitary protection zone (including the ISFSF/SWTSF site and Landfill Disposal Facility site) and the surveillance zone is evaluated based on radionuclide activity concentration measurement results in taken samples of the environmental components. The environmental components, their sampling periodicity and the sequence are established in the Radiological Environmental Monitoring Programme [28].

Find below the radiological monitoring results based on the Report of the INPP Region and Maišiagala Radioactive Waste Storage Facility Radiological Monitoring Results for Year 2023 [29].

2.1.1 Discharge of Radionuclides and Radionuclide Activity Concentration in the Atmospheric Air

The air volume discharged during 2023 into the atmosphere from the INPP organised airborne discharge sources amounted to 1.659E+10 m^3.

The total volume of long-lived radionuclides discharged into the atmosphere from the INPP during 2023 amounted to $4.266 \cdot 10^7$ Bq which made up 1.47 % from the limit discharge value of 2.90E+09 Bq/year, as set in the Plan on Radionuclide Releases into the Environment from the Ignalina NPP, No. MtDPl-5(3.254) [30]).

H-3 discharges amounted to 1.08E+10 Bq/year (0.11% from the limit discharge value of 1.01E+13 Bq/year, as set in [30]). C-14 discharges amounted to 5.79E+10 Bq/year (40.77% from the limit discharge value of 1.42E+11 Bq/year, as set in the Plan [30]).

The total activity of radionuclides discharged into the atmosphere during 2023 constituted 6.877E+10 Bq/year and was far below the permissible values set in the Plan [30] (the limit value of 3.81E+13 Bq/year). Co-60, Sr-90, Cs-137, H-3, C-14 mostly contributed to the activity of the overall discharges from all the on-site INPP nuclear installations.

Table 2.1-1 Radionuclide composition, discharge activity and the resultant dose of the representative person during 2023

Radionuclide	Released activity, Bq/year	Input to dose, %	Dose, Sv
Co-60	1.986E+07	14.46	1.948E-07
Sr-90	1.235E+06	0.83	1.113E-08
Cs-137	2.166E+07	54.34	7.321E-07
H-3	1.085E+10	0.08	1.064E-09
C-14	5.788E+10	30.30	4.081E-07
Total from all NI on the INPP site	6.877E+10	100.00	1.347E-06

Table 2.1-2 Activity discharged from the new NI and resultant doses of the representative person during 2023

Bld.	Activity released per year, Bq/year	Dose, Sv
B1 (ISFSF)	5.743E+08	3.778E-09
B2 (SWRF)	1.496E+07	1.468E-07
B34 (SWTSF)	1.917E+10	1.119E-07

Based on the exposure dose calculations, the total exposure dose of the representative person resulting from the radionuclide discharges into the atmosphere from the INPP in 2023 constituted 1.347E-03 mSv, what makes up 1.35 % of the half (0.1 mSv) of the dose constraint - 0.2 mSv.

2.1.2 Radionuclide Activity Concentration in the Atmospheric Precipitation

Based on the atmospheric precipitation measurement results from 15 sampling points installed within the INPP surveillance (SZ) and sanitary protection zones (SPZ), the natural radionuclides Be-7, K-40 mostly determined the radionuclide composition in precipitation in 2023. The total radionuclide activity concentration (Be-7, K-40 excluded) in the atmospheric precipitation during 2023 in SZ amounted to 0.042 10^4 Bq/(km^2 day), whereas in the SPZ it amounted to 0.62 10^4 Bq/(km^2 day).

The average concentration of Be-7 in SZ was 180 10^4 Bq/(km^2 day) ranging from 62.0 to 252 10^4 Bq/(km^2 day). The average concentration of Be-7 in SPZ was 93 10^4 Bq/(km^2 day) ranging from 23.3.0 to 124 10^4 Bq/(km^2 day).

The average concentration of K-40 in SZ was below the detection limit. The average concentration of K-40 in SPZ was 0.54 10^4 Bq/(km^2 day) ranging from 1.91 to 4.54 10^4 Bq/(km^2 day).

2.1.3 Radionuclide Activity Concentration in the Aquatic Environment

The water volume discharged from the organized waterborne discharge sources during 2023 amounted to 2.3E+06 m^3.

The total volume of radionuclides discharged into Lake Drūkšiai from the INPP with the wastewater during 2023 (including debalanced water[1]) constituted 4.626E+10 Bq/year (0.31% from the limit volume of 1.50E+13 Bq/year [30]). The list of discharged radionuclides and their activity values correspond to radionuclide discharges in 2022.

No Pu isotopes were detected in the water of the inlet and discharge channels. The detection limit of Pu-239+240 does not exceed 0.0002 Bq/kg.

The total annual Tritium activity discharged into Lake Drūkšiai through all organized waterborne discharge sources in 2023 amounted to 0.31% of the annual Tritium discharge limit (1.50E+13 Bq/year) specified in the Plan on Radionuclide Discharges into the Environment from the Ignalina NPP [30].

The total annual Cs-137 activity discharged into Lake Drūkšiai through all organized waterborne discharge sources in 2023 amounted to 0.22% of the annual Cs-137 discharge limit (3.00E+09 Bq/year) specified in the Plan on Radionuclide Discharges into the Environment from the Ignalina NPP [30].

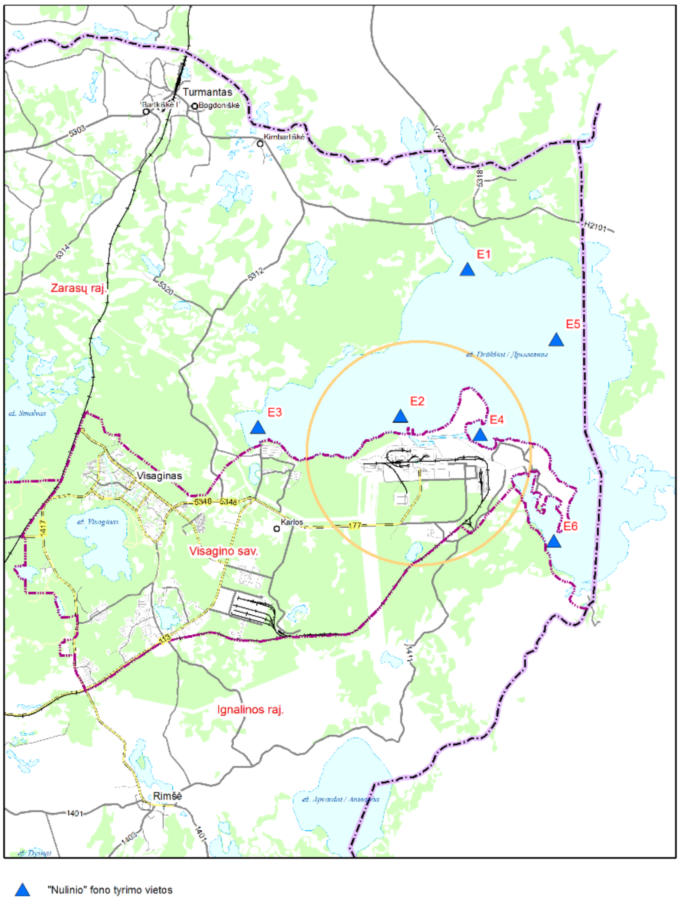
The total annual Co-60 activity discharged into Lake Drūkšiai through all organized waterborne discharge sources in 2023 amounted to 1.04% of the annual Co-60 discharge limit (4.644E+08 Bq/year) specified in the Plan on Radionuclide Discharges into the Environment from the Ignalina NPP [30].

[1] Debalansed water is the wastewater originating due to processing of the liquid radioactive waste, then cleaned following the normative requirements and discharged (directed) to the water body.

Figure 2.1-1 Layout of water sampling points

IK, PK, GPNN-1,2, GPNN-3, GPNN-SPBKS (Lithuanian abbreviation) denoting the channels as presented in the order below:

- (IK) Discharge channel – service water discharge from Bld. 101/1,2;
- (PK) Inlet channel;
- (GPNN-1,2) Industrial and Surface Wastewater Drainage channels 1,2 – discharge of rainwater and melted snow from the entire INPP site, discharge of service and debalanced water from Bld. 150 (INPP Liquid Radioactive Waste Treatment and Bituminising Facility);
- (GPNN-3) Industrial and Surface Wastewater Drainage channel 3 – discharges of process equipment located in Bld. 120/1,2 (pumping stations) and drainage water from Bld. 101/1,2;
- (GPNN-PBKS) Dry Type Spent Fuel Storage Facility (the old storage facility) site channel – discharge of rainwater from this site and household wastewater.



(▲ Sampling locations)

Figure 2.1-2 Baseline sampling locations in Lake Drūkšiai

The estimation of the dose of the representative person due to radionuclide discharges into Lake Drūkšiai is provided Table 2.1-3.

Table 2.1-3 Dose of the representative person due to radionuclide discharges into Lake Drūkšiai in 2023

Radionuclide	Activity discharged, Bq/year	Dose, Sv
H-3	5.00E+10	4.06E-08
Co-60	2.74E+07	1.77E-07
Sr-90	0	0
Cs-137	1.39E+07	3.93E-07
Total	**4.63E+10**	**2.56E-07**

The estimated dose of the representative person due to radionuclide discharges into Lake Drūkšiai (including debalanced waters) equalled to 2.56E-04 mSv and it made up 0.3 % of the half (0.1 mSv) of the dose constraint – 0.2 mSv.

The total estimated dose to the representative person during 2023 due to airborne and waterborne discharges from the INPP equalled to 1.603E-03 mSv, which was 124.7 times less than the dose constraint of the representative person - 0.2 mSv/year.

2.1.4 *Radionuclide Activity Concentration in the Water of Monitoring Wells*

Within the framework of the Radiological Environmental Monitoring Programme [28] monitoring of the condition of the ground water, its chemical and radiological composition is performed. Periodicity and monitoring scope of the ground water parameters is established in the Radiological Environmental Monitoring Programme [28]. Twice a year, in spring and autumn, the ground water level, gamma nuclide composition, Sr-90 and H-3 are measured.

The layout of monitoring wells within the territory of the ISFSF/SWTSF and the Landfill Disposal Modules is provided in Fig. 2.1-3.

The measurement results of radionuclide activity concentration in the water of monitoring wells in the vicinity of the ISFSF/SWTSF showed that H-3 concentration in the water of almost all of the monitoring wells on the ISFSF/SWTSF territory was 0 Bq/kg. H-3 concentration of 3.65 Bq/kg was measured in only one monitoring well (54319) during 2023 and could be compared to tritium concentration values in natural environment (1÷4 Bq/kg, in non-contaminated surface waters and rainwater [31], but they were significantly lower than the value of tritium activity concentration of unconditional clearance level, equal to 100 kBq/kg^{-1} [32]. Radiochemical analysis of Sr-90 and gamma spectrometric radionuclide measurements showed that Sr-90 activity concentrations during 2023 remained at the same level as during the previous years and varied within the range of <0.0000574 and 0.000603 Bq/kg and could be compared with the background concentrations.

The measurement results of radionuclide activity concentration in the water of monitoring wells in the vicinity of the Landfill Disposal Modules showed that H-3 concentration in the water of almost of all of the monitoring wells on the Landfill Disposal Modules territory is 0 Bq/kg with the exception of one well (44037) where H-3 activity concentration was equal to 10.6 Bq/kg. Radiochemical analysis of Sr-90 and gamma spectrometric radionuclide measurements showed that Sr-90 activity concentrations during 2023 remained at the same level as during the previous years (preoperational (baseline) monitoring results) and could be compared with the background concentrations (the range of Sr-90 values in 2023 was between <0.0000868 and 0.000162 Bq/kg).

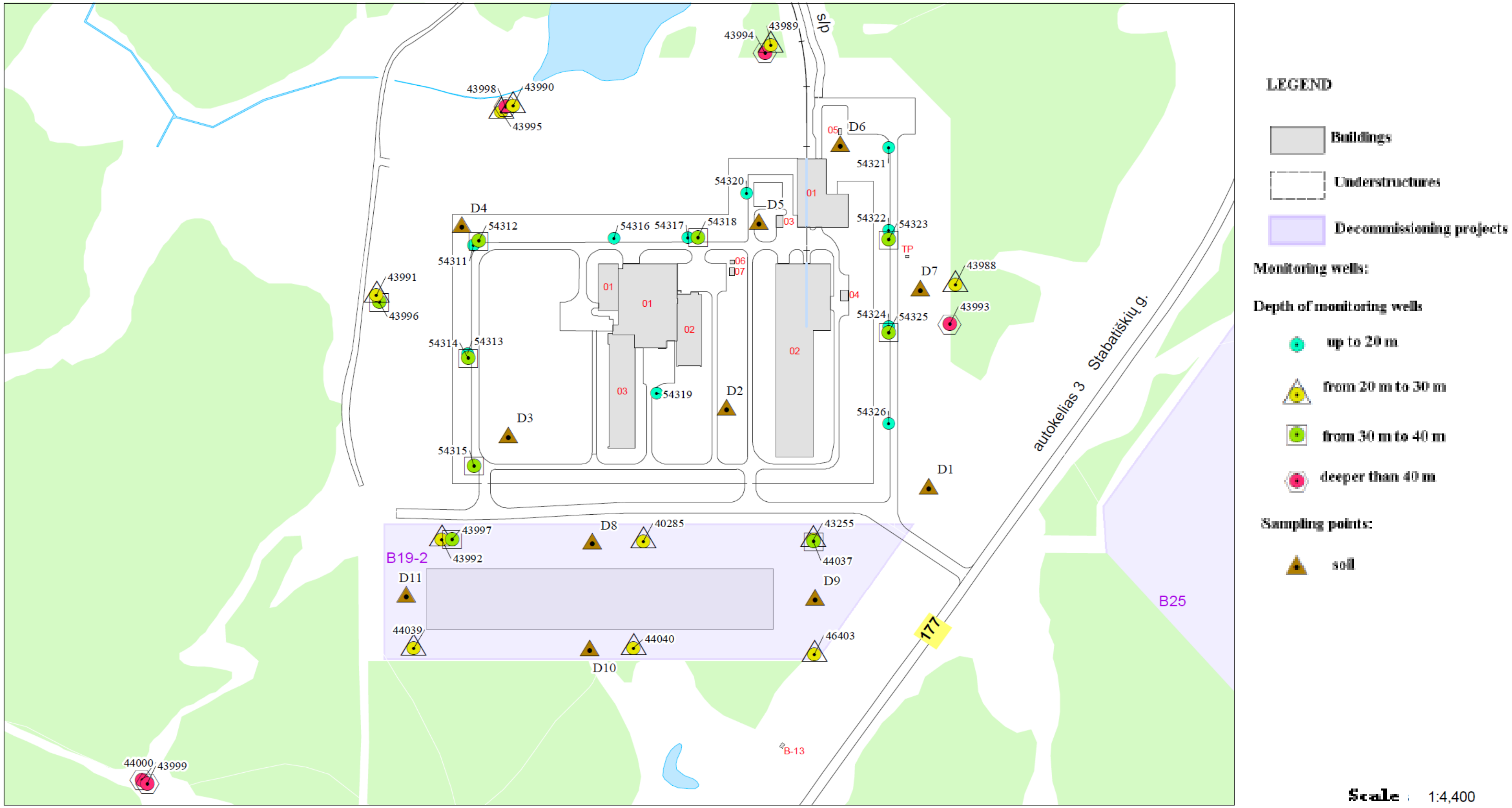


Figure 2.1-3 Layout of monitoring wells within the territory of ISFSF/SWTSF and Landfill Disposal Modules (B19-2)

The measurement results of radionuclide activity concentration in the water of monitoring wells in the vicinity of the SWRF showed that H-3 concentrations in most of the monitoring wells varied between 0 and 84.3 Bq/kg with the exception of two monitoring wells that demonstrated higher H-3 concentration values in the water of monitoring wells close to the SWRF reaching 898 Bq/kg (monitoring well 29202) and 1508 Bq/kg in the water of monitoring well 29535 located in the vicinity of Bld. 157/1 (see Fig. 2.1-4 the layout of the monitoring wells in this area), but which is lower than H-3 concentration value measured during 2022 (1990 Bq/kg) and which is still lower than the value of tritium activity concentration of unconditional clearance level, equal to 100 kBq/kg^{-1} [32]. The increased tritium concentration in the water of the monitoring wells located close to the Interim Radioactive Waste Storage Facilities (Bld. 155, 155/1, 157, 157/1) was already detected in 1995 in the water of the monitoring wells located around the Bld. 155 and the industrial waste storage site. As the underground transfer of most of radionuclides is a very slow process, the potential cause of origination of higher Tritium concentrations in these monitoring wells is due to presence of H-3 sources in the waste, i.e. assumingly broken flashing warning signs "Exit" containing Tritium of the activity more than 1 Curie. The calculations showed that H-3 activity in the dumped waste will meet the conditional clearance levels until 2028-01-01. The radiological impact to the representative person of the untight flashing warning signs was assessed for hypothetical enveloping scenarios and the calculations showed that the radiological impact is assessed as of low significance (the conservatively assessed exposure of the representative person is less than 1 μSv) [33].

Radiochemical analysis of Sr-90 and gamma spectrometric radionuclide measurements showed that Sr-90 activity concentrations during 2023 were in the range of <0.000113 and 0.000319 and could be compared with the background concentrations.

Performed measurements also showed that only very negligible traces of Co-60 characteristic for the nuclear industry radioactive waste were detected just in several monitoring wells (in the vicinity of Bld. 157/1) (ranging between 0.02 and 0.98 Bq/kg) and has the tendency for decrease in comparison with the previous year monitoring results, see Report on the Implementation of the Post-Project Analysis Programme for the New INPP Nuclear Installations for Year 2022.

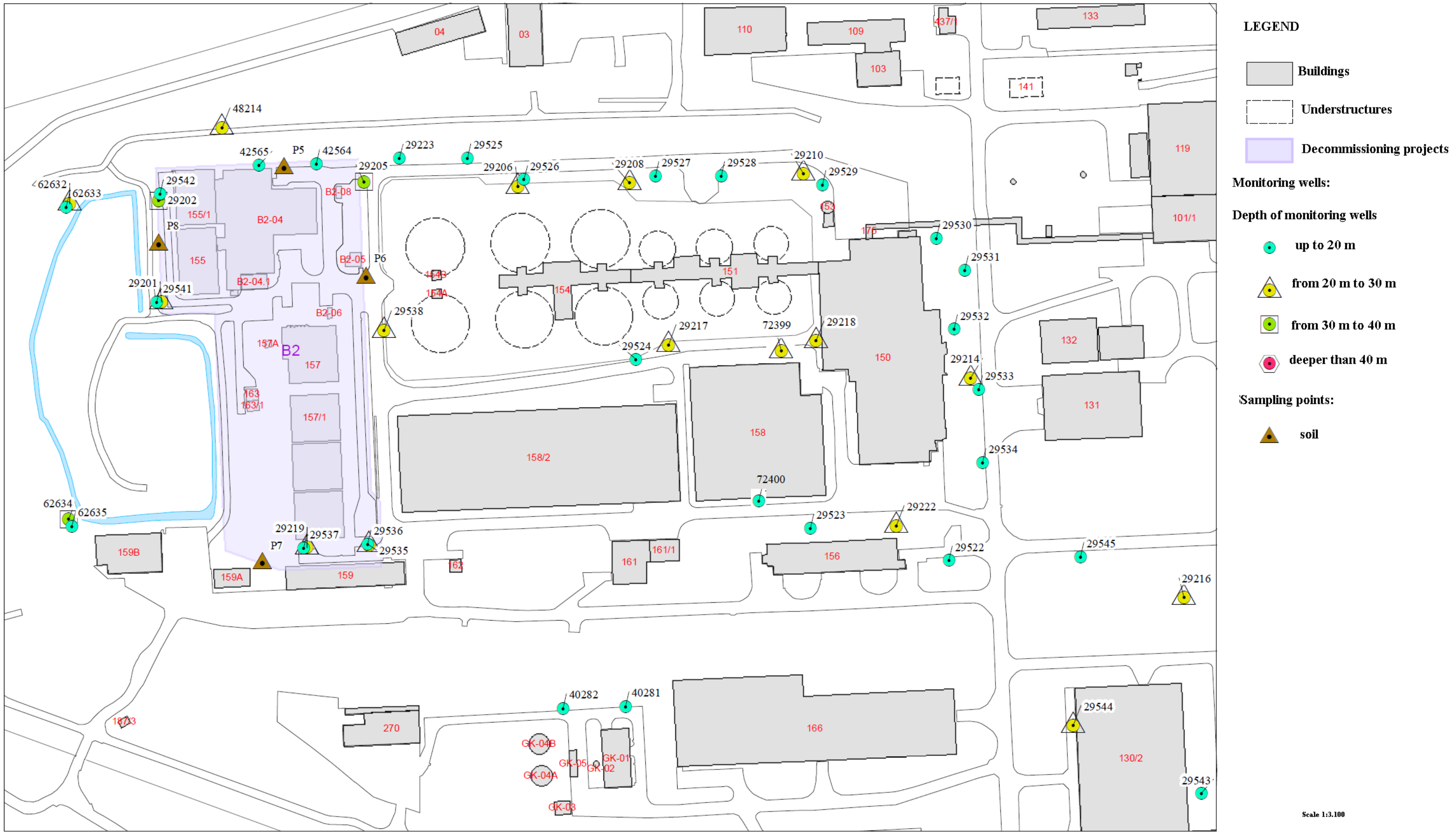


Figure 2.1-4 Layout of monitoring wells within the territory of Interim Radioactive Waste Storage Facilities

Figure 2.1-5 represents Tritium concentration fluctuation close to the Interim Radioactive Waste Storage Facilities clearly showing the tendency for decrease.

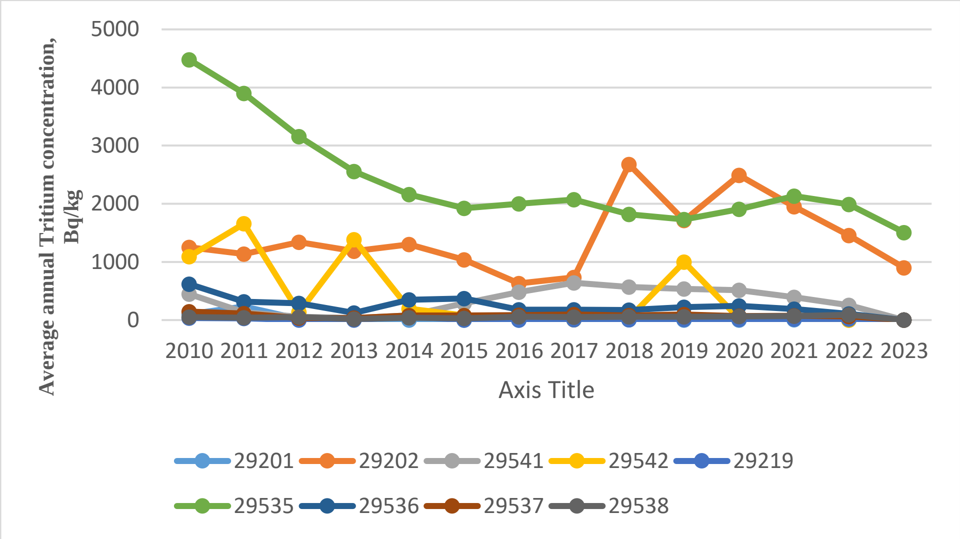


Figure 2.1-5 Tritium concentration in the water of monitoring wells located in the vicinity of the Interim Radioactive Waste Storage Facilities

Based on the multiyear monitoring data, the radionuclide activity concentration in water of monitoring wells indicate the clearly expressed tendency for decrease therefore it could be stated that this indicates sufficiently good state of the physical barriers providing radionuclide confinement. Continuous functioning and control of the INPP buildings drainage systems also serve as preventive measure against contamination of the groundwater. Migration of H-3 towards Lake Drūkšiai is not observed since the increased values of H-3 were not detected in the water of the sampling point GPNN-1 (see Fig. 2.1-1) located in the close vicinity to the above indicated monitoring well.

To assess the potential consequences due to the increased Tritium concentration in the groundwater, the conservative assessment of the cumulative effective dose due to Tritium impact on the human body after its consumption was performed. Based on the European Commission publication „Methodology for Assessing the Radiological Consequences of Routine Releases of Radionuclides to the Environment“ on average 600 litres intake rate is assumed in assessment for the tritium model. If the tritium concentration is 1508 Bq/kg (one of the highest Tritium concentrations in year 2023 close to SWRF), then $9.05*10^5$ Bq would get into the human body. The annual effective dose of the representative due to tritium impact as a consequence of water consumption as the only source of potable water is equal to 0.0163 mSv and is lower than the dose constraint of the annual effective dose - 0.2 mSv set in the Lithuanian Hygiene Standard HN 73:2018 “Basic Standards of Radiation Protection” [26]. It should be noted that the water from the monitoring wells located on the INPP site is not intended for human consumption or any other human needs.

2.1.5 Radionuclide Activity Concentration in the Soil

The ISFSF, SWTSF, SWRF and the Landfill Disposal Modules operation did not have impact on the radionuclide activity concentration in the soil of the INPP region. K-40, Th-232 and Ra-

226 and the globally distributed in the atmosphere radionuclide Cs-137[2] mostly contribute to the soil activity (natural radionuclides K-40, Th-232 and Ra-226 are not released from the INPP). The radionuclide activity concentration (Ra, Th, K excluded) in the soil of the ISFSF/SWTSF was in the range of 0.70 and 6.54 Bq/kg, whereas radionuclide activity concentration (Ra, Th, K excluded) in sampling points of the SWRF were in the range between 8.37 to 42.2 Bq/kg. Radionuclide activity concentration (Ra, Th, K excluded) in sampling points on the Landfill Disposal Modules area were in the range between 0 to 9.07 Bq/kg. The total radionuclide activity concentration in the soil samples of the INPP region shows the tendency for decrease.

2.1.6 Radionuclide Activity Concentration in the Bottom Sediments of Water Bodies (not related to the ISFS, SWTSF, SWRF and Landfill Disposal Modules operation)

in 2023 is provided in Table 3.1-16..

Natural radionuclides K-40, Th-228 and Ra-226 (not discharged from the INPP) mostly contributed to the activity of bottom sediments of water bodies (the layout of sampling points is provided in Fig. 2.1-1 and Fig. 2.1-2). The total radionuclide activity concentration (K-40, Th-228 and Ra-226 excluded) in bottom sediments of water bodies in 2023 was 36 Bq/kg. The average Cs-137 activity concentration was 32.5 Bq/kg and the average Sr-90 activity concentration was 3.51 Bq/kg. Cs-137 and Sr-90 background concentrations in bottom sediments of Lake Drūkšiai during the start-up period varied between 44 and 170 Bq/kg (Cs-137) and from 0.9 to 1.3 Bq/kg (Sr-90) for dry mass. Specific radionuclide activity concentrations during 2023 were within the level of the background values.

2.1.7 Radionuclide Activity Concentration in Plants and Foodstuff

No nuclear origin radionuclides were detected in vegetative and animal products sampled during 2023. The total annual exposure dose due to consumption of measured products due to induced radionuclide activity constituted $15.9 \cdot 10^{-4}$ mSv and was practically in line with the previous year's results. The calculated exposure dose due to consumption of fish amounted to $6.54 \cdot 10^{-4}$ mSv and due to consumption of mushrooms - to $9.32 \cdot 10^{-4}$ mSv.

Measurements showed that natural radionuclides K-40 and Be-7 make the biggest contribution to the total specific activity of algae during 2023. The total specific radionuclide activity concentration (K, Be, Th, Ra excluded) in algae varied in the range of 0.68 and 23.7 Bq/kg.

2.1.8 Dose Rate. Exposure Dose

The INPP environmental monitoring includes monitoring of the exposure dose and dose rate in different locations of the INPP region. Continuous dose rate monitoring is performed by the "Skylink" system stationary gamma detectors. 12 detectors are installed in the INPP SPZ (Fig. 2.1-6). 10 detectors are installed in the 30 km surveillance zone (Fig. 2.1-7). In addition to

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[2] Globally distributed in the atmosphere radionuclide Cs-137 is one of the major radioactive contamination components of the biosphere, mostly originating due to nuclear weapon tests and nuclear accidents. Cs-137 is the main fission product of the nuclear fission of uranium-235 (reactor fuel). Since Cs-137 concentrations measured in the environmental components in the INPP surroundings are at the background values level, separation of globally distributed in the atmosphere Cs-137 from the INPP activity induced Cs-137 is not possible. Therefore, the INPP controls radionuclide composition and activities in all airborne and waterborne discharges into the environment from all the NI located in the INPP SPZ, including also Cs-137, as well as possesses authorisations for discharge of respective amounts of radionuclides that are agreed in the procedure established by the legal acts of the Republic of Lithuania. Each year INPP performs environmental impact assessment of the activities conducted by the INPP NI, also encompassing assessment of Cs-137 impact.

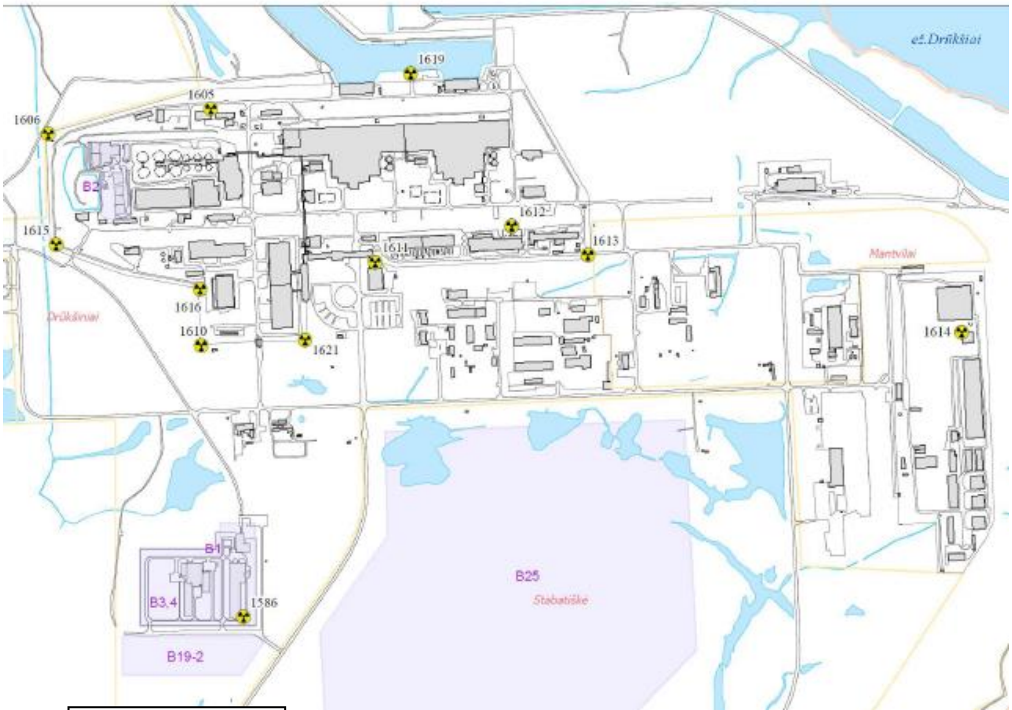
stationary detectors, dose rate is measured by portable devices 4 times per year in various locations of the surveillance zone.

The measured dose rate within the surveillance zone was between 0.069 and 0.189 μSv/h during 2023. During 2023 the average dose rate within the surveillance zone was 0.101 μSv/h. The maximum dose rate value (up to 0.189 μSv//h) was detected in case of intensive precipitation (22.6 mm, 25 July 2023).

The measured dose rate within the sanitary protection zone was between 0.071 and 0.181 μSv/h during 2023. During 2023 the average dose rate within the sanitary protection zone was 0.102 μSv/h.

The average gamma radiation dose rate in the INPP region measured by the portable dosimeters was 0.090 μSv/h in 2023. The average dose rate of the representative persons, living in the surveillance zone, due to external radiation background measured by the portable dosimeters was 0.79 mSv/year in 2023.

The radiological impact to the population and the environment due to nuclear origin radionuclides detected in the atmosphere and water media is far below than the impact due to cosmogenic radionuclides and the globally distributed in the atmosphere radionuclide Cs-137.



Skylink system detectors

Figure 2.1-6 Layout of the Skylink system gamma detectors within the INPP 3 km zone

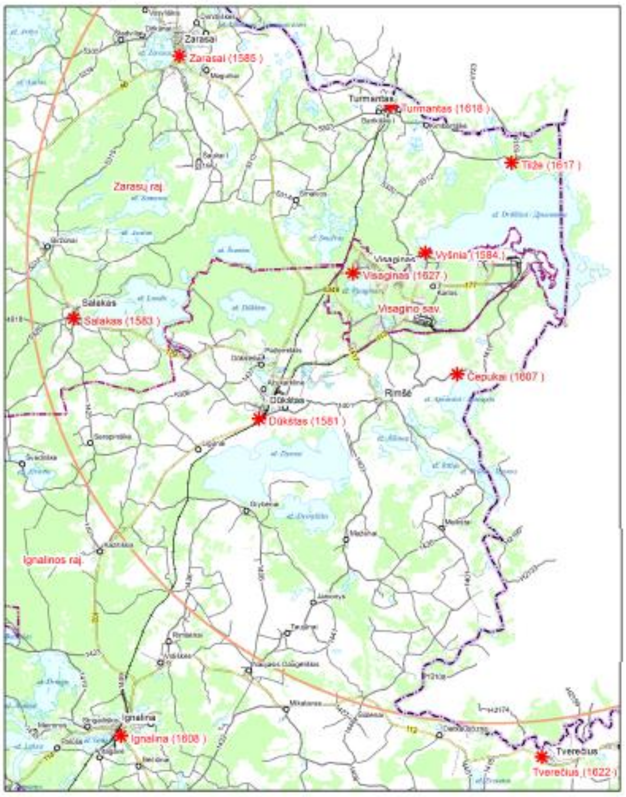


Figure 2.1-7 Layout of the Skylink system gamma detectors within the INPP 30 km zone

The annual ambient dose equivalent of the representative person due to all gamma radiation sources in the sanitary protection zone and surveillance zone continuously measured by 25 thermoluminescent dosimeters (Fig. 2.1-8) was in the range of 0.35 mSv and 0.80 mSv with the average value of 0.56 mSv in 2023.

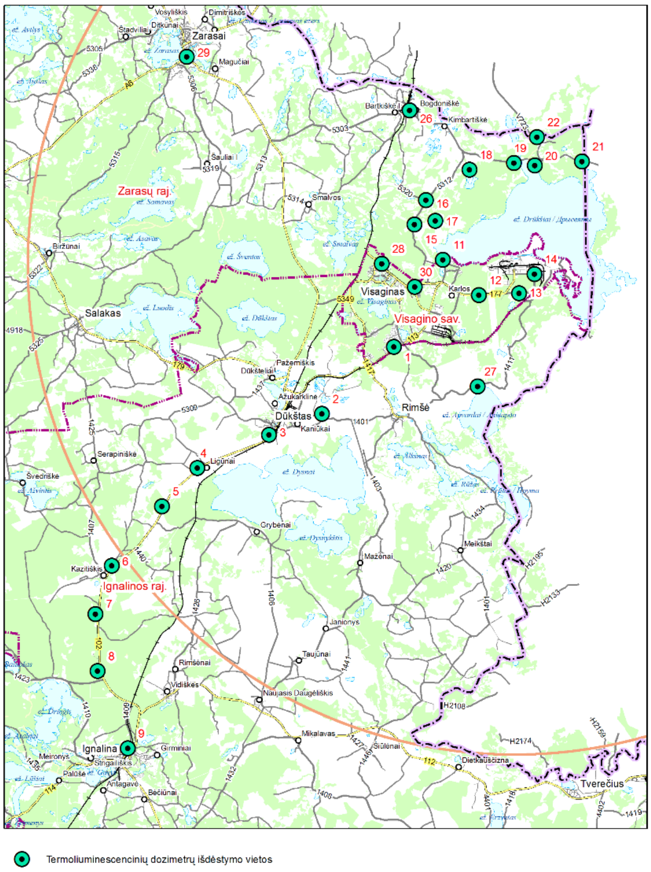


Figure 2.1-8 Layout of TLD dosimeters in the INPP area

The annual ambient dose equivalent measurements on the ISFSF/SWTSF site are performed continuously by 17 thermoluminescent dosimeters (8 dosimeters around the ISFSF and 9 dosimeters around SWTSF) (Fig. 2.1-9). The estimated average annual ambient dose equivalent of the representative person in 2023 based on TLD measurement results was in the range of 0.54 and 0.62 mSv with the average value of 0.57 mSv.

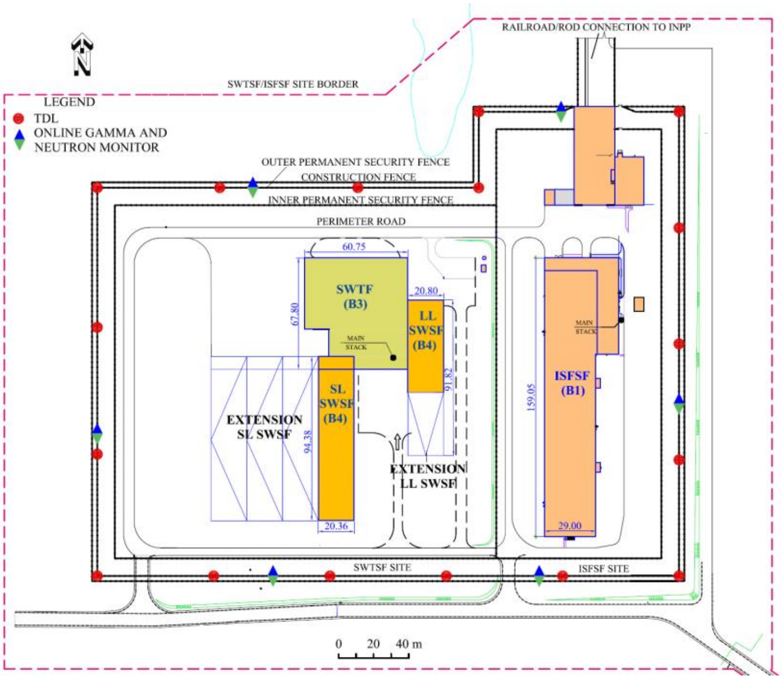


Figure 2.1-9 Layout of TLD, gamma and neutron dosimeters on the ISFSF/SWTSF sites

The annual ambient dose equivalent measurements on the Landfill Disposal Modules site are performed continuously by 15 thermoluminescent dosimeters. The estimated annual ambient dose equivalent of the representative person on the Landfill Disposal Modules site based on TLD measurement results was in the range of 0.47 and 0.65 mSv with the average value of 0.24 mSv.

2.1.9 *Conclusions*

The operation of the ISFSF, SWRF, SWTSF and the Landfill Disposal Modules did not have impact on the radiological situation within the INPP sanitary protection zone and the surveillance zone in 2023, as:

- No radionuclides that had not been identified in the Plan on Radionuclide Release into the Environment from the Ignalina NPP [30] were identified in airborne discharges from the ISFSF, SWRF, SWTSF and the Landfill Disposal Modules, including no other radionuclide discharge pathways had been identified.
- During the operation of the ISFSF, SWRF and SWTSF discharged radionuclide activities (5.743E+08 Bq/year, 1.496E+07 Bq/year and 1.917E+10 Bq/year, respectively) were far below the permissible values set in the Plan [30] (limit value of 3.81E+13 Bq/year) and it constitutes the input of 28.8% into the total annual airborne radionuclide discharges from all the nuclear installations on the INPP site.
- The contribution of radionuclides discharged from the ISFSF, SWRF and SWTSF into the total exposure dose due to airborne discharges from all the INPP nuclear installations constitutes 3.788E-09 Sv, 1.468E-07 Sv and 1.119E-07 Sv, correspondingly, and the total exposure dose of the representative person due to airborne discharges from all the NI on the INPP site is equal to 1.347E-03 mSv and constitutes 1.35 % of the half (0.1 mSv) of the dose constraint - 0.2 mSv [26].
- No uncontrolled waterborne discharges into the environmental waters during the normal operation of the new nuclear installations have been detected. The total volume of radionuclides discharged into the environmental waters from other NI on the INPP site was 4.626E+10 Bq/year (0.31% from the limit value of 1.50E+13 Bq/year). The estimated dose of the representative person due to radionuclide discharges into Lake Drūkšiai (including debalanced waters) is equal to 2.56E-04 mSv and it makes up 0.3 % of the half (0.1 mSv) of the dose constraint – 0.2 mSv [26].
- The total estimated dose to the representative person during 2023 due to airborne and waterborne discharges from all the INPP nuclear installations is equal to 1.603E-03 mSv which is 124.7 times less than the dose constraint of the representative person - 0.2 mSv/year [26].
- The radiological impact to the population and the environment due to nuclear origin radionuclides detected in the atmosphere and water media is far below than the impact due to cosmogenic radionuclides and the globally distributed in the atmosphere radionuclide Cs-137.
- No operational occurrences breaching the safe operating limits and conditions have occurred. All the required accident elimination instructions and plans related to the ISFSF, SWRF, SWTSF and the Landfill Disposal Modules operation are developed and tested regularly.
- No uncontrolled radionuclide airborne and waterborne discharges from the ISFSF, SWRF, SWTSF and the Landfill Disposal Modules to the environment have been detected.

- Operation of the SWRF facility, i.e. retrieval and further processing of the stored INPP operational radioactive waste from the existing interim radioactive waste storage facilities (Bld. 155, 155/1, 157, 157/1) will improve the groundwater state.
- The ISFSF, SWRF, SWTSF operation and the Landfill Disposal Modules regular radioactive waste loading campaign and subsequent radioactive waste storage, including operation of all other INPP nuclear installations did not have negative impact on the health of the population and the environment of the neighbouring countries.

Besides, based on the measurements conducted by the Radiation Protection Centre of the Republic of Lithuania during 2023 within the scope of the State Environmental Monitoring Programme 2018–2023 encompassing, among others, monitoring of airborne and waterborne discharges from the Ignalina NPP and radiological measurements of Lake Drūkšiai water, bottom sediments and biota and the summarised results provided in the State Radiological Environmental Monitoring Report for Year 2023 [34], it is concluded that:

- The analysis of obtained radiological environmental monitoring survey and measurements results show that the radiological situation of the environment did not change due to the INPP activities, no higher-than-normal volumes of radioactive substances in the environment were detected;
- The average annual ambient dose equivalents in the Ignalina Region (0.64±0.05 mSv) reliably did not differ from the average annual ambient dose equivalent values in other measuring points within the territory of the Republic of Lithuania. For comparison in the Kupiškis region, with no industrial enterprises and located at a sufficient distance from the INPP, it constituted 0.66±0.06 mSv. Therefore, it indicates that decommissioning activities carried out at the Ignalina NPP do not cause additional exposure of the population of Lithuania;
- Contamination of foodstuffs (meat, fish, milk, grain, vegetables) and drinking water by Cs-137 and Sr-90 was negligible. The analysed radionuclide activity concentrations in samples from the INPP region do not differ from the activity concentrations in samples taken from other regions of Lithuania. The activity concentrations of radionuclides in most of the taken samples is less than 0.1 Bk/kg;
- Cs-137 and Sr-90 activity concentration values in water samples of Lake Drūkšiai are below the minimum detection activity during the last decade;
- Cs-137 and Sr-90 activity concentrations in bottom sediments and vegetation of Lake Drūkšiai show clear tendency for decrease for the last decade.

2.2 Chemical Monitoring Results

The scope of monitoring of the chemical parameters is established in the INPP Environmental Monitoring Program [35] and the Summarising Report on Monitoring of the Impact of the Facilities located on the SE INPP Territory to the Groundwater for Years 20017-2021 and the Programme for Years 2022-2026 [36].

The results of Lake Drūkšiai water chemical monitoring performed by the accredited INPP Laboratories according to the INPP Environment Monitoring Program [35] are provided in Table 3.2-1. Sampling locations are provided in Fig. 3.2-1.

According to the data of Table 3.2-1, Lake Drūkšiai water quality indicators comply with the established norms. According to the physical and chemical quality elements indicators values based on the results of the Environmental Monitoring Report [37] Lake Drūkšiai water quality complies with the criteria established for lakes of good (according to N total content) and very good (according to P total content) ecological state [38].

Table 2.2-1 Pollutants concentration in water of Lake Drūkšiai

Parameters	Limit values according to the established norms	2023	
		Min. values	Max. values
t, ^{0}C	28	6.9	25.8
pH,	6 – 9	6.3	8.4
Suspended solids, mg/l	≤25	2,3	5.7
BOD_7, mgO_2/l	≤ 6	0.6	2.8
COC, mgO_2/l		30	50
NH_4-N content, mg/l	≤0.78	<0.036	<0.036
NO_3-N content, mg/l	-	0,046	0.271
NO_2-N content, mg/l	≤0.045	0,011	0.021
N total content, mg/l	0.9-1.20	0.21	0.65
PO_4-P content, mg/l	≤0.13	<0.035	0.044
P total content, mg/l	0.030-0.050	0.030	0.049
Petroleum products content, mg/l	0.2	0.059	0.750

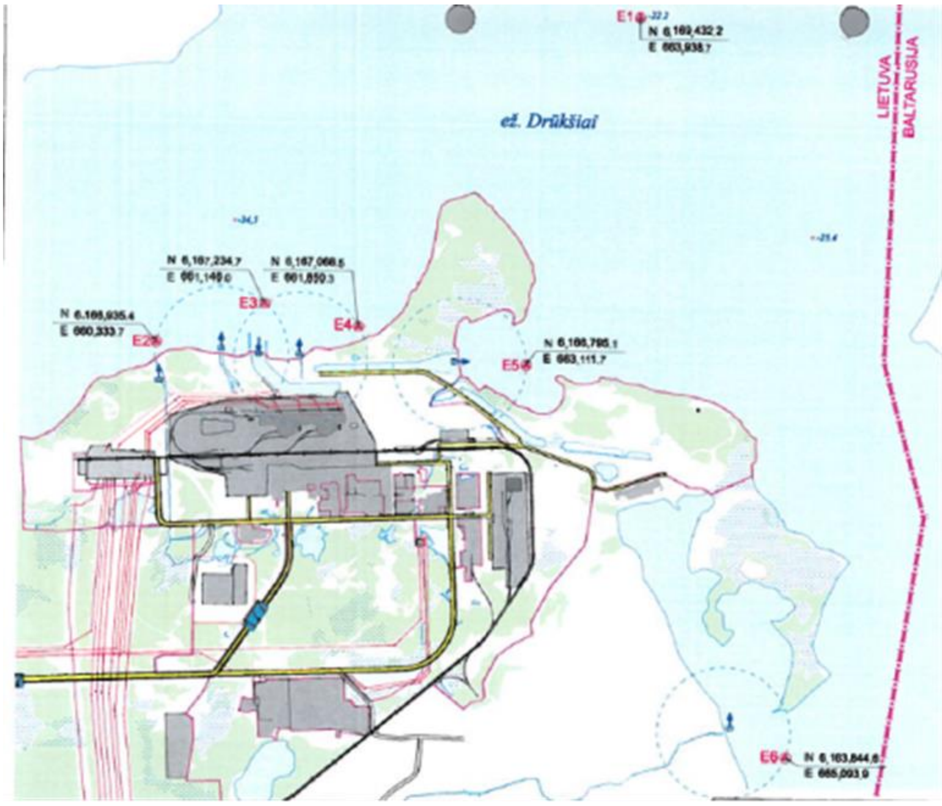


Fig. 2.2-1 Lake Drūkšiai Water Sampling Locations

Regarding the atmospheric air pollution from the established air pollution source (Steam Boiler Plant) during the monitored period (2023), it could be stated that the measured values do not exceed the limit values set in the Permit for Pollution No. TV(2)-3 /TL-U.5-13/2016 [39] and are in line with the discharge values measured in 2022.

In compliance with the Regulation of Environmental Monitoring of Economic Entities [40] analysis of data on monitoring of the impact to the underground water and the related conclusions are performed and submitted each 5 years. The certified INPP laboratory develops simplified annual monitoring reports providing the performed measurement data and the 5-year period aggregated data are summarised in the report developed by the contracted company. The last 5-year period report is developed for the period 2017-2021. The next 5-year reporting period expires in 2026.

In compliance with the Summarising Report on Monitoring of the Impact of the Facilities located on the SE INPP Territory to the Groundwater for Years 2017-2021 and the Programme for Years 2022-2026 [36] developed on the basis of the requirements of the Regulation of Environmental Monitoring of Economic Entities [40] the following general chemical composition parameters, general pollution indicators and indicators specific to the INPP activity and produced waste are measured 2 times/year: groundwater level, temperature, pH, oxygen concentration, electric conductivity, total chemical analysis (dissolved solids total. hardness total, Permanganate, Bichromate index, Cl, SO_4, NO_2, NO_3, Na, K, Ca, Mg, NH_4), COD, petroleum products total content, heavy metals content, Nitrogen (N), Phosphate (P) total content, PO_4, BOD_7.

In summarising the annual groundwater monitoring results [36], it should be stated that the measured values of the following monitored microelements/heavy metals Cd, Cr, Cu, Hg, Zn did not exceed the maximum permissible concentrations (hereafter referred to as MPC), but the measured values of Pb, Ni in several monitoring wells increased in comparison with the monitoring results of the previous years. Such increase of heavy metals concentrations in the groundwater of the INPP territory stands out against the clean hydrochemical background of the groundwater of the INPP territory according to the other measured parameters and could be explained by the fact that a specific rarely found hydrogeological environment has formed in this area that is favourable for accumulation and migration of these metals.

The episodic groundwater pollution by petroleum products is observed, but not exceeding the MPC (1 mg/l) and the tendency for reduction is observed. Results of measurement of such parameters as electric conductivity, water temperature, pH, dissolved oxygen show that neither increased salinity of the water, nor abnormal temperatures are observed. In most cases pH of monitoring wells water is within the range of 7-8. However increased acidity (pH<7) of the water is observed in the vicinity of the Solid Radioactive Waste Retrieval Facility and the area between the Units and Lake Drūkšiai. This may be related to technological processes carried out in these facilities using acids. Increased alkalinity (pH>8, pH>10-12) of the water is observed in the area between the Units and Lake Drūkšiai and the Buffer Storage of the Landfill Disposal Facility and is related to degradation of organic materials.

Analysis of Cl, SO_4, NO_2, NO_3, Na, K, Na, Ca, Mg, NH_4-N in samples indicate that only NH4-N is of concern (MPC – 10 mg/l). The maximum values are observed in shallow monitoring wells in the vicinity of the recultivated wastewater sludge dumping site reaching 35.2 – 63.5 mg/l. However, in deeper monitoring wells the values are within the range of background level and do not exceed 0.5 mg/l, thus indicating that only shallow ground water is polluted by sludge.

Permanganate index does not exceed the established value of <20 mg/l O_2 in water of none of the monitoring wells, however BI/COD (MPC<30 mg/l O_2) values within the range of 30 – 100 mg/l O_2 (average pollution level) are detected. The maximum measured values of BOD7 (MPC 29 mg/l O_2) in the water of monitoring wells close to the recultivated wastewater sludge dumping site (the only monitoring point) reached only 8.4 – 8.5 mg/l O_2 and are considered as negligible.

The total content of Nt (MPC - 30 mg/l) and Pt (MPC - 4 mg/l), as well as PO_4-P (MPC - 3.3 mg/l) are also measured only in the water of monitoring wells close to the recultivated wastewater sludge dumping site and the maximum values of Nt reaches 34.2- 58.3 mg/l. All this nitrogen is bonded into ammonium. The maximum values of Pt and PO_4-P are far below the established MPC and are negligible.

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DETALŪS METADUOMENYS	
Dokumento sudarytojas (-ai)	Lietuvos Respublikos aplinkos ministerija 188602370, A. Jakšto g. 4, LT-01105 Vilnius
Dokumento pavadinimas (antraštė)	REPORT ON IMPLEMENTATION OF THE POST-PROJECT ANALYSIS PROGRAMME FOR THE NEW INSTALLATIONS OF IGNALINA NUCLEAR POWER PLANT
Dokumento registracijos data ir numeris	2024-09-06 Nr. D8(E)-4151
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Dokumento specifikacijos identifikavimo žymuo	ADOC-V1.0
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Parašą sukūrusio asmens vardas, pavardė ir pareigos	Justas Ruškys, Viceministras
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Pridedamo dokumento pavadinimas (antraštė)	–
Pridedamo dokumento registracijos data ir numeris	–
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