PLANNED ECONOMIC ACTIVITY

DECOMMISSIONING OF THE IGNALINA NPP

The planned economic activity is not considered to be of overriding public interest and is not considered to be important for public security

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Version 1

2025

This project is funded by the Ignalina Programme of the EUROPEAN UNION Grant No. 1A.23/02/EIA.01

The Ignalina Programme is a financial instrument to support the Republic of Lithuania in the safe decommissioning of Ignalina Nuclear Power Plant.

Name of the planned economic activity	**Decommissioning of the Ignalina NPP** The planned economic activity is not considered to be of overriding public interest and is not considered to be important for public security
Location of the planned economic activity	**Utena County, Visaginas Municipality, State Enterprise Ignalina Nuclear Power Plant** **Land plot No. 4400-2111-1391**
EIA report revision	**1**
Year of preparation	**November 2025**
Organiser of the planned economic activity	**State Enterprise Ignalina Nuclear Power Plant** Address: Ignalina NPP, Elektrinės str. 4, K47, Drūkšiniai village, 31152 Visaginas municipality, Lithuania Website: www.altra.lt Contact person: Viktorija Mirošnik Phone: +370 682 61 989 E-mail: viktorija.mirosnik@altra.lt

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Developer of Environmental Impact Assessment	**Public institution "Lithuanian Energy Institute"** **Nuclear Engineering Laboratory** Address: Lithuanian Energy Institute, Breslaujos str. 3, 44403 Kaunas, Lithuania Website: www.lei.lt
EIA Report Preparation Leader	Habil. Dr. Povilas Poškas Phone: +370 37 401 891 E-mail: Povilas.Poskas@lei.lt
Authors of the EIA report	

Author	Phone	Chapters prepared
P. Poškas	+370 37 401 891	1, 4, 5, 6, 8, 10
V. Ragaišis	+370 37 401889	1, 2, 4, 5, 8, 9, 10
A. Šmaižys	+370 37 401890	3, 4, 5, 6, 7, 8, 10
A. Sirvydas	+370 37 401888	3, 5, 8, 10
A. Šimonis	+370 37 401902	2, 3, 5, 7, 10
E. Narkūnas	+370 37 401883	3, 4, 5, 10
R. Poškas	+370 37 401929	3, 5, 7
R. Kilda	+370 37 401992	3, 4, 6
D. Grigaliūnienė	+370 37 401992	4, 5, 8
G. Poškas	+370 37 401840	3, 4, 5
J. Ulickas	+370 687 81345	3, 4, 5
S. Subačiūtė	+370 37 401887	Vertimas

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NUCLEAR ENGINEERING LABORATORY

CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT OF THE DECOMMISSIONING PROCESS OF THE IGNALINA NPP

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Revision 1

Habil. Dr. P. Poškas

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Authors: P. Poškas, V. Ragaišis, A. Šmaižys, A. Sirvydas, A. Šimonis, E. Narkūnas, R. Poškas, R. Kilda, D. Grigaliūnienė, G. Poškas, J. Ulickas, S. Subačiūtė	*Project leader:* Habil. Dr. P. Poškas	*P.p./P.p. of Appendices:* 227 /0
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Summary:

The report provides an assessment of the possible cumulative impact of the planned economic activity – the decommissioning of the Ignalina NPP – on the environmental components. The report has been prepared in accordance with the environmental impact assessment program approved by the competent authority. Technological solutions for the decommissioning process of the Ignalina NPP are presented in the report. The environmental components are described and assessed how they could potentially be affected by the planned economic activity, mitigating measures are envisaged. Possible alternatives to the planned economic activity are also analyzed and accidental situations (risks) that may occur during the implementation of the planned economic activity are considered and their impacts on the environment are assessed.

Keywords:

Decommissioning of NPP, environmental impact assessment, radioactive waste, radionuclide migration, radiation safety.

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Nuclear Engineering Laboratory
Lithuanian Energy Institute
Breslaujos str. 3
LT-44403 Kaunas, Lithuania

Phone: +370 37 401883
E-mail: Ernestas.Narkunas@lei.lt
Website: http://www.lei.lt

Reviewed:

Head of Nuclear Engineering Laboratory

E. Narkūnas

Approved:

Director of Lithuanian Energy Institute

S. Gudžius

TABLE OF REVISIONS

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0	2025-10-29	Submitted for Customer's review.
1	2025-11-12	Customer approved version. For informing the public and transboundary environmental impact assessment procedures.

CONTENT

SUMMARY

A summary of the Environmental Impact Assessment Report is provided as a separate document.

ABBREVIATIONS AND DEFINITIONS

CJSC	Closed joint-stock company
CA	Controlled area
D&PT	Dismantling and pretreatment (sorting, shredding, decontamination, packaging for transportation)
EIA	Environmental impact assessment
FDP	Final decommissioning plan
IAEA	International Atomic Energy Agency
INPP	Ignalina nuclear power plant
IRWSF	Interim reactor waste storage facility
ISFSF-1	1st interim spent nuclear fuel storage facility (building No. 196)
ISFSF-2	2nd interim spent nuclear fuel storage facility (project B1)
LEI	Lithuanian Energy Institute
LILW	Low and intermediate-level radioactive waste
LL	Long-lived radioactive waste
LM	Lifting mechanisms
LRW	Liquid RW
MFU	Mobile filtering unit
MZ	Monitoring zone
NF	Nuclear facility
NFB	Nuclear facility building
NPP	Nuclear power plant
PI	Public institution
PPE	Personal protective equipment
RU	SRW retrieval unit (RU-1, RU-2, RU-3)
RW	Radioactive waste
SE	State Enterprise
SL	Short-lived radioactive waste
SNF	Spent nuclear fuel
SPZ	Sanitary protection zone
SRW	Solid radioactive waste
SSS	Spent sealed sources (Class F SRW)
SWMSF	Solid waste management and storage facility, consisting of SWRF, SWTF and SWSF
SWRF	Solid radioactive waste retrieval facility (Project B2)

SWSF	Solid radioactive waste storage facility (Project B4)
SWTF	Solid radioactive waste treatment facility (Project B3)
SWTSF	Solid waste treatment and storage facility, consisting of SWTF and SWSF
VATESI	State Nuclear Power Safety Inspectorate
VLLW	Very low-level activity waste

The ALARA Principle – "As Low as Reasonably Achievable" optimises the radiation protection of the population or occupationally exposed personnel to ensure that the level of individual doses, the probability of exposure and the number of people exposed to it are as low as can be achieved, taking into account the latest technical knowledge, economic and social factors. The optimisation principle applies not only to the optimisation of the effective dose, but also to the equivalent dose, as a precautionary measure against possible harm to health, in order to take into account doubts as to whether the threshold values for the reaction of tissues to ionising radiation are not exceeded.

Decommissioning of a Nuclear Facility (NF) means the implementation of legal, organizational and technical measures to manage the NF in accordance with the decision that the facility will never be used for its primary purpose.

Employee – a person who works under a contract with ionizing radiation sources or is exposed by them and radiation exposure doses may exceed the limits defined for the population.

Decontamination – removal of radioactive contamination or reduction of its level.

The effective dose is the sum of the equivalent doses multiplied by the weighting factors of the external and internal exposure of all tissues and organs of the body.

Final shutdown is the process during which the NF power unit is shut down and the licensee implements NF decommissioning measures (unloading and transferring spent nuclear fuel from the unit, managing waste generated during operation, isolating unnecessary systems, etc.) until there is no spent nuclear fuel left in the power unit.

The final condition of the NF and/or its site is defined by the criteria for the final state of the object itself and/or its site set out in the NF final decommissioning plan, after which it is considered that the decommissioning of the NF is completed.

Population means natural persons, apart from employees, trainees or students who are exposed to radiation, as well as natural persons who are irradiated for the purpose of health care or who voluntarily assist patients or participate in biomedical research.

Hot tests means tests during which, using radioactive materials, systems and elements of the NF are checked, tests are performed to demonstrate the safe interaction of equipment and the general operational capabilities of the NF, and the aim is to determine the compliance of the NF and its equipment with the design solutions.

Conservative assessment is an assessment of the radionuclides activity or the exposure dose when, due to a lack of accurate data or insufficiently accurate radionuclide dispersion models, assumptions are made that lead to more unfavourable assessment results than could be obtained under real conditions.

Controlled area means an area in which special rules of protection against the ionizing radiation and spread of radioactive contamination are in force and access to which is controlled.

Residual building/structure equipment – equipment of the systems that continues to be in operation after the dismantling of the technological equipment, building/structure engineering systems equipment and equipment for primary waste treatment plants.

The equivalent dose is the absorbed dose of a tissue or organ multiplied by a weighting factor that depends on the type and energy of the ionizing radiation.

Immediate dismantling of a NF means a method of NF decommissioning when the management of facility structures, systems and components contaminated with radionuclides is carried out immediately after the final shutdown of this NF.

Post-operation – refers to the safe, reliable and economical operation and maintenance of INPP facilities and systems left in operation after the final shutdown of the power units, as well as safe operation, technical maintenance, repair work of the new facilities for spent nuclear fuel, radioactive waste management and other technological processes, also including activities related to saving energy resources.

Representative – a person who, due to the radiation dose received, is classified as a member of the population exposed to higher radiation, excluding people with non-standard or unusual habits. The exposure of the population is assessed based on the radiation dose(s) calculated for the representative(s).

Brown field state of a nuclear facility and/or its site – the final state of the NF and/or its site, upon reaching which the concentration of radionuclide activity in buildings, engineering structures and/or site (or part thereof) exceeds the unconditional clearance levels of radionuclides for the materials and surface activity levels when only surface activity is checked, and the use of buildings, engineering structures and/or site (or part thereof) of this facility is possible only with restrictions due to the possible effects of ionizing radiation.

Radioactive contamination means the unintended or unwanted presence of radioactive materials on surfaces or in solids, liquids, gases or on the human body.

Sanitary protection zone – a zone around a nuclear facility (a zone within a radius of 3 km around the INPP), where the established special conditions of land use apply due to the possible negative impact of ionizing radiation on human health and the environment.

Observation area is a 30 km radius zone around the INPP, where special radiation safety regulations are not applied, but radiation monitoring is carried out.

Supervised area – a part of the company's territory not assigned to the controlled area, in which it is necessary to monitor the conditions of occupational exposure, but special safety measures are not required.

Cold tests – tests during which, without the use of radioactive materials, all systems and elements of the NF are checked, tests are performed to demonstrate the safe interaction of all equipment and the general operational capabilities of the NF, and the aim is to determine the compliance of the NF and its equipment with the design solutions.

Green field status of a nuclear facility and/or its site – the final state of a nuclear facility and/or its site, upon reaching which the radionuclide activity concentration in buildings, engineering structures and/or the site (or part thereof) does not exceed the unconditional clearance levels of radionuclides for the materials and surface activity values, when only surface activity is checked, and restrictions on the use of the buildings, engineering structures and/or the site (or part thereof) of this facility due to the possible impact of ionizing radiation are not imposed.

1 INTRODUCTION

The planned economic activity is the decommissioning of the Ignalina Nuclear Power Plant (INPP). Law of the Republic of Lithuania on the Environmental Impact Assessment of planned economic activity [1] states (see Articles 3.2, 3.5, 3.7 and 3.8 of Annex 1) that such planned economic activity is likely to have significant negative effects on the environment by their nature and scale and that an environmental impact assessment (EIA) is therefore mandatory for such activity.

United Nations Convention on Environmental Impact Assessment in a Transboundary Context, 1991 [2] and the Law on the Environmental Impact Assessment of the Planned Economic Activity of the Republic of Lithuania [1] (see Article 10) provide that transboundary environmental impact assessment procedures are mandatory for planned economic activities.

The planned economic activity is planned to be carried out by preparing and implementing separate, relatively independent INPP decommissioning projects (DP). EIA program for the decommissioning of the INPP [3] that was approved in 2004, stipulated that EIA had to be carried out for separate DP. The EIA report for each new DP had to evaluate the EIA results of the previous DP. This would ensure that the EIA carried out together with the decommissioning of the INPP is based on detailed information obtained from the DP being prepared.

In 2023, the provision of the Law on the Environmental Impact Assessment of Planned Economic Activity of the Republic of Lithuania [1] came into force prohibiting the division of the planned economic activity into smaller-scale planned economic activities (see Clause 8 of Article 3) as well as the provision defining the scope of the assessment of the cumulative environmental impact of planned economic activity (see Clause 9 of Article 3). ARTEMIS mission held in Lithuania [5], based on international nuclear safety recommendations and good practices, also recommended conducting an environmental impact assessment of the entire INPP decommissioning process. Therefore, the new EIA program for the decommissioning of the INPP was approved in 2023 [6] provides for a cumulative EIA of the entire INPP decommissioning process.

This EIA report has been prepared in accordance with the Law on EIA of Planned Economic Activity [1], the description of the procedure for the preparation of EIA documents [4] and the EIA program for the planned economic activity approved by the competent authority [6].

The following objectives have been set for the EIA carried out in accordance with Article 4 of the Law [1]:

1) to determine, describe and assess the potential direct and indirect effects of the planned economic activity on the following elements of the environment: soil, land surface and its depths, air, water, climate, landscape and biodiversity, focusing in particular on species

and natural habitats of European Community interest, also on other species protected by the Law on the Protected Species of Fauna, Flora and Fungi, material assets, immovable cultural properties and the interrelationship between these elements;

2) to identify, describe and assess the potential direct and indirect effects of biological, chemical and physical factors caused by the planned economic activity on public health, also on the interrelationship between elements of the environment and public health;
3) to determine the potential impact of the planned economic activity on the elements of the environment referred to in point 1 of this paragraph and on public health by virtue of the risk of vulnerability of the proposed economic activity due to emergency events and/or potential emergencies;
4) to identify the measures to be taken to avoid, reduce or, if possible, compensate for the expected significant adverse impact on the environment and public health;
5) to determine whether the planned economic activity, having assessed its nature, scale, location and/or effect on the environment, meets the requirements of environmental protection, public health, immovable cultural heritage protection, fire and civil protection legislation; whether it will not have a significant negative impact on the elements of the environment referred to in point 1 of this paragraph, public health and their mutual interactions.

The operation of INPP (i.e. the production of electricity using nuclear technology) was completed on 31 December 2009. The INPP nuclear reactors are permanently shut down and preparatory work for decommissioning and the decommissioning of INPP are being carried out at INPP. Taking into account the current situation, this EIA report performs both a retrospective and prospective assessment of the environmental impact of the decommissioning of INPP, covering the period from 2010, when the dismantling and initial treatment of INPP equipment actually began, to 2045-2050, when, in accordance with the activities provided in the final INPP decommissioning plan [7], the dismantling of equipment and buildings on the INPP industrial site will be completed, the dismantled materials will be disposed of and the planned condition of the INPP industrial site will be achieved.

The public is informed about the environmental impact assessment in accordance with the Procedure for Public Information and Participation in the EIA Process of a Planned Economic Activity [4]. The planned economic activity is not attributed to the overriding public interest and is not considered important for public security

The EIA relevant parties that review the prepared EIA report and provide conclusions within their competence are:

- Visaginas Municipality Administration;
- State Nuclear Power Safety Inspectorate (VATESI);
- Fire Protection and Rescue Department under the Ministry of the Interior;
- Radiation Protection Centre;
- Panevėžys-Utena Territorial Division of the Department of Cultural Heritage under the Ministry of Culture;
- Utena Department of the National Public Health Center under the Ministry of Health;
- State Service for Protected Areas under the Ministry of Environment.

The Ministry of Environment of the Republic of Lithuania is the is an institution authorised by the government that coordinates the transboundary environmental impact assessment process. Three countries have expressed their willingness to participate in transboundary environmental impact assessment procedures (the Kingdom of Denmark, the Republic of Latvia, the Republic of Belarus). Three more countries (the Republic of Estonia, the Kingdom of Sweden, the Republic of Poland) have indicated their willingness to receive information on the environmental impact of the planned economic activity. Transboundary environmental impact assessment procedures are carried out in accordance with the EIA Transboundary Environmental Impact Assessment Procedures Description [4].

The Environmental Protection Agency is the responsible institution that, after examining the EIA report and evaluating the conclusions of the EIA relevant parties, the proposals of the interested public and the results of transboundary consultations, will make a decision on the environmental impact of the planned economic activity.

2 GENERAL INFORMATION

2.1 Location and objectives of the activity

The Ignalina Nuclear Power Plant (INPP) site is located in the north-eastern part of the Republic of Lithuania, on the southern shore of Lake Druksiai, approximately 6 km from Visaginas. INPP is located approximately 130 km from the Lithuanian capital Vilnius, close to the state borders with the Republic of Belarus (approximately 4 km) and the Republic of Latvia (approximately 8 km), Figure 2.1-1. Other countries participating in transboundary environmental impact procedures or wishing to receive information are located more than 200 km (Republic of Estonia, Republic of Poland) and 500 km (Kingdom of Sweden, Kingdom of Denmark) from INPP.

Figure 2.1-1. Location of the Ignalina INPP site in the Republic of Lithuania and the nearest neighbouring countries

Two power units with RBMK-1500 type reactors have been built and operated at the Ignalina NPP site. The design thermal power of each reactor was 4800 MW, and the electric power was 1500 MW. The first power unit of the Ignalina NPP was put into operation at the end of 1983, and the second – in August 1987. The intended (design) operating life of the reactors was 30 years (until 2013 and 2017, respectively).

In accordance with the obligations stipulated in the Treaty of Accession of the Republic of Lithuania to the European Union and the National Energy Strategies adopted by the Seimas on their basis [8], [9], the first reactor of the INPP was finally shut down at the end of 2004, the second – at the end of 2009. The main activity of INPP has become preparation for decommissioning and radioactive waste management.

The following is planned during the implementation of this planned economic activity:

- To dismantle the equipment, systems and communications located in the INPP industrial site;
- To demolish the buildings and structures located in the INPP industrial site;
- To manage radioactive and other (non-radioactive) waste generated during the operation and decommissioning of the INPP;
- To clean up the INPP industrial site by achieving the status of the INPP industrial site as envisaged in the final INPP decommissioning plan [7].

2.2 Site status and territorial planning documents

The planned economic activity will be carried out on the INPP industrial site and in the sanitary protection zone surrounding the INPP industrial site.

The INPP industrial site is located on a land plot with a unique number 4400-2111-1391. The INPP industrial site occupies only part of this land plot - the area of the INPP site is 82 ha, and the area of the entire plot is 178 ha, Figure 2.2-1.

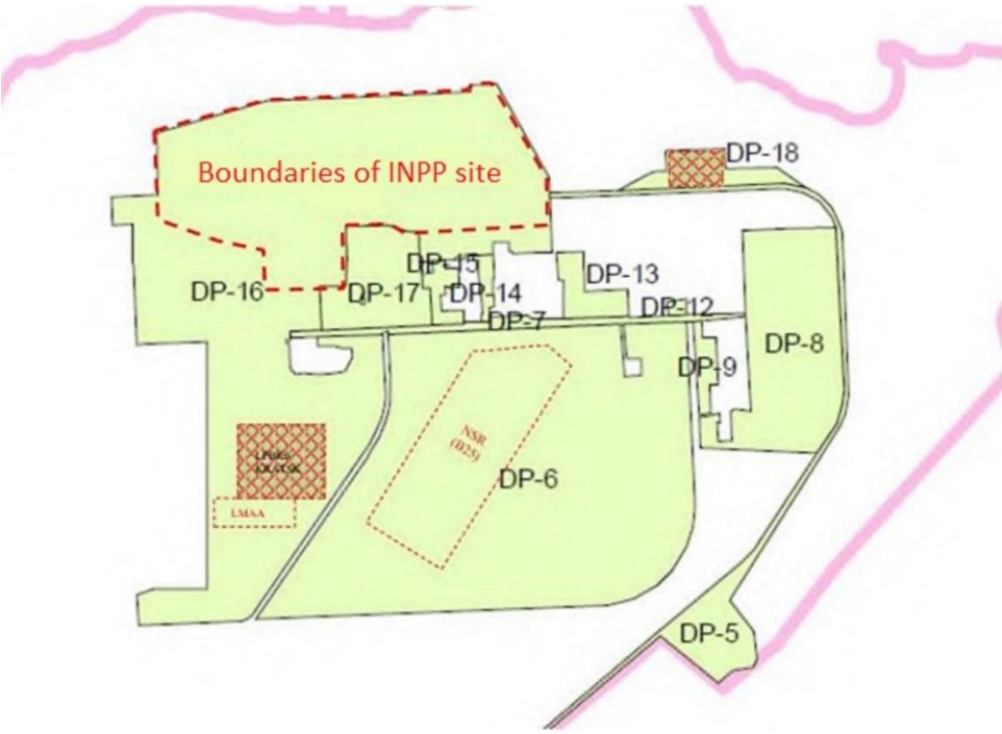

Figure 2.2-1. Plots managed by the INPP by right of ownership and the location of the INPP industrial site

INPP industrial site (see Figure 2.2-2) is considered to be the territory bounded by the INPP physical security perimeter (physical barrier). The INPP as a nuclear facility, the operation of which is being terminated, consists of 71 buildings (as they are registered in the real estate register). A diagram of the site with the layout of the buildings is presented in Figure 2.2-3.

The INPP industrial site and the buildings located there are divided into controlled and observed areas, see Figure 2.2-3. Buildings located in the controlled area contain materials from the nuclear fuel cycle, or the building or components, structures, systems contained therein are affected by radioactive materials. Special rules and measures are applied in this area to ensure the protection of personnel from ionizing radiation or to prevent the spread of radioactive contamination. Access to the controlled area shall be restricted by administrative measures or physical barriers. Radioactive contamination in the observed area is very low or absent. Special rules and measures are not applied in the observed area, however, in order to ensure protection from ionizing radiation, this area is monitored. All buildings located in the INPP industrial site are considered to be affected by radionuclides, until it is demonstrated that they are unaffected as set out in Regulation BST-1.5.1-2020 [25].

A sanitary protection zone (SPZ) with a radius of 3 km has been established around the industrial site of the INPP, Figure 2.2-4. There are no permanent residents in the SPZ, and any economic activity not related to the operation and decommissioning of the INPP is restricted by administrative measures. The INPP SPZ, which has an area of about 28 km^2, includes parts of the territories of three municipalities (Visaginas, Zarasai district and Ignalina district).

New radioactive waste management and storage facilities and disposal sites are/will be built at INPP SPZ, where radioactive waste from INPP operation and decommissioning will be treated, stored and disposed of, Figure 2.2-4:

- ISFSF-1 – interim SNF dry storage facility (Building No. 196);
- ISFSF-2 – interim SNF dry storage facility (Project B1);
- SWRF – solid radioactive waste retrieval and separation facility (Project B2) with SRW removal units RU-1, RU-2 and RU-3;
- SWTSF – solid radioactive waste treatment (Project B3) and storage facility (Project B4);
- Substance radioactivity release levels measurement devices (Project B10);
- Very low-level activity short-lived waste (VLLW) repository buffer storage facility (Project B19-1);
- Very low-level activity short-lived waste (VLLW) repository (Project B19-2);

- Low and intermediate-level radioactive short-lived waste (LILW-SL) repository (Project B25).

For these facilities, which are stand-alone NF, the SPZ surrounding them have been identified, which currently fall within the SPZ of the INPP industrial site.

Figure 2.2-2. Panorama of the INPP site

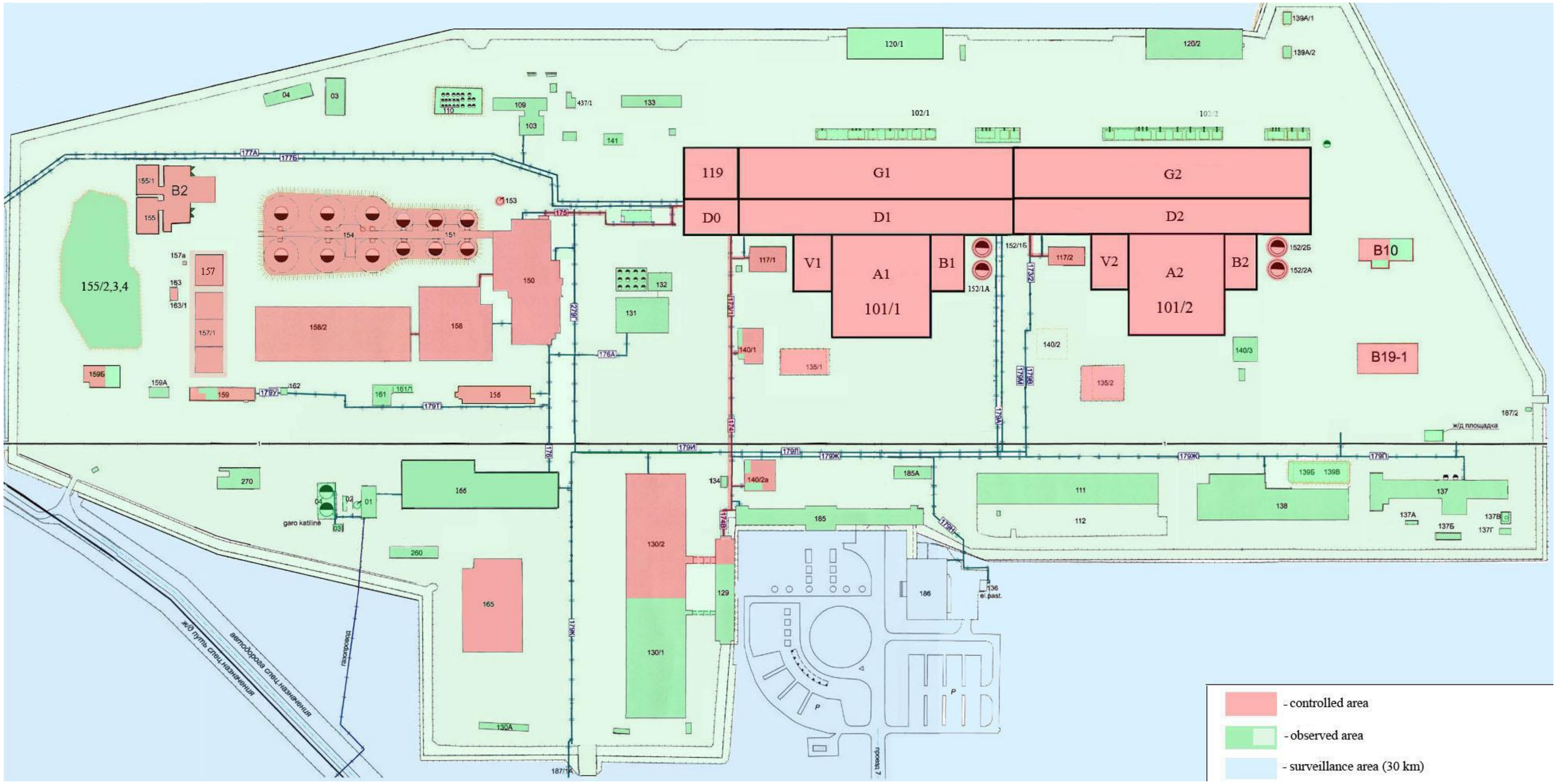

Figure 2.2-3. Scheme of the layout of the buildings of the INPP site. The structures assigned to the controlled area are marked in red. Other buildings on the site and the territory of the site are assigned to the observation area (marked in green)

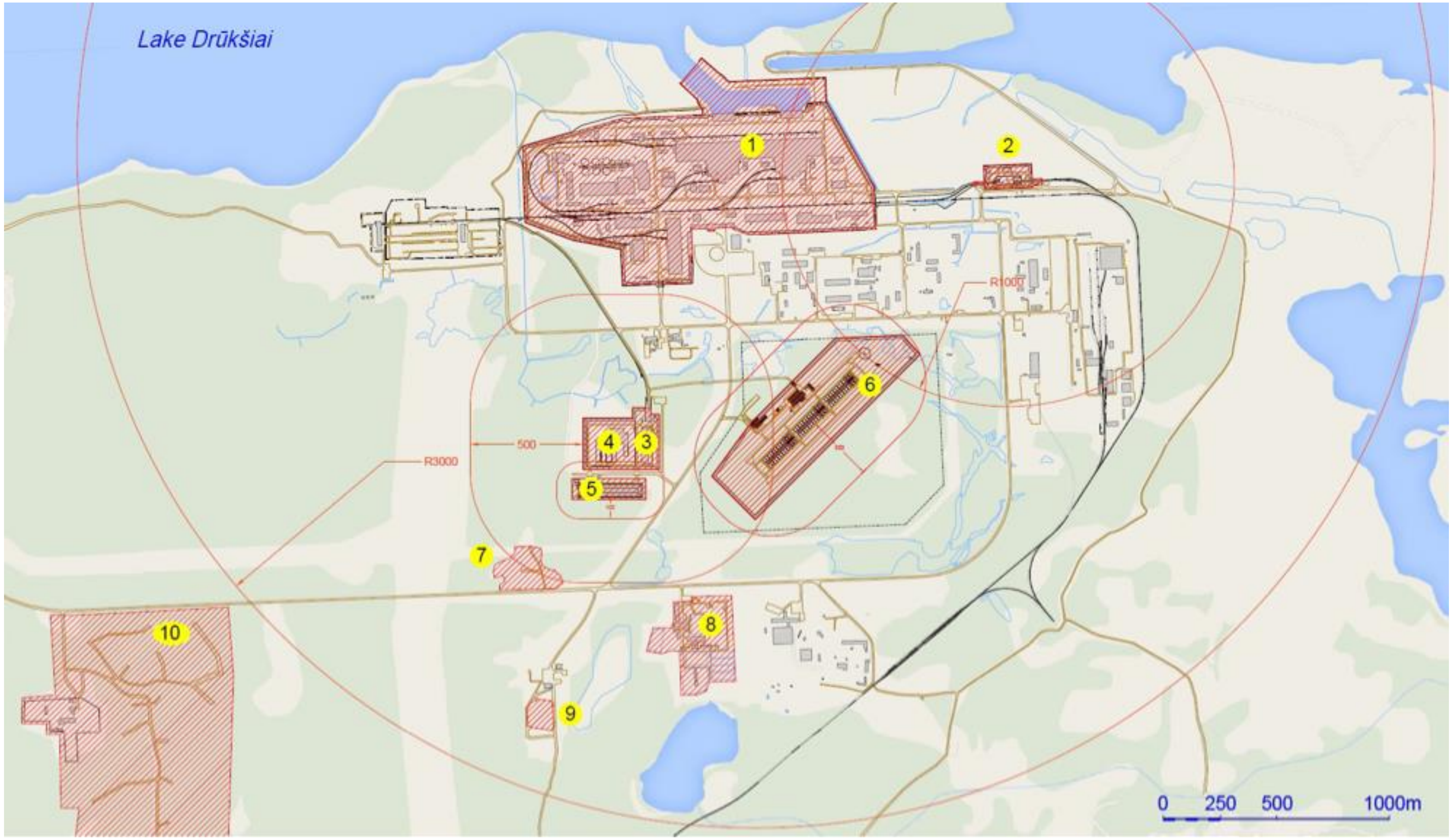

Figure 2.2-4. INPP industrial site and adjacent existing and planned NF sites and their SPZ

1 – INPP industrial site; 2 – site of the first interim spent fuel storage facility (ISFSF-1); 3 – site of the second interim spent fuel storage facility (ISFSF-2); 4 – solid waste treatment and storage facility (SWTSF) site; 5 – site of the very low-level radioactive waste (VLLW) repository; 6 – low and intermediate level radioactive short-lived waste (LILW-SL) repository site; 7 – sewage sludge landfill site; 8 – wastewater treatment plants of Visaginas; 9 – Karlai (Visaginas) household waste landfill; 10 – Visaginas watering-place.

2.3 Stages of activity, their interactions and implementation periods

The EIA report assesses the INPP decommissioning preparation and decommissioning periods starting in 2010, when the dismantling and initial treatment of INPP equipment actually began, and ending in 2045-2050, when, when, in accordance with the activities provided in the final INPP decommissioning plan [7], the dismantling of equipment and buildings on the INPP industrial site will be completed, the dismantled materials will be disposed of and the planned condition of the INPP industrial site will be achieved. The main stages of the INPP decommissioning are shown in Figure 2.3-1.

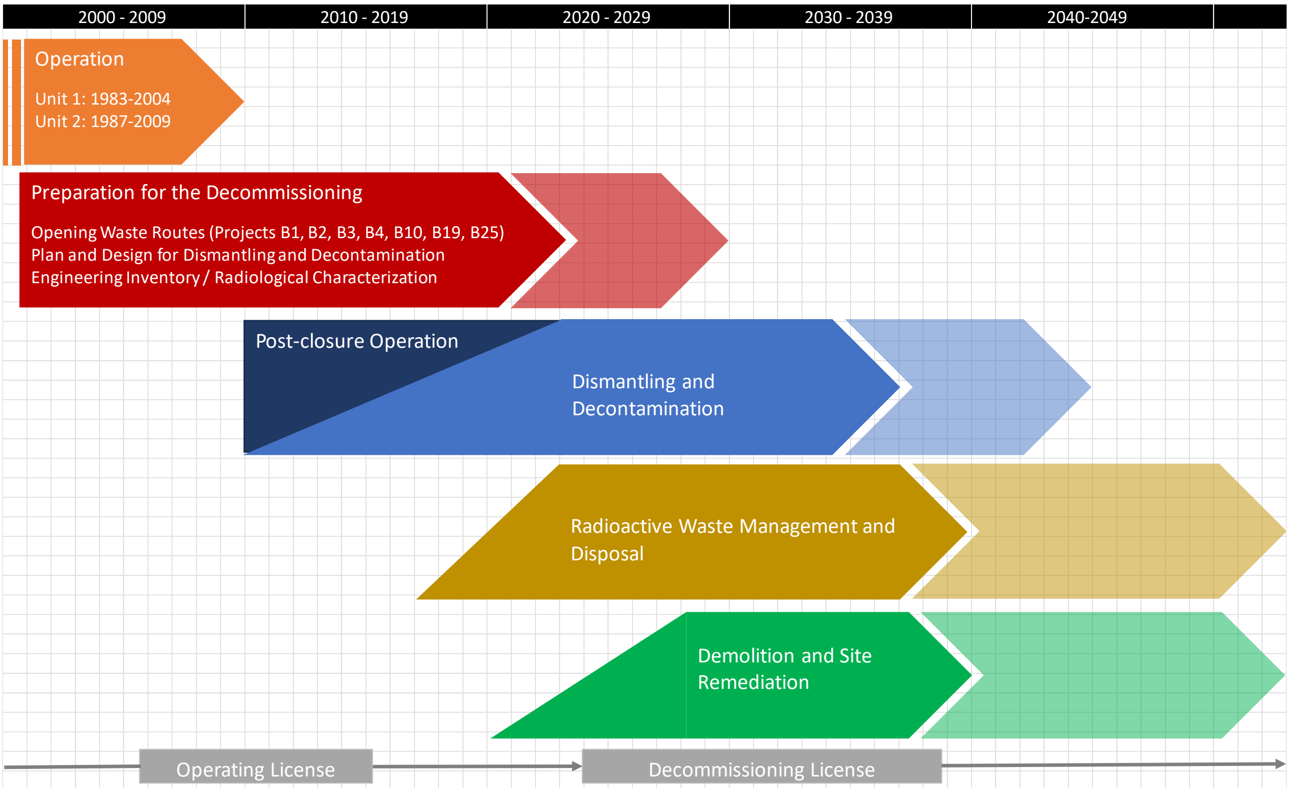

Figure 2.3-1. The main stages of the INPP decommissioning

After the shutdown of INPP Units 1 and 2 at the end of 2004 and 2009, they were granted the status of permanently shut down units. According to the legal regulations of the Republic of Lithuania [10], permanently shut down units are considered to be in operation until all spent nuclear fuel (SNF) has been removed from them.

Part of the SNF was removed for interim (50 years) storage to the dry spent nuclear fuel storage facility ISFSF-1 operated by the INPP since 2000. Another dry spent nuclear fuel storage facility ISFSF-2 was to be built for unloading the remaining SNF from the reactor units and for interim storage. The industrial operation of ISFSF-2 began in 2017. In the period from the final shutdown of the reactor units to the removal of all SNF from the units in 2022, the preparation for decommissioning and decommissioning works were regulated by the valid INPP operating license.

According to the Nuclear Safety Requirements BSR-1.5.1-2019 [11] governing the decommissioning of NF, during the final shutdown phase of a NF, it is permitted to implement measures in preparation for decommissioning, such as unloading and removing the SNF from the power unit, isolating, decontaminating, and dismantling unnecessary systems, and managing radioactive waste generated during the operation of the NF.

The analysis of INPP systems carried out during the initial phase of the decommissioning of INPP Units 1 and 2 identified systems or their parts that can be decommissioned after the final shutdown of the reactors, as they no longer perform safety important and safety related functions and are not necessary for further NF operation and NF decommissioning activities.

The dismantling of the equipment of the INPP power units began in 2010 with the dismantling of the emergency cooling system of the Unit 1 reactor located in building No. 117/1. Since then, INPP has been implementing the isolation, modification, and dismantling of equipment that is no longer needed for further operation or decommissioning and waste management activities.

The decommissioning license for both power units of INPP and existing radioactive waste storage facilities on the industrial site was obtained in 2024.

The INPP decommissioning process is divided into a number of decommissioning projects, the entirety of which is combined by the INPP Final Decommissioning Plan (FDP). A decommissioning project is a separate specific process that includes a defined scope of actions, which determines the scope of work, the planned organization and execution of the work, conducts an environmental impact assessment, and justifies the safety of the planned activities. The INPP FDP covers the entire period of INPP decommissioning, starting with the preparation for decommissioning and ending with the planned achievement of the condition of the INPP site. The FDP is regularly reviewed and updated if necessary.

The currently valid FDP [7] and the EIA program for this economic activity [3] prepared on its basis foresees that the decommissioning works could be completed by 2038. However, the ongoing design of the reactor dismantling works is changing the concept and duration of the previously planned decommissioning works. The critical activities that determine the completion of the INPP decommissioning are the dismantling of both reactor cores (R3 zones). It is currently planned that the dismantling of the R3 zone of the Unit 1 reactor could be ready (work designed, permits obtained, dismantling equipment and systems necessary for dismantling installed and tested) in 2035. Only after the dismantling of both reactors and the remaining equipment of units A1 and A2, buildings of these units would be demolished, the territory of the industrial site of the INPP could be cleaned up and the planned condition of the site at the end of the decommissioning (around 2045-2050) could be achieved.

In this EIA report, the assessment of the environmental impact of the INPP decommissioning can be divided into two stages:

- decommissioning activities for 2010-2024, for which a retrospective environmental impact assessment is carried out;
- decommissioning activities from 2025 to the end of the decommissioning, for which a prospective environmental impact assessment is carried out.

The retrospective assessment is based on the relevant results of environmental monitoring and analyses the actual impact of the decommissioning activities already carried out on the environment. The prospective assessment analyses the planned future activities of the decommissioning, the ways in which the activities are implemented and forecasts the possible impact on the environment. The forecast is based on the results of the retrospective impact of the INPP applied decommissioning methods and the INPP environment, as well as the experience gained by the INPP in reducing and limiting the environmental impact of the decommissioning.

2.4 Demand for Resources and Materials

Data on energy resources consumed and planned to be consumed are summarized in Figure 2.4-1, Figure 2.4-2 and Figure 2.4-3. Thermal energy is purchased from CJSC Visagino energija. At the end of 2029, it is planned to completely abandon the purchase of thermal energy and supply heat to the INPP by installing heat pumps. After the introduction of a new liquid radioactive waste evaporation technology (see Section 3.2.3), the existing steam boiler plant, which is currently the largest consumer of natural gas in the INPP, will no longer be used. A small demand for natural gas will remain for some time to come due to the autonomous gas heating of individual administrative buildings. The increase in electricity consumption from 2029 is associated with the use of heat pumps. As can be seen, during decommissioning works and optimizing the use of energy resources, the consumption of energy resources will gradually decrease.

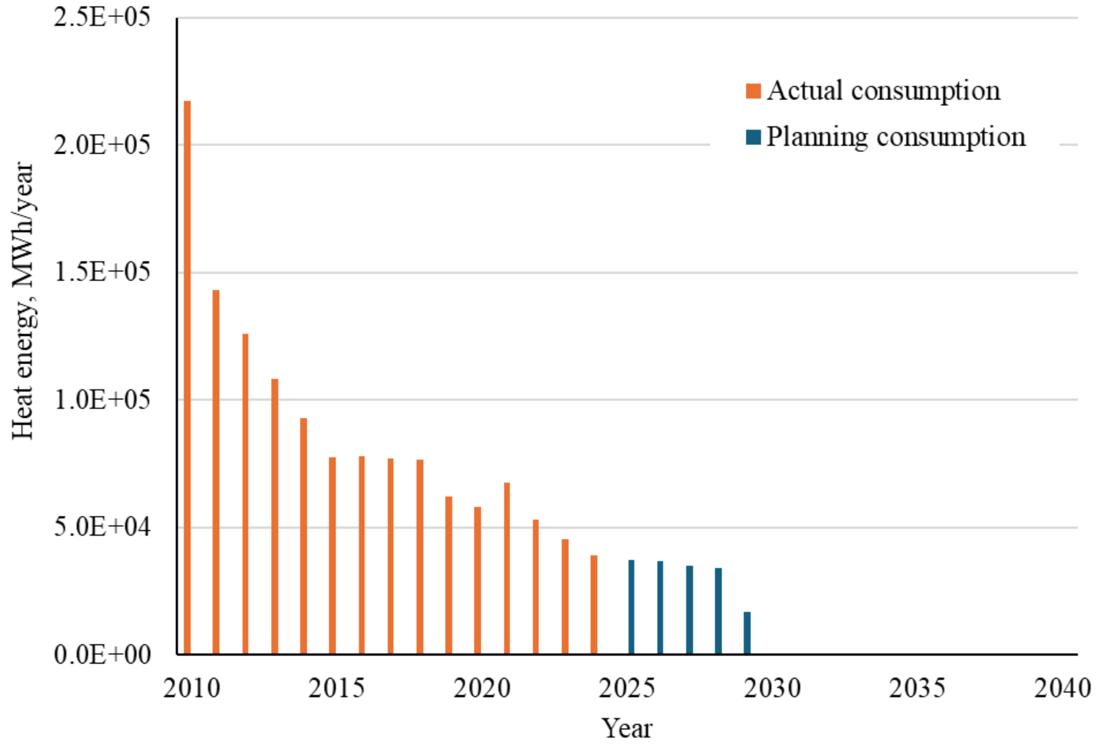

Figure 2.4-1. Current and planned thermal energy consumption

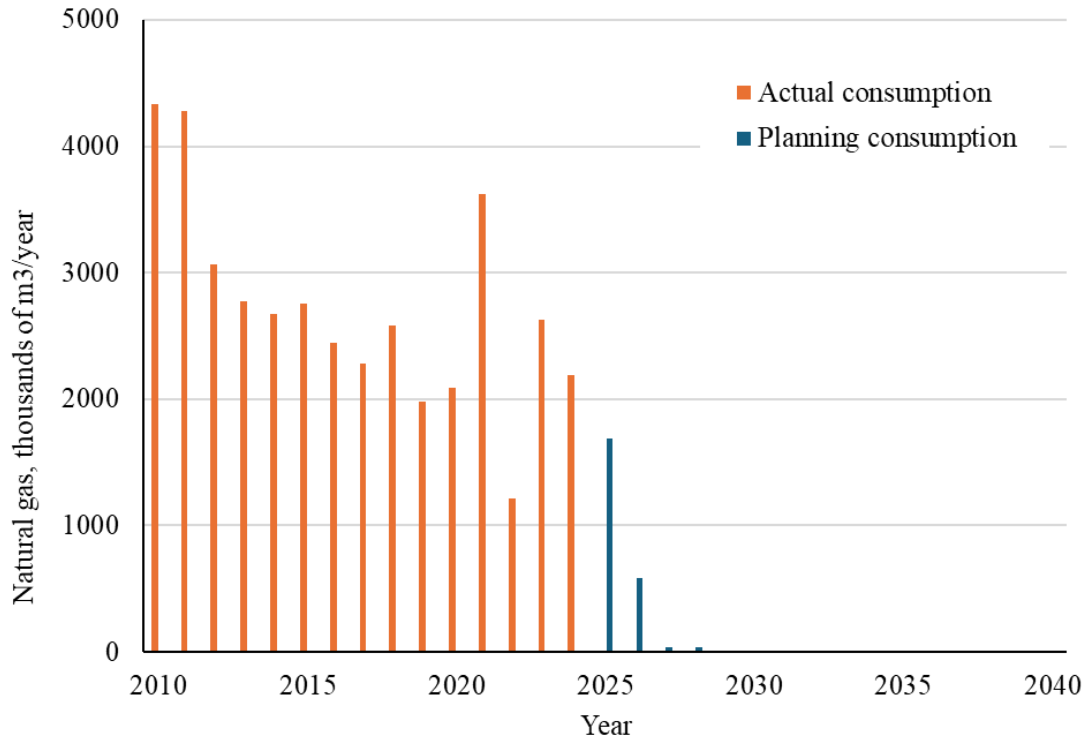

Figure 2.4-2. Current and planned gas consumption

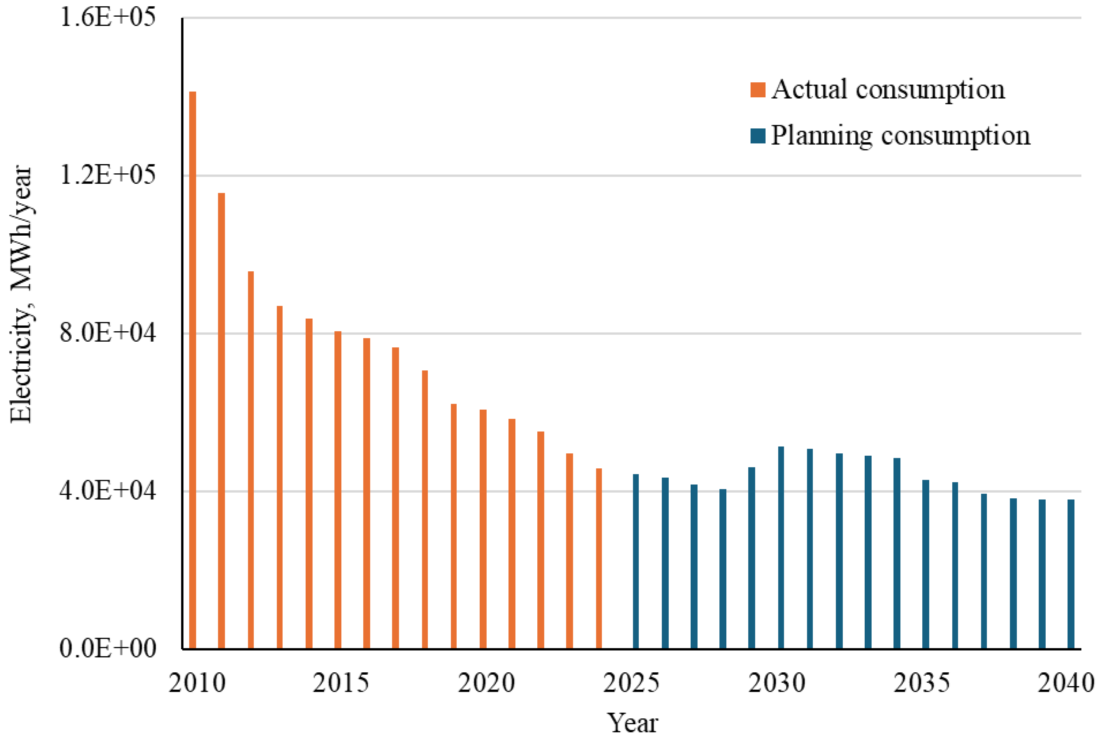

Figure 2.4-3. Current and planned electricity consumption

Water consumption and planned water supply demand summarised in Figure 2.4-4 and Figure 2.4-5. The INPP uses surface and groundwater (artesian) water for its own needs.

Surface water is used to cool technological equipment. The source of surface water is Lake Drūkšiai. The INPP extracts surface water itself. At the beginning of the decommissioning, the demand for surface water was relatively higher due to spent nuclear fuel (SNF) cooling. After the introduction of a new liquid radioactive waste evaporation technology and the abandonment of the use of existing evaporation facilities and steam boiler plant, surface water will no longer be needed.

Artesian water is used in the INPP for domestic needs (e.g. drinking, showers, toilets) and technological processes that require clean water (e.g. decontamination, cementation of radioactive waste). Artesian water is supplied to the INPP by CJSC "Visagino energija". During the decommissioning works, the need for artesian water will gradually decrease.

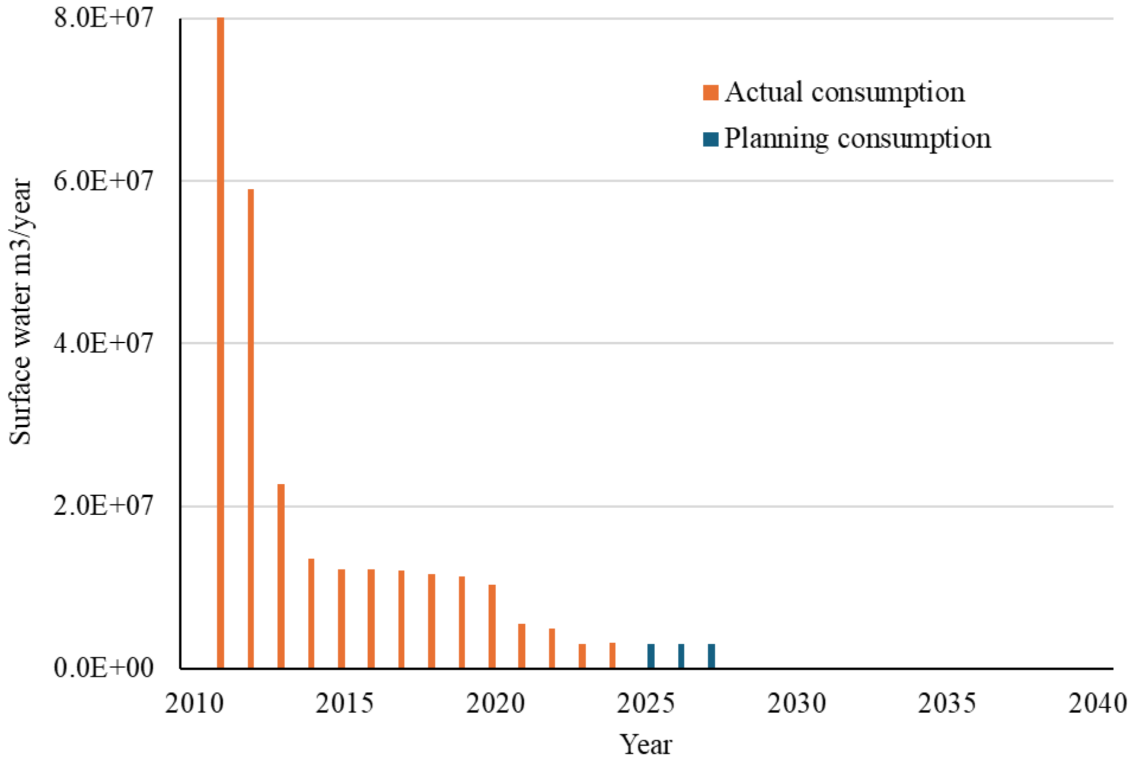

Figure 2.4-4. Actual and planned consumption of surface water

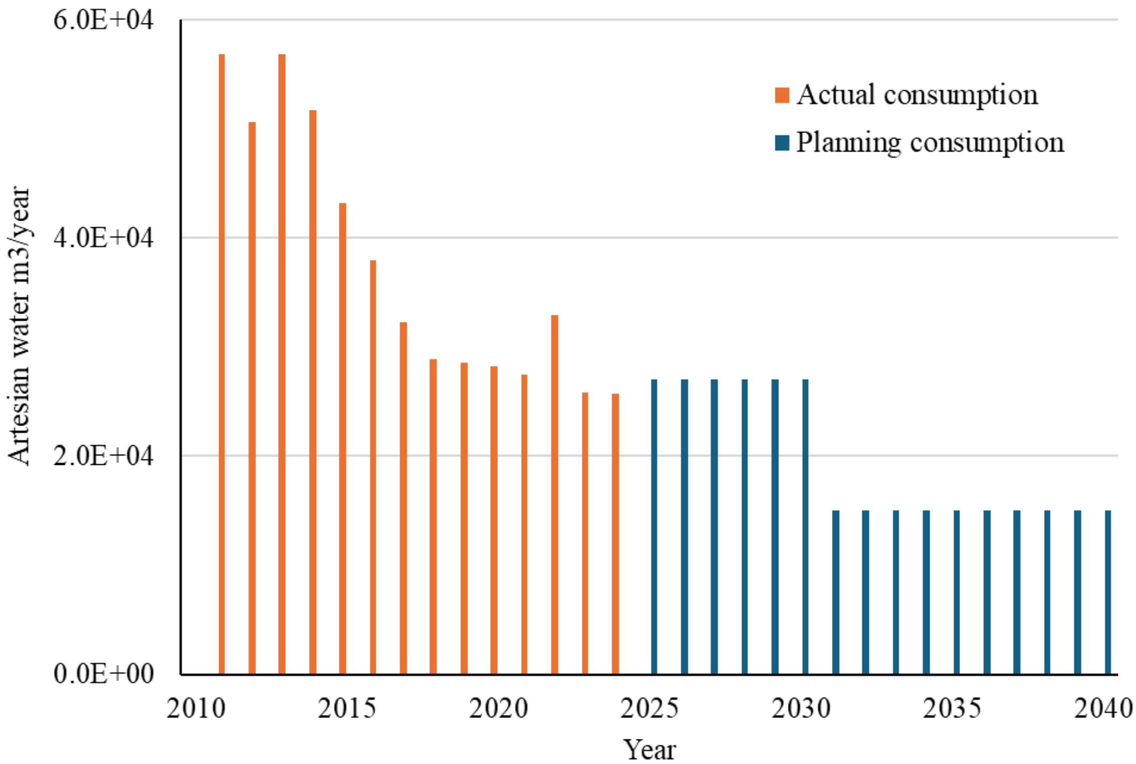

Figure 2.4-5. Actual and planned consumption of groundwater (artesian water)

Diesel fuel and gasoline at the INPP are used in transportation vehicles (cars, trucks, tractors, railway locomotives), diesel fuel is used to power electric generators (backup of electricity supply), diesel is a backup fuel for the steam boiler plant. A conservatively estimated demand for diesel fuel and gasoline for automobile and railway transport is summarized in Table 2.4-1. Actual gasoline and diesel fuel consumption at INPP in 2010-2024 decreased from 23 to 5 tons for gasoline and from 153 to 75 tons for diesel. Electric vehicles are also used for the transportation of radioactive waste.

Table 2.4-1. Planned fuel demand for road and rail transport

Fuel source	**Planned consumption, tons/year**	**Source of receipt**	**Storage method**
Diesel	~ 100	External supply	Special containers
Petrol	~ 15		

The materials planned for the final treatment of radioactive waste are summarized in Table 2.4-2.

Cement CEM I is used for cementing solid RW packages. During the hot tests of SWTF (see Section 3.2.6) in 2017-2020, about 150 tons of cement were used for cementing the RW. After the start of industrial operation of SWTF, cement consumption increased annually and reached 750 tons in 2024. The forecast cement consumption for cementing of solid RW until the completion of the decommissioning is about 950 tons per year.

Cement CEM III and bentonite are used for cementing the evaporation residue of liquid radioactive waste (see Section 3.2.3). The consumption of cement and bentonite increased with the increase in the cementing volumes of LRW and in 2024 amounted to 495 tons of cement and 44 tons of bentonite. Consumption changed from 105 tons to 495 tons. Table 2.4-2 presents the forecasted consumption of cement and bentonite until 2031. From 2031, the cementing volumes of LRW will decrease (see Section 3.1.1.2.3), accordingly, the quantities of materials used for cementation will also decrease.

Table 2.4-2. Chemical substances planned to be used for the final treatment of radioactive waste

Chemical substance	**Planned consumption, tons/year**	**Classification of the substance**		**Mode of transport**	**Storage method**
		Hazard class and category	**Hazard statement**		
Cement, CEM I, CAS No. 65997-15-1, CAS No. 68475-76-3	~ 950	Skin irritation, 2; Allergic skin reaction, 1; Serious eye damage, 1; Respiratory irritation, 3	H315 H317 H318 H335	Road transport	Closed warehouse
Cement, CEM III, CAS No. 65997-15-1,	~ 691				

CAS No. 68475-76-3					
Bentonite CAS No. 1302-78-9	~ 70	Skin irritation, 2; Serious eye irritation, 2; Respiratory irritation, 3.	H315 H319 H335		

Once the LILW-SL repository starts its operation (see Section 3.2.7.2), the production and use of concrete containing CEM III cement at the LILW-SL repository site will increase. The F-ANP and LILW-SL packages will be finally treated (concreted) in the technological building of the LILW-SL repository. The concrete will also be used for concreting RW packages placed in vaults and for sealing the vaults. The amount of concrete consumed at the MVRA-TA site will be approximately 1760 m^3/year.

Data on other hazardous chemicals and chemical mixtures planned to be used in decommissioning activities, their transportation and storage methods are presented in Table 2.4-3. Acetylene and oxygen are used for hot cutting of dismantled equipment (carbon steel). Chemicals (acids, alkalis) are used for chemical and electrochemical decontamination of dismantled equipment.

Table 2.4-3. Other hazardous chemicals and chemical mixtures planned to be used

Substance or mixture	**Planned consumption, tons/year**	**Classification of the substance**		**Mode of transport**	**Storage method**
		Hazard class and category	**Hazard statement**		
Acetylene, CAS No 74-86-2	~ 9	Flammable gas 1 Pressurized gases	H220 H280 H230	Road transport	Cylinders, gas warehouse
Oxygen CAS No. 7782-44-7	~ 40	Oxidizing gases 1 Pressurized gases	H270 H280		
Methane CAS No. 74-82-8	~ 0.338	Flammable gas 1 Pressurized gases	H220 H280		
Nitrogen (chilled) CAS No 7727-37-9	~ 40	Chilled liquefied gas	H281		Diuaro dishes
Acetic acid CAS No. 64-19-7	~ 0.2	Flammable liquid 3 Skin irritation 1A	H226 H314		Special warehouse
Nitric Acid CAS No. 7697-37-2	~ 20	Oxidizing liquid 3 Skin Corrosion 1A	H272 H314		Special containers
Aqueous solution of ammonia 25-30%, CAS No. 1336-21-6	~ 0.2	Skin irritation, 1B Hazardous to the aquatic environment 1	H314 H400 H335		
Sodium hydroxide, liquid, CAS No. 1310-73-2	~ 10	Skin irritation 1A	H314		

3 DESCRIPTION OF THE PLANNED ECONOMIC ACTIVITY

3.1 Dismantling and handling materials

During the decommissioning of the INPP, approximately 180 000 tons of equipment and system structures will need to be dismantled. The dismantling and demolition of buildings, structures, and constructions will generate about 1 700 000 tons of construction waste. All radioactive and non-radioactive materials and waste are classified and, depending on their classification, are managed – sorted, treated, disposed of or placed in the appropriate repositories. If economically feasible, some non-radioactive materials (e.g. metals) may be returned for reuse.

3.1.1 Radioactive materials

3.1.1.1 Classification of solid radioactive waste and requirements for its management

The classification of RW and the method of treatment or placement of a separate class of RW in a repository are determined by the nuclear safety requirements BSR-1.3.2-2017 [12].

The requirements for the classification of solid RW (SRW) are summarized in Table 3.1-1. SRW are divided into classes according to the radiological properties, which determine the intended method of final waste disposal. Final treatment of SRW is not required only for waste that is uncontrolled and very low-level radioactive waste (VLLW). Other classes of SRW must undergo final treatment before being disposed of in RW repositories.

Depending on the applied methods of RW treatment and final processing, individual classes of RW are additionally sorted into decontaminated, incinerated, compactable, non- compactable, etc. RW treatment technologies used at INPP and related RW sorting methods are described in Section 3.2 “Technological processes”.

Table 3.1-1. Classification of solid RW

RW Class	Definition	Abbreviation	Surface dose, mSv/h	Final RW Treatment	Disposal method *
0	Uncontrolled waste	UW	-	Not required	Managed and disposed of in accordance with [44]
Short-lived very low-, low- and intermediate-level radioactive waste**					
A	Very low level waste	VLLW	< 0.2	Not required	VLLW surface repository
B	Low level waste	LLW-SL	0.2 - 2	Required	Near surface repository
C	Intermediate level waste	ILW-SL	> 2	Required	Near surface repository
Long-lived low- and intermediate-level radioactive waste***					
D	Low level waste	LLW -LL	< 10	Required	Near surface repository (cavities at intermediate depth)

E	Intermediate level waste	ILW -LL	> 10	Required	Deep geological repository
High level waste					
G	Highly radioactive waste	HLW	-	Required	Deep geological repository
Spent sealed sources					
F	Spent sealed sources	SSS	-	Required	Near surface or deep geological repository ****

* The method of placement in a radioactive waste repository is determined taking into account the compliance of radioactive waste packages with the criteria for acceptance into a specific radioactive waste repository.
** Containing alpha emitters with a half-life longer than the half-life of Cs-137 and a specific activity measured and/or calculated using validated methods, in an individual radioactive waste package does not exceed 4000 Bq/g, provided that the average specific activity of these alpha emitters calculated for all radioactive waste packages does not exceed 400 Bq/g. The activity of alpha, beta and/or gamma emitters must not exceed the values set out in the radioactive waste acceptance criteria of the surface radioactive waste repository.
*** Containing alpha emitters with a half-life longer than the half-life of 137Cs and a specific activity measured and/or calculated using approved methods, in a separate radioactive waste package exceeds 4000 Bq/g, as well as if the average specific activity of these alpha emitters calculated for all radioactive waste packages exceeds 400 Bq/g and/or the activity of alpha, beta and/or gamma emitters exceeds the values set out in the radioactive waste acceptance criteria of a surface radioactive waste repository.
**** Depending on acceptance criteria applied to spent sealed sources.

The current classification of SRW applied at INPP was introduced in 2001 in preparation for the decommissioning of INPP and is used for the management of INPP decommissioning materials.

The SRW generated during INPP operation was classified using a different SRW classification system, which determined the management and storage of SRW in the existing storage facilities at INPP, Table 3.1-2. SRW were divided into three groups – low, intermediate and high activity. The SRW accumulated during the operation of the INPP will have to be re-sorted and managed by applying the current classification of SRW, Table 3.1-1. This activity is already being carried out during waste retrieving from the existing storage facilities, see Section 3.2.2.

Table 3.1-2 Classification of solid RW accumulated during the operation of the INPP

RW Group	**Abbreviation***	**Surface dose rate mSv/h**	**Surface contamination, Bq/cm²**	
			Beta emitters	Alpha emitters
I, low activity	G1	0.0006 – 0.3	8.3-330	0.17 – 33.3
II, intermediate activity	G2	> 0.3 – 10	>330 – 3.3E+5	>33.3 – 3.3E+4
III, high activity	G3	> 10	> 3.3E+5	> 3.3E+4

* Abbreviation used in this report

A comparison of the RW classification systems applied during the operation of the INPP (so-called "old") and those applied during the decommissioning of the INPP (so-called "new") is shown in Figure 3.1-1.

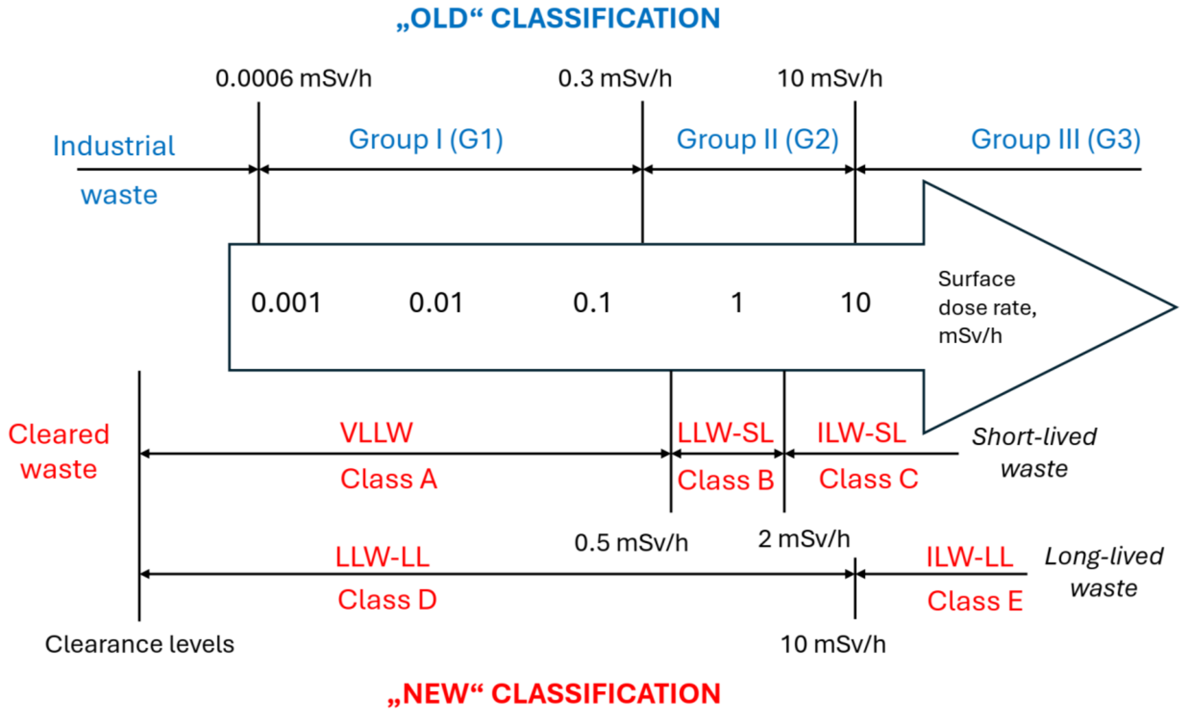

Figure 3.1-1. Comparison of the "old" and "new" solid radioactive waste classification systems, taking into account only the surface dose rate (classes of spend sealed sources and highly radioactive waste are not shown)

INPP operational and decommissioning liquid RW are divided into two classes according to the radiological properties of the waste, Table 3.1-3. During final treatment, liquid RW is solidified and further classified and managed using the classification of solid RW, Table 3.1-1.

Table 3.1-3. Classification of liquid RW

Definition	Volumetric activity, Bq/l
Low level radioactive liquid RW	< 4E+05
Intermediate level radioactive liquid RW	≥ 4E+05

3.1.1.2 Amounts of radioactive material

3.1.1.2.1 Spent nuclear fuel

Spent nuclear fuel (SNF) is classified as highly radioactive class G SRW (Table 3.1-1). During the operation of INPP about 21600 SNF assemblies were generated (Figure 3.1-2) containing about 2400 tons of uranium. The technical characteristics of nuclear fuel assemblies of various initial enrichments are presented in Table 3.1-4. After the final shutdown of the reactors, the storage of SNF assemblies at INPP is summarized in Table 3.1-5. By 2010, a part (about 28% of the total amount and only 2% of the initial enrichment) of the fuel assemblies had already been placed into the CASTOR RBMK-1500 and CONSTOR RBMK-1500 dry storage casks and transported to the SNF storage facility ISFSF-1 at the INPP. The remaining fuel assemblies (about 78% of the total amount) were stored in the reactor units. Currently, all SNF is removed from the power units and stored in the ISFSF-1 and ISFSF-2 storages, see Section 3.2.1 .

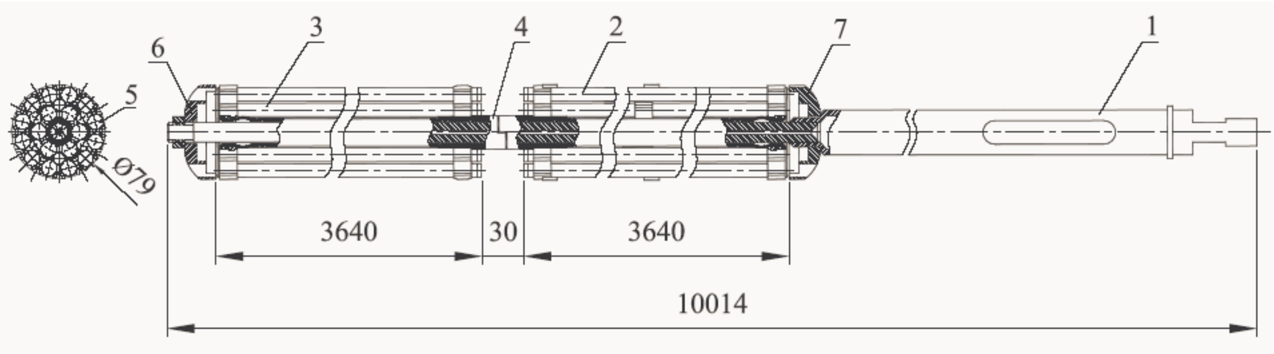

Figure 3.1-2. Scheme of the RBMK-1500 fuel assembly: 1 – extension rod, 2 – upper bundle, 3 – lower bundle, 4 – carrier tube/rod, 5 – heat-emitting element, 6 – lower cap, 7 – upper cap. Dimensions are given in mm [27]

Table 3.1-4. Technical characteristics of RBMK-1500 nuclear fuel assemblies of various initial enrichment [27]

Characteristic	**Type of nuclear fuel (initial fuel enrichment)**				
	2.0 %	**2.1 %**	**2.4 %**	**2.6 %**	**2.8 %**
Nominal mass fraction of U-235 in uranium, % of mass U	2.0	2.1	2.4	2.6	2.8
Average mass fraction of erbium absorber (E_2O_3), % of U mass	-	-	0.41	0.5	0.6
Uranium mass (isotope composition), kg	111.20 ± 1.60			111.08 ± 1.60	
Mass of uranium dioxide (UO_2), kg	~ 126				
Average burnup, MWd/FA	1900	1700	2500	2700	3000
Maximum burnup, MWd/FA	2600	2100	3000	3050	3200

Table 3.1-5. After the final shutdown of the reactors (at the end of 2009), the accumulated SNF assemblies at the INPP

SNF storage location		**Number of SNF assemblies, pcs.**
Building	**Object**	
Building 101/1, Block A1	Reactor	0
	SNF pools	7 175
Building 101/2, Block A2	Reactor	1 634
	SNF pools	6 746
Total in reactor units		**15 555**
In the existing ISFSF-1	SNF casks	6 016
Total INPP		**21 571**

3.1.1.2.2 Solid radioactive waste accumulated during the INPP operation and post-operation periods

Solid radioactive waste (SRW) of groups G1, G2 and G3 generated during the operation of the INPP was accumulated and temporarily stored in the SRW storage facilities, buildings No. 155, No. 155/1, No. 157 and No. 157/1. Separate groups and separate types of SRW were also placed in buildings No. 157 and No. 157/1 during preparation for decommissioning until 2018, Figure 3.1-3, i.e. until the new SRW management facilities – the VLLW sorting module (B2-1), the buffer storage facility of the VLLW repository (B19-1), the SRW treatment (B3) and the storage (B4) facility – were built and started operation. During the post-operational maintenance period, the amount of SRW in existing storage facilities increased slightly, about 1-9%, depending on the group and type of waste. In total, around 12 600 tonnes of groups G1, G2 and G3 SRW have been stored in the existing storage facilities, Table 3.1-6.

Table 3.1-6. Quantities of SRW accumulated in existing storage facilities in 2018

SRW group	SRW type	Volume, m^3	Mass, tons
G1	Combustible	12 000	3 700
	Non- combustible	8 900	5 700
G2	Combustible	2 300	600
	Non- combustible	3 100	1 600
G3	Non- combustible	910	970
All	**All**	**27 200**	**12 600**

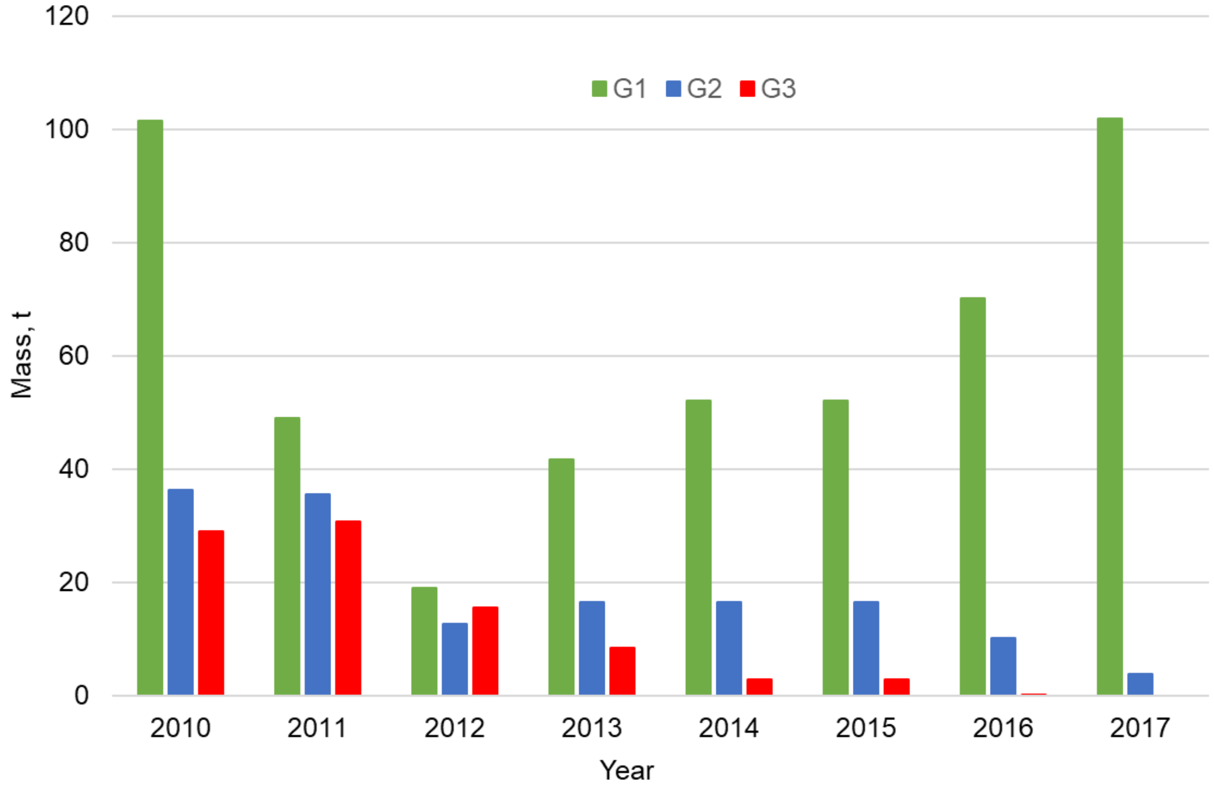

Figure 3.1-3. Amount of SRW placed into existing storage facilities after the final shutdown of the INPP

3.1.1.2.3 Liquid radioactive waste

Liquid radioactive waste (LRW) is generated continuously at INPP and has been treated since the start of operation of INPP power units. After the final shutdown of the reactors, the activities determining the generation of LRW and the treatment needs can be divided into the following groups:

- LRW accumulated and untreated during the operation of the INPP;
- LRW generated during INPP post-operational maintenance activities;
- LRW generated during INPP decommissioning activities (dismantling of facilities, system structures, decontamination, etc.);
- LRW generated during INPP SRW treatment, storage and disposal activities.

The liquid waste generated during the operation of the INPP was accumulated in liquid RW storage facilities (buildings No. 151, 154, 154A, 154B) and processed in the LRW treatment facility (building No. 150). This facility operates during the decommissioning of the INPP. It is also planned that the LRW evaporation technologies operating in the facility will be upgraded, replacing them with more advanced and economical LRW processing technologies.

The quantities of LRW stored and managed by the INPP vary depending on the activities carried out by the INPP and the specifics of these activities. From the point of view of LRW treatment technologies used by the INPP, three main types of LRW wastewater are distinguished, for the treatment of which different technologies are applied:

- Wastewater from various processes and systems;
- Distillation residue (aqueous mixture of wastewater evaporation sediment);
- Aqueous mixtures of used filtering materials (ion change resins, perlite).

The volumes of wastewater collected in 2010-2024 and the volumes of treated wastewater are shown in Figure 3.1-4. During this period, on average, about 36000–39000 m^3 of wastewater were treated in water evaporation plants per year. The excess of additionally cleaned evaporation condensate that is no longer used for INPP needs is released into the environment. Discharges have been carried out since 2010 – during the operation of reactor units, specially purified condensate was fully used in the technological processes of the INPP and was not discharged into the environment. In the period 2010–2013, an average of about 8000 m^3 of specially cleaned condensate was released into the environment per year.

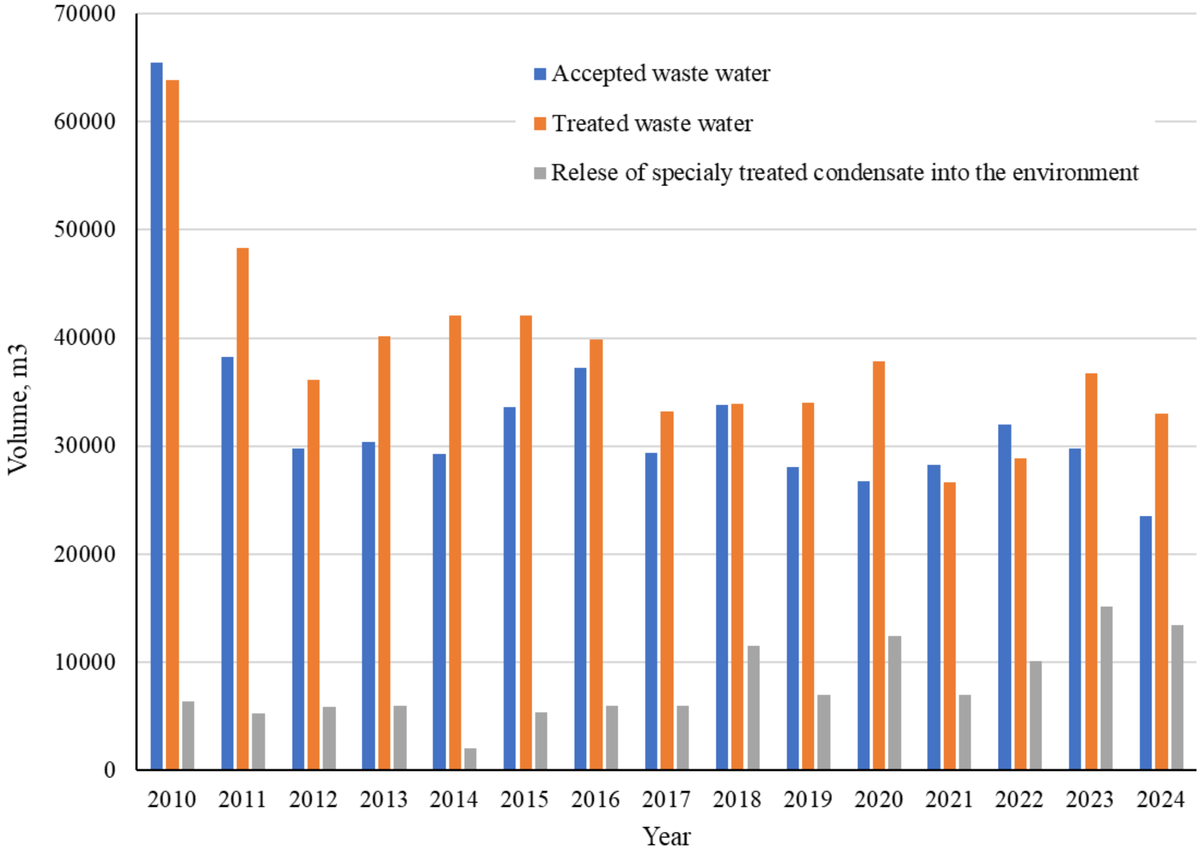

Figure 3.1-4. Volumes of wastewater collected and treated in the INPP LRW treatment facility and volumes of specially cleaned condensate discharged into the environment

It is expected [26] that the volume of wastewater collected and treated will be significantly reduced after 2025, Figure 3.1-5. It is estimated that up to 15 000 m^3 of wastewater will need to be treated annually in the period 2025-2035, i.e. more than twice as much as was treated in the period 2010-2024. Wastewater, depending on the source of pollution, can be classified as low-level or intermediate-level radioactive LRW, see Table 3.1-3.

The dismantling of the R3 reactor zones is planned to begin in 2031-2035. The R3 reactor zones contain about 1 600 m^3 of water filling (800 t per reactor), which will have to be removed during the dismantling of the R3 zones. Also, some of the reactor technological channels (reflector cooling channels, temperature, gas sampling) will also have to be managed, which will be removed during the dismantling of reactor zones R1 and R2 and placed in the SNF pool hall. After the channels are shredded and taken to the SWTSF for treatment, the water from the pools will have to be discharged and treated as LRW, about 3 500 m^3.

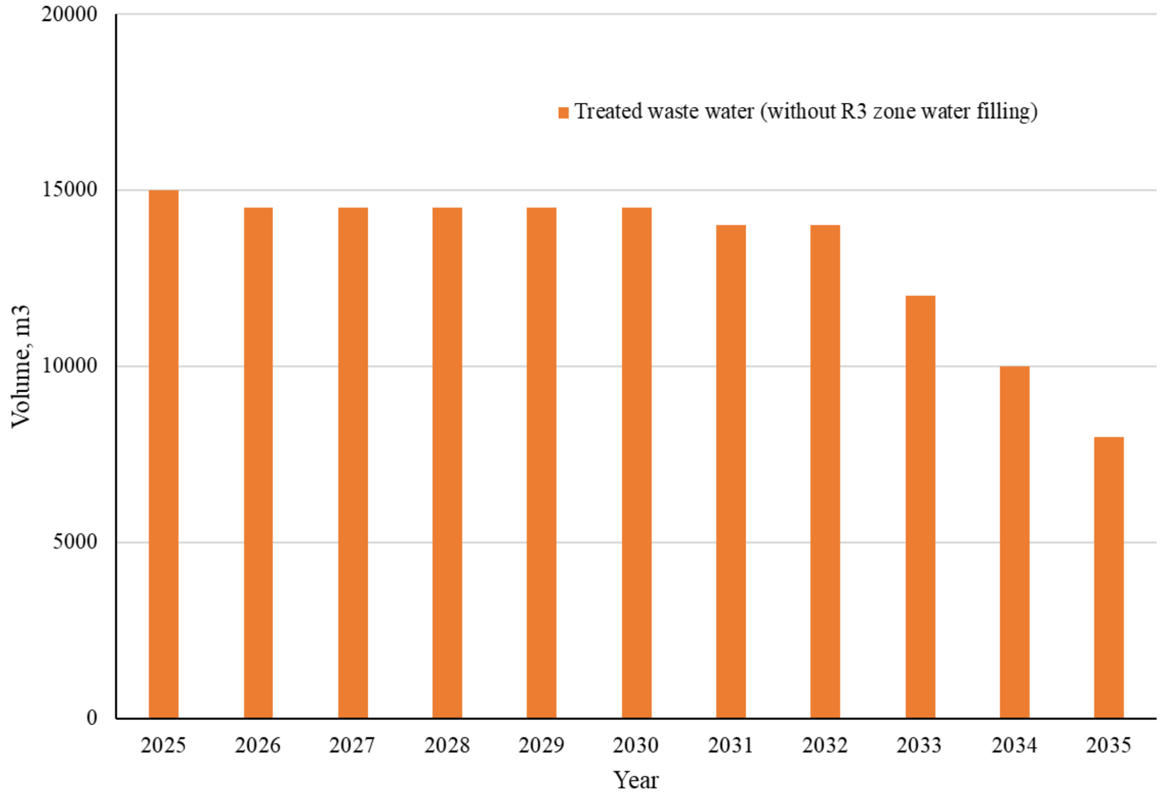

Figure 3.1-5. 2024-2035 forecast volumes of treated wastewater

Until 2015, the distillation residue was solidified using bituminization technology. In 2015, bituminization was stopped and was not resumed later. Since 2017, the aqueous mixture of evaporation sediments has been cemented together with the mixture of used filtering materials.

Aqueous mixtures of used filtering materials (ion exchange resins, perlite) were stored in tanks at the INPP, and since 2006 they have been solidified using cementation technology. In the period 2010-2024, about 2600 m^3 of LRW was treated, on average about 170 m^3/year, Figure 3.1-6.

The design capacity of the cementation unit is 450-460 m^3 of LRW per year, therefore it is planned to maintain these cementation volumes in the future. The predicted [26] volumes of the LRW treated by cementation technology are summarize in Table 3.1-7. It is planned [26] that these LRW will be processed by 2035, Figure 3.1-7.

Aqueous mixtures of distillation residue, spent filtering materials are classified as intermediate level radioactive LRW, see Table 3.1-3. Cemented RW packages are classified as class C SRW.

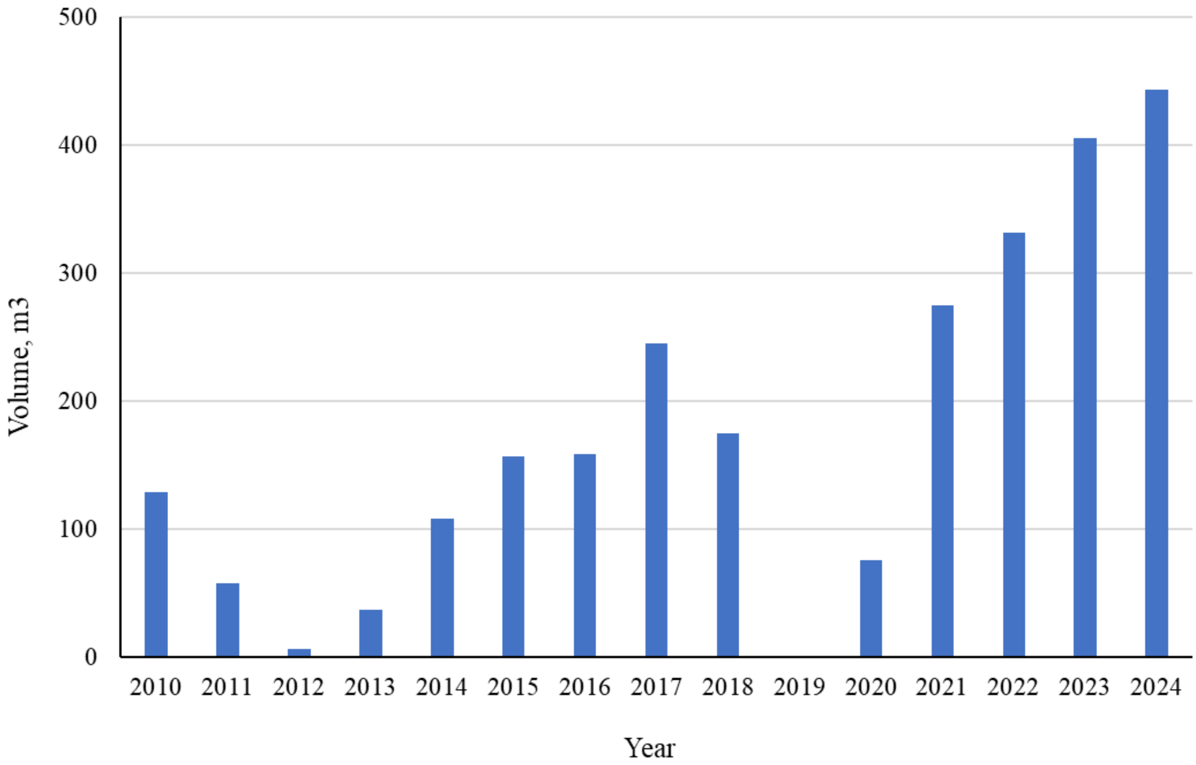

Figure 3.1-6. Volumes of LRW treated with cementation technology in the INPP LRW treatment facility

Table 3.1-7. Predicted volumes of LRW treated with cementation technology

LRW	**Volume, m^3**
Existing tanks have accumulated aqueous mixtures of used filtration materials and evaporation sediments by 2024	3 530
Aqueous mixtures of used filtration materials and evaporative sediments to be generated in the period 2024-2035	300
Total:	**3 830**

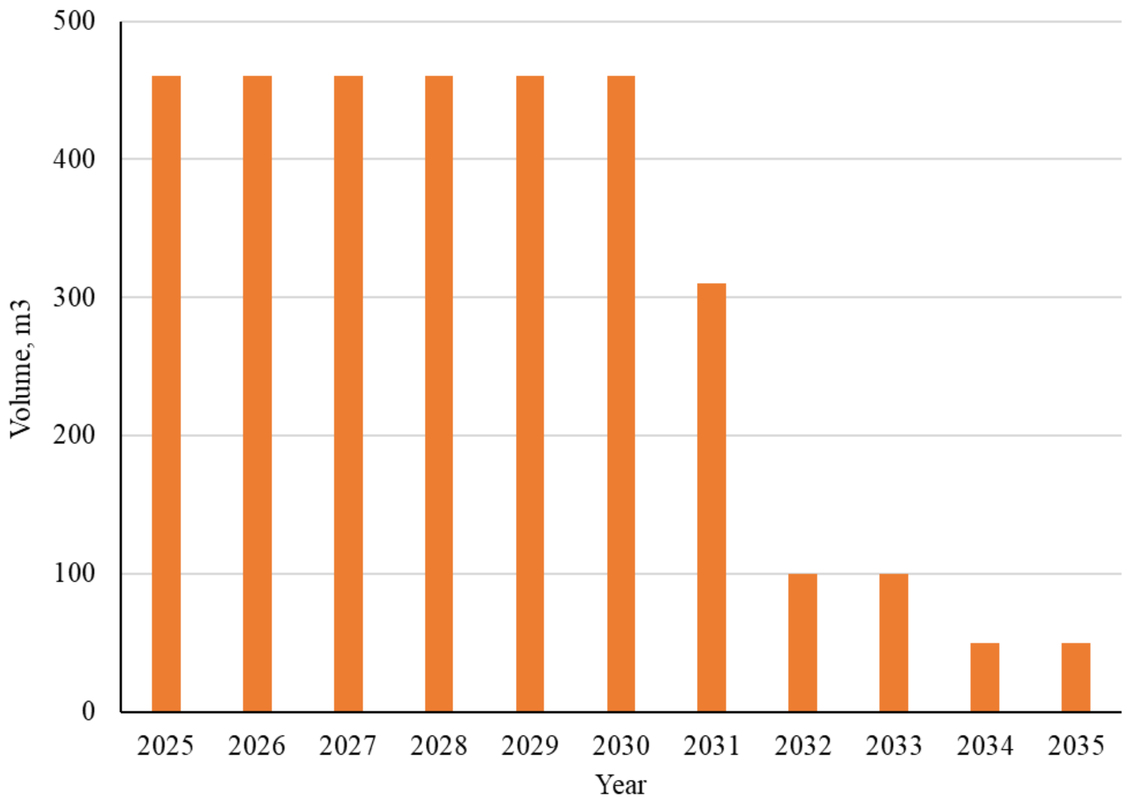

Figure 3.1-7. Forecast volumes of LRW processed by cementation technology in 2025-2035

3.1.1.2.4 Spent sealed sources and SRW from other organizations

The SSS generated during the operation of INPP, as well as the SSS accepted for storage from other organizations (so-called "small radioactive waste producers") were classified as solid RW (see Table 3.1-2) until 2000 and were placed in existing storage facilities (see Section 3.1.1.2.2) together with other non-combustible RW. It has been estimated that the existing storage facilities may contain about 30 000 pcs of SSS mixed with SRW [7]. The SSS have been stored separately from other SRW only since 2000. There are about 50 000 pcs of separately stored SSS. When sorting SRW retrieved from existing storage facilities, SSS will have to be separated and managed as a separate stream of class F SRW. The SSS generated during the operation of INPP and accepted from other organizations will be temporarily stored in the SWSF-LL storage facility, see Section 3.2.8.1, and in the planned interim reactor waste storage facility (IRWSF), see Section 3.2.8.2.

During the decommissioning of the INPP, the RW transported to the INPP in 2023-2025 and planned to be transported to the INPP in 2023-2025, which are generated due to the decommissioning of the Maišiagala RW storage facility and the recultivation of the Maišiagala RW storage site, will also be managed. The waste packages from the Maišiagala RW storage facility will be placed for temporary storage in the emptied SRW storage building No. 155/1. After the completion of the retrieval and treatment of the operational SRW in the VLLW sorting module, the SRW of the

Maišiagala RW storage facility will be sorted in this module. The amount of waste from the Maišiagala RW storage facility is summarized in Table 3.1-8. The amount of waste is not large, it accounts for about 5% of the volume of SRW accumulated during the operation of the INPP. The SSS transported from the Maišiagala RW storage facility, as well as the SSS that will no longer fit into the SWSF-LL facility, are planned to be temporarily stored in the newly planned interim reactor waste storage facility (IRWSF), see Section 3.2.8.2.

Table 3.1-8. RW from the decommissioning of the Maišiagala radioactive waste storage facility

RW type	**RW class**	**RW volume, m^3**
Solid RW	0, A	1 100
	D	330
Liquid RW	-	5
SSS	F	19
Total:		**1 460**

3.1.1.2.5 Dismantling equipment and system structures

The quantities of materials from the dismantling of equipment and system structures during the INPP decommissioning activities were estimated after conducting the INPP engineering inventory [18]. During the decommissioning of INPP, approximately 180 000 tons of equipment and systems structures will need to be dismantled. About 85% of the total mass of equipment and structures to be dismantled is concentrated in the INPP controlled area (CA). These materials are considered potentially contaminated with radionuclides, i.e. radioactive waste.

The distribution of the mass of the dismantled equipment and structures in the controlled area of the INPP site is summarized in Table 3.1-9. About 95% of the total mass of the dismantled equipment and structures at the controlled area consists of the equipment of Unit 1 and Unit 2. The mass of the RW management equipment (liquid and solid RW storage, removal, treatment) operating in the controlled area is about 4% of the total mass of the dismantled equipment and structures at the controlled area.

Table 3.1-9. The distribution of the masses of the dismantled equipment and system structures in the controlled are

Activity	**Equipment and system constructions**	
	tons	%
Unit 1 equipment	72 900	47.8%
Unit 2 equipment	72 600	47.6%
LRW treatment equipment	4 000	2.6%
SRW treatment equipment	2 400	1.6%
Equipment for other activities	800	0.5%
Total:	**152 600**	**100.0%**

The distribution of the mass of the equipment and structures to be dismantled in the INPP power units in the individual buildings of the controlled area is summarized in Table 3.1-10. About 97% of the total mass of the dismantled equipment and structures of the power units is concentrated in buildings 101/1 and 101/2, and about 46% of this mass is made up of reactors in blocks A1 and A2 and the equipment surrounding them.

Table 3.1-10. Distribution of masses of dismantled equipment and system structures in individual buildings and units

Place	**Equipment and system constructions**	
	tons	**%**
Building 101/1, including:	69 700	95.6%
Reactor 1	14 800	20.3%
Block A1	17 800	24.4%
Bloke B1	2 200	3.0%
Block D0	700	1.0%
Block D1	8 600	11.8%
Block G1	24 200	33.2%
Bloke V1	1 300	1.8%
In other buildings	3 200	4.4%
Total in the Unit 1	**72 900**	
Building 101/2 and including:	71 100	97.9%
Reactor 2	15 400	21.2%
Block A2	18 500	25.5%
Bloke B2	2 000	2.8%
Block D2	8 800	12.1%
Bloke G2	25 000	34.4%
Bloke V2	1 500	2.1%
In other buildings	1 500	2.1%
Total in the Unit 2	**72 600**	

Table 3.1-9 and Table 3.1-10 provide information on the distribution of the masses of the dismantled equipment and systems structures in the INPP territory and are also summarized in Figure 3.1-8. The mass of the installations and systems in buildings Nos 101/1 and 101/2 of the controlled area accounts for approximately 80% of the total mass of the installations and structures dismantled during the decommissioning period, i.e. approximately 140 800 tonnes.

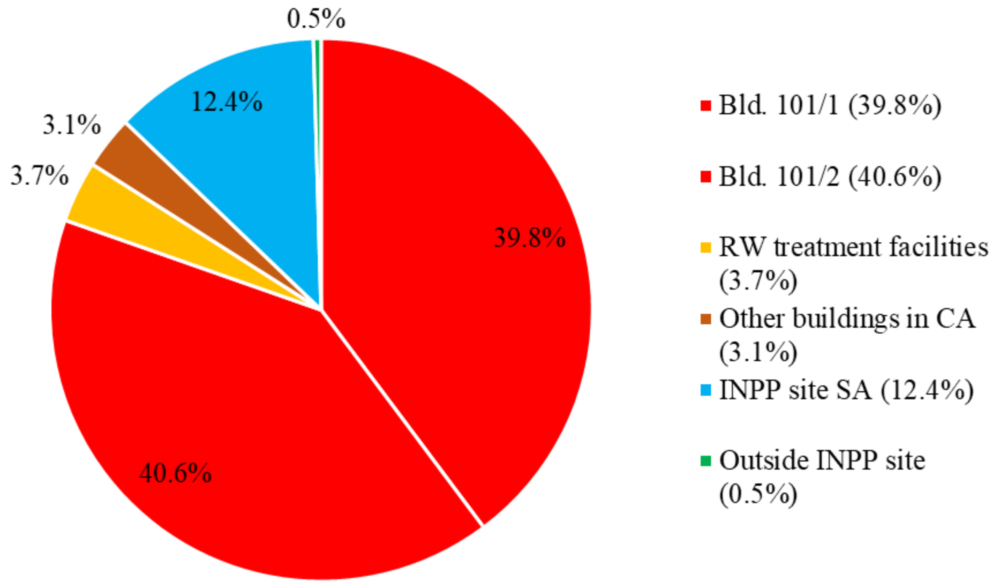

Figure 3.1-8. Distribution of masses of equipment and system structures to be dismantled during INPP decommissioning activities at the INPP site

The distribution of the masses of equipment and system structures dismantled during the INPP decommissioning activities (so-called "initial masses") by RW classes is shown in Figure 3.1-9. About 96% of the mass of materials consists of class 0 and A RW, i.e. uncontrolled and short-lived very low-level radioactive waste. The mass of decontaminated Class A RW (e.g. metals with a contaminated surface) can be reduced by decontaminating such materials to class 0. Materials dismantled in the observation area and outside the INPP site are classified as class 0 or are not classified as RW.

The remaining approximately 4-5% of the total mass of dismantled equipment and system structures consists of low-level and intermediate-level short-lived (classes B and C) and long-lived (classes D and E) radioactive waste. The mass of class B and C radioactive waste is approximately 1800 tons. The mass of class D and E radioactive waste is approximately 6000 tons, of which the largest part consists of graphite irradiated in reactors (approximately 3800 tons).

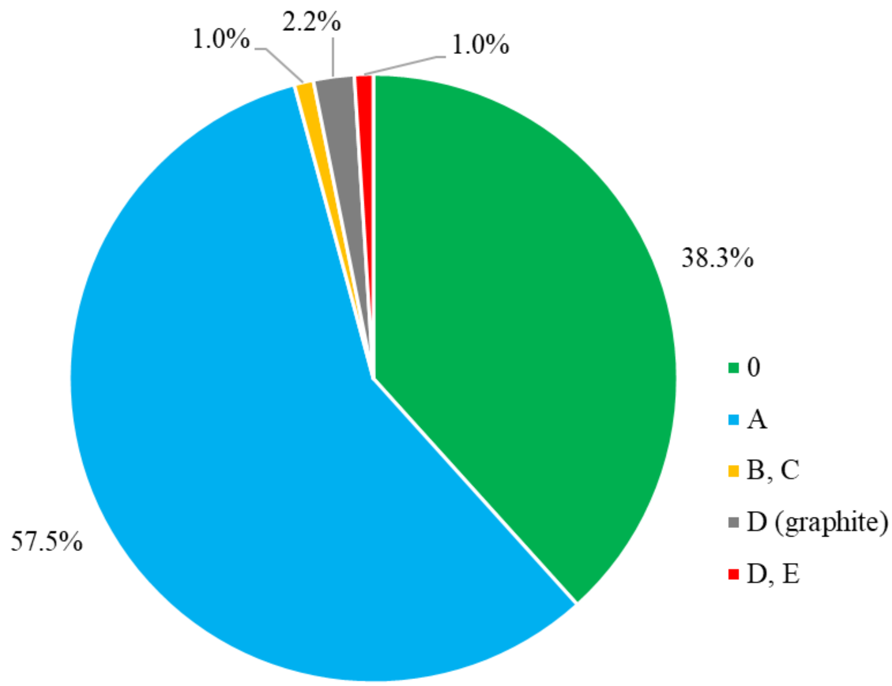

Figure 3.1-9. The distribution of the masses of equipment and system structures dismantled during the INPP decommissioning activities by RW classes

The distribution of the individual masses of RW classes ("initial masses") of the equipment and system structures dismantled in the activities of the INPP decommissioning in the buildings of the CZ is shown in Figure 3.1-10. About 80% of the total mass of class B, C dismantled materials and 100% of the total mass of class D, E dismantled materials is concentrated in the reactors. The reactors also contain materials classified as class A and class 0. In reactor unit buildings No. 101/1 and No. 101/2, in the equipment and system structures surrounding the reactors, about 80% of the total mass of class A dismantled materials and almost 20% of the total mass of class B, C dismantled materials are concentrated. In other buildings in the controlled area, only class A and class 0 materials are dismantled (excluding the relatively small mass of class B and C materials of several tons, which may be generated during the dismantling of RW treatment facilities located outside buildings No. 101/1 and No. 101/2).

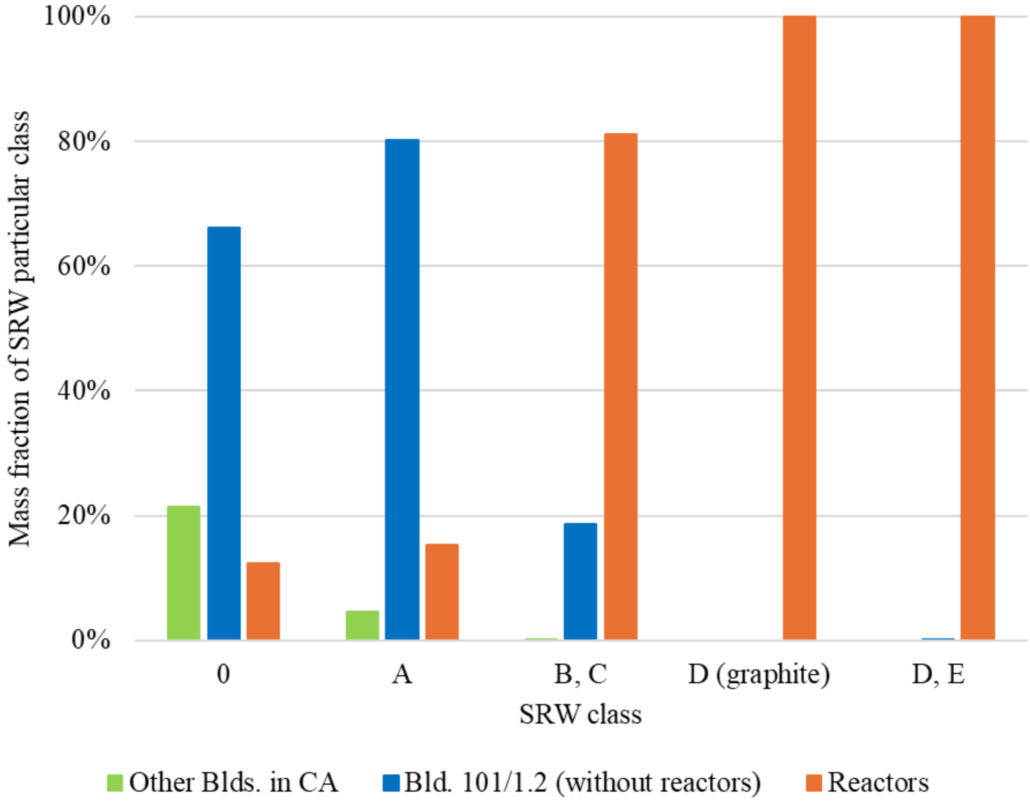

Figure 3.1-10. Distribution of the individual masses of RW classes of the equipment and structures to be dismantled during INPP decommissioning of the buildings in the CA

The distribution of the masses of equipment and system structures to be dismantled in power units (excluding the reactors themselves) according to the types of individual materials is shown in Figure 3.1-11. Metals (carbon steel, stainless steel, non-ferrous metals) make up the largest mass of materials to be dismantled, about 62%. Another 33% is made up of the mass of dismantled concrete structures.

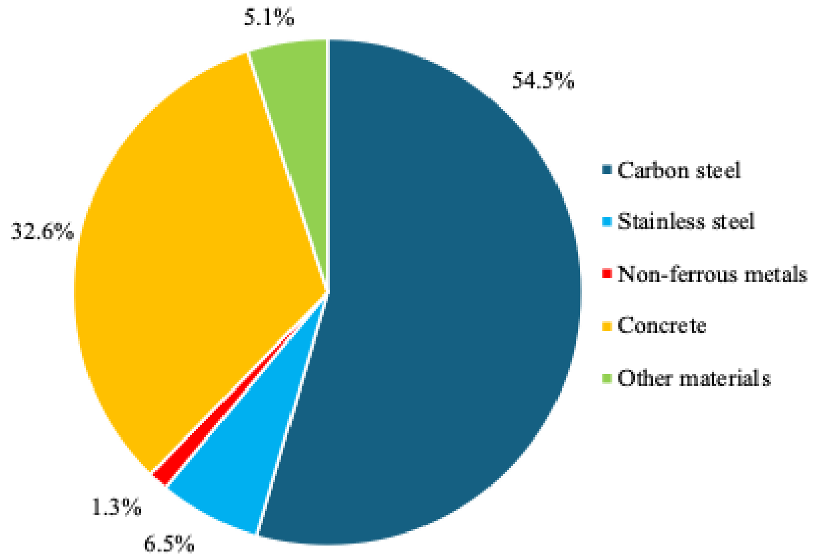

Figure 3.1-11. Distribution of masses of equipment and system structures (excluding reactors) to be dismantled in power units by material types

In reactors (R1, R2 and R3 zones, see Figure 3.2-16 and Figure 3.2-17 in Section 3.2.4.1) the composition of the materials to be dismantled is shown in Figure 3.1-12. Metals make up about 33% of the mass of the materials to be dismantled, graphite about 13%. The largest mass consists of fillers of various structural schemes and spaces (serpentinite, sand, gravel, crushed stone, metal shots), about 55% of the total mass of the reactors.

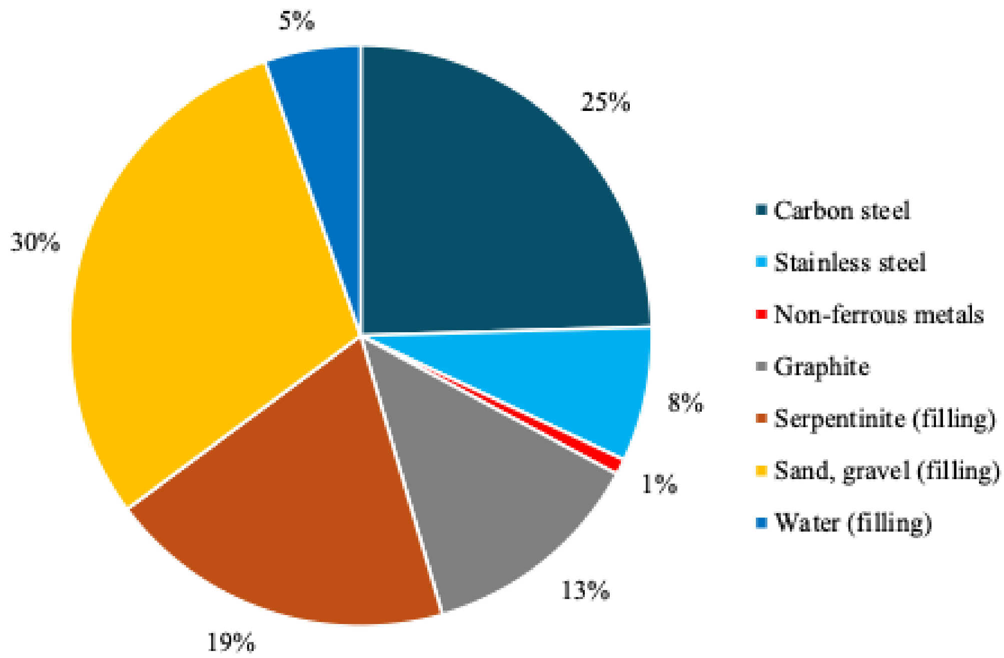

Figure 3.1-12. Distribution of masses of materials to be dismantled in reactors according to individual types of materials

3.1.1.2.6 Building structures to be dismantled

The quantities of building and construction structure materials to be dismantled in the controlled area during the INPP decommissioning activities were estimated after carrying out an inventory assessment of the INPP [18]. It is estimated that about 1 694 000 tons of reinforced concrete structures will have to be dismantled in the CA. Some building structures, usually their surfaces, are contaminated with radionuclides [19]. Contaminated parts of structures will have to be separated (by decontamination, mechanical removal, etc.) from non-contaminated ones and will continue to be managed as radioactive waste. The masses of the buildings and construction structures to be dismantled by the INPP CA are summarized in Table 3.1-11. The mass of building structures contaminated with radionuclides accounts for about 10% of the total mass of building structures in the CA, about 165 000 tons.

Table 3.1-11. Masses of buildings and construction structures to be dismantled in the INPP control zone

Activity	**Building structures**		**Contaminated building structures**	
	tons	%	tons	%
Unit 1 buildings	732 000	43.2%	72 900	4.3%
Unit 1 buildings	709 000	41.9%	66 500	3.9%
LRW treatment facility structures	111 000	6.6%	13 100	0.8%
SRW management facility structures	122 000	7.2%	12 100	0.7%
Buildings of other activities	20 000	1.2%	400	0.02%
Total:	1 694 000	100.0%	165 000	9.7%

The location of structures contaminated with radionuclides in the INPP reactor units is summarized in Table 3.1-12. About 68% of the total mass of contaminated structures is in blocks A1 and A2, another about 23% of the mass of contaminated structures is in blocks D1, G1 and D2, G2.

Table 3.1-12. Masses of structures contaminated with radionuclides in INPP power units

Place	**Contaminated building structures**	
	t	**%**
Block A1	51 500	37.0%
Block B1	3 800	2.7%
Block D0	400	0.3%
Block D1	6 300	4.5%
Block G1	8 500	6.1%
Block V1	800	0.6%
In other buildings	1 600	1.1%
Total in the buildings of the Unit 1	**72 900**	**52.3%**
Block A2	43 900	31.5%
Block B2	3 900	2.8%

Block D2	8 000	5.7%
Block G2	8 600	6.2%
Block V2	800	0.6%
In other buildings	1 400	1.0%
Total in the buildings of the Unit 2	**66 500**	**47.7%**
In total, both units' buildings	**139 400**	**100.0%**

Information on the distribution of the masses of reinforced concrete structures to be dismantled in the INPP CA is provided in Table 3.1-11 and Table 3.1-12 and also summarized in Figure 3.1-13. The mass of contaminated building structures in buildings No. 101/1 and No. 101/2 of the controlled area accounts for about 83% of the total mass of contaminated building structures in the CA, i.e. about 136 500 t.

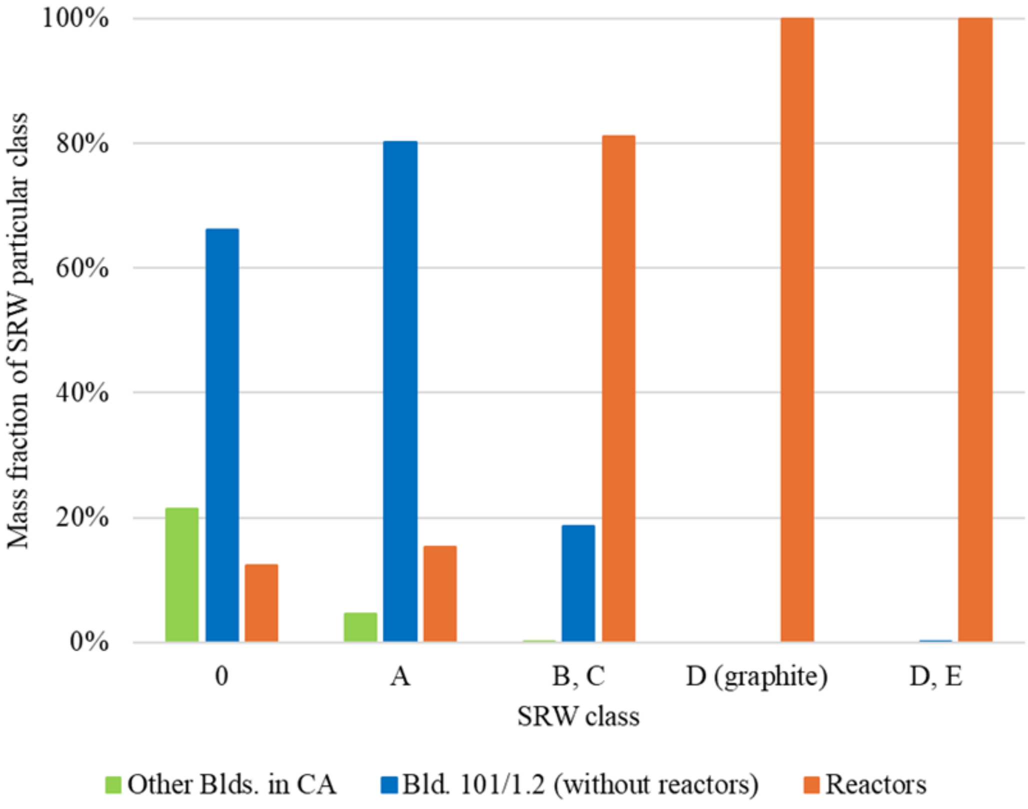

Figure 3.1-13. Distribution of masses of contaminated building structures in buildings at CA

3.1.1.2.7 Radioactive waste with hazardous properties

Part of the radioactive waste from the INPP operation (see Section 3.1.1.2.2) and decommissioning (see Sections 3.1.1.2.5, 3.1.1.2.6) may be classified as hazardous waste or contain hazardous substances [13]. Such RAs are:

- asbestos and asbestos-containing radioactive waste (e.g. thermal insulation elements, serpentinite filler of reactor R3 zone structures) in total about 4200 tons;

- radioactive lead waste (e.g. lead sheets, blankets), waste contaminated with petroleum products (e.g. oils, lubricants, rags), other waste (e.g. galvanic cells, fluorescent lamps), in total about 950 tons.

Asbestos and asbestos-containing RW account for about 80% of the total amount of radioactive waste with hazardous properties.

3.1.2 Non-radioactive materials

3.1.2.1 Classification of non-radioactive materials and requirements for their handling

Non-hazardous waste generated during the Ignalina NPP operation is classified and managed in accordance with the “Instruction for the Management of Non-Radioactive Waste at the Ignalina Nuclear Power Plant, 2023-07-19 No.EIn-160(7.119E)", which was prepared in accordance with the provisions of the Law on Environmental Protection of the Republic of Lithuania [14], the Law on waste management [15], the requirements of the Visaginas Municipality Waste Management Rules [16] and other normative documents.

Non-radioactive waste from the Ignalina NPP is sorted at the place of its generation, taking into account the type and nature of the waste, classified, packaged and transferred for temporary storage to the Material Resources Management Department (MRMD) of the Ignalina NPP. Non-radioactive waste is classified as non-hazardous and hazardous waste (which has one or more hazardous properties specified in the Annexes to Commission Regulation (EU) No. 357/2014 of 18 December 2014 and Council Regulation (EU) 2017/997 of 8 June 2017). Sorted waste is collected, temporarily stored, transported in such a way that it does not cause a negative impact on public health and the environment. MRMD transfers the temporarily stored hazardous and non-hazardous waste generated by the Ignalina NPP to waste management companies with which waste management contracts have been concluded.

Construction and demolition waste is collected in piles and/or containers designated for construction waste. The requirements for the management of construction waste are set out in the Rules on Construction Waste Management [17].

3.1.2.2 Quantities of non-radioactive materials

The main quantities of non-radioactive materials will be generated during the demolition of structures. It is preliminary estimated [18], [19] that the mass of reinforced concrete of demolished buildings and structures not contaminated with radionuclides and decontaminated to uncontrollable radioactivity levels is about 1 830 000 tons (about 800 000 m^3), Table 3.1-13. The main part of the waste (about 71% of the total mass of reinforced concrete) consists of the buildings of the Unit 1 and

Unit 2 located in the controlled area (CA), see Table 3.1-11. Structures and structures located in the observation zone (OZ) and outside the INPP site account for about 16% of the total mass of reinforced concrete waste. In addition to reinforced concrete, the demolition of buildings will also generate other waste – glass, plastic, wood, roofing, the provisionally estimated quantities of which are 343, 170, 124 and 2 330 tons, respectively [20].

Table 3.1-13. Mass and volume of buildings and construction structures being demolished at INPP

Place	**Buildings and building structures**		
	Mass, tons	**Volume, m^3**	**%**
CZ of the INPP site	1 529 000	665 000	83.7%
OZ of the INPP site	265 000	115 000	14.5%
Outside the INPP site	32 000	14 000	1.8%
Total:	**1 826 000**	**794 000**	**100%**

Excluding the amount of metal contained in the structures (steel beams and reinforcement, which will be removed and sold as secondary raw materials) and underground parts of the buildings that will not be demolished (in accordance with the provisions of STR 1.01.08:2002 “Types of Construction of a Building”, a building is considered demolished when all its structures have been dismantled, except for those remaining deeper than 0.5 m below the ground surface), the volume of crushed concrete will be approximately 706 000 m^3 according to a preliminary estimate. Approximately half of this amount could be crushed and the resulting crushed stone used to fill the underground cavities of buildings being demolished (this is a more economically beneficial solution than transporting concrete to a landfill and bringing soil to fill the cavity). Unused crushed stone and other materials generated during demolition would be managed in accordance with the legal acts regulating the management of such waste. During the demolition of INPP structures, construction waste is transferred to the INPP Material Resources Management Department with an aim to transferring it to waste management companies under contracts.

Ignalina NPP has prepared a construction waste management strategy (2018-2038 strategy) [20], which describes guidelines and methods for efficient and optimal management of construction waste generated during the decommissioning of the INPP. Based on the preliminary data provided in the strategy, the Table 3.1-14 has been compiled, which indicates the volumes of the above-ground parts of individual buildings being demolished (up to a depth of 0.5 m) that can be crushed, and the resulting crushed stone can be used to fill the underground cavities of the buildings.

Table 3.1-14. Volumes of reinforced concrete structures of buildings being demolished

Building No.	Name of the building	Amount of structures to be demolished for crushing (crushed stone), m^3	Amount of crushed stone, m^3	The amount of crushed stone, required for filling the underground part of the building (up to -0.5 m alt.) m^3
A1	Reactor unit with ventilation stack	109785	164677.5	31800
B1	Special Chemical Water Treatment Block Unit	9714	14571	11450
V1	Auxiliary Technological Systems Block Unit	8781	13171.5	6590
G1	Turbine Hall Unit	39482	59223	58320
D1	Deaerator Unit	47186	70779	42753
D0	Auxiliary block unit	4363	6544.5	6417
119	Cogeneration Unit Facility	3672	5508	0
102/1	Electricity Supply Equipment of the Power Unit			
117/1	Reactor Emergency Cooling System Tank Building	1430	2020	2144
120/1	Technical Water Supply Pumping Station	3239	4858.5	21946
135/1	Gas storage chamber (underground structure)			
152/1a 152/1b	Low salinity water storage tanks	1291	1856	160
A2	Reactor unit with ventilation stack	109785	164677.5	31800
B2	Special Chemical Water Treatment Block Unit	10344	15516	11450
V2	Auxiliary Technology Systems Block Unit	8781	13171.5	6590
G2	Turbine Hall unit	39482	59223	58320
D2	Deaerator Unit	47186	70779	42753
102/2	Electricity Supply Equipment of The Power Unit (Open Transformer Unit)			
117/2	Reactor Emergency Cooling System Tank Building	970	1340	1411
173/2	Gallery from Building 101/2 to Building 117/2	158	235	0
120/2	Technical Water Supply Pumping Station	3247	4870.5	21946
135/2	Gas storage chamber (underground structure)			
152/2A 152/2B	Low Salinity Water Storage Tanks	1357	2051	160
161, 161/1	Bitumen warehouse with yard	217	306	948
103	Transformer Revision Tower	665	998	0
109	Oil warehouse apparatus with oil drainage tanks	489	734	0
110	Oil warehouse with oil pipeline bypass	590	885	0
111	Backup Diesel Power Plant	7073	9972	7482
137	Nitrogen and oxygen station	2279	3214	1886
138	Compressor building	4026	5677	7195
129	Administrative building	6148	7378	5746

140/3	Enterprise and contractors' warehouses and household building with the gallery	545	709	0
139A/1, 2	Foam fire-fighting tanks and pumping stations (underground structures)	6	9	0
165	Fresh Nuclear Fuel Warehouse (Interconnected Warehouse)	4301	6452	0
260	Metal warehouse with access points	313	470	0
270	Liquid gas warehouse with ramp	714	1071	0
	In total:	**477 619**	**712 948**	**379 267**

The largest quantities of demolished structures will be generated by demolition of buildings 101/1 (blocks A1, B1, V1, G1, D1, D0), No. 119 and 101/2 (blocks A2, B2, V2, G2, D2). The reactor units (A1 and A2) will be demolished last, but together they account for about 50% of the total volume of structures to be demolished.

3.2 Technological processes

3.2.1 Spent Nuclear Fuel Management

Spent Nuclear Fuel (SNF) is classified as highly radioactive, Class G SRW (Table 3.1-1). Currently, the SNF at INPP is temporarily stored in two dry type storage facilities. Once Lithuania has installed a deep geological repository, the SNF and other long-lived radioactive waste temporarily stored at INPP will have to be placed in this repository [28].

Before being placed in storage cask, the fuel assembly is disassembled, separating (see Figure 3.1-2) the extension rod, the carrying rod, the caps and the upper and lower bundles. The bundles are placed in the SNF storage casks as class G RW. Other metal parts of the fuel assembly are processed (the rods are shredded) and further treated as class E RW. Fuel assemblies are disassembled and processed in the Hot Cells of reactor units A1 and A2. SNF processing equipment (hot cells, long parts shredding equipment, group G3 RW transport containers) and processing procedures are part of the INPP operation and are carried out in accordance with the conditions of the INPP operating license.

Hot tests of the first SNF storage facility (ISFSF-1) began and the first casks with SNF were placed in 1998. At the beginning of 2010, the storage facility was fully filled. In total, this storage facility stores 118 casks (20 CASTOR RBMK-1500 type casks and 98 CONSTOR RBMK-1500 type casks) containing 6018 spent fuel assemblies. The SNF stored in the storage facility has 2% 235U initial enrichment.

Figure 3.2-1. SNF storage facility ISFSF-1 with casks

ISFSF-1 could accommodate only a part of the SNF accumulated by the INPP. A second SNF storage facility (ISFSF-2) has been built to store the rest of the SNF. During the operation of ISFSF-1, SNF was fully discharged from the Unit 1 reactor core (at the end of 2009) into the SNF storage pools of Unit 1. In the Unit 2, SNF was stored both in SNF storage pools and in the reactor core (until 2018, before ISFSF-2 was put into operation).

The construction of ISFSF-2 was completed and hot tests began in 2016. After the completion of hot tests, industrial operation of ISFSF-2 began in 2017. The process of cask with SNF transferring from the INPP reactor units and placing them in ISFSF-2 is shown in Figure 3.2-2.

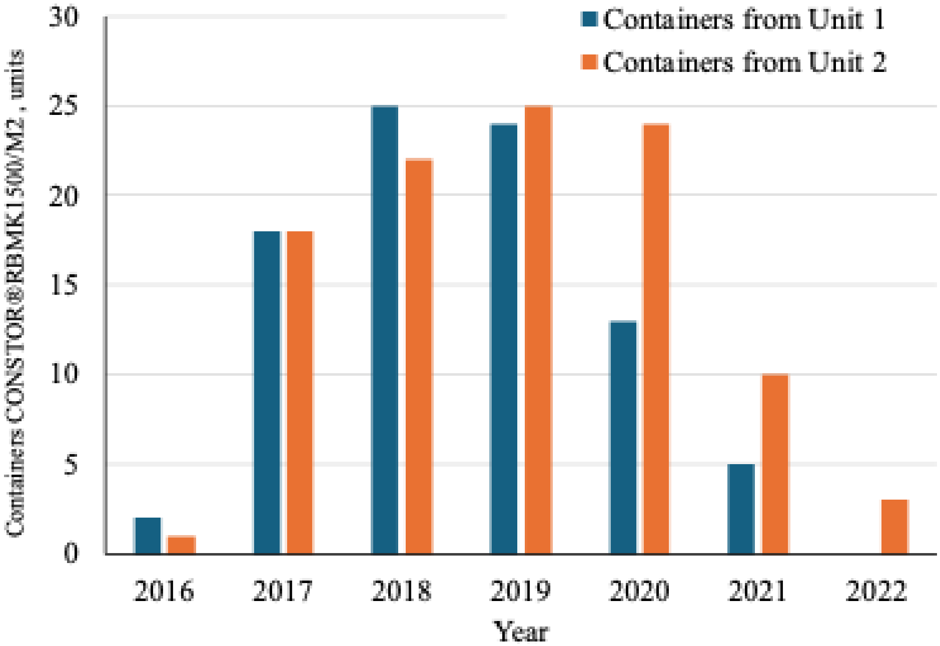

Figure 3.2-2. CONSTOR®RBMK1500/M2 casks with SNF transfer and placement to ISFSF-2

In 2020, the management of damaged SNF started, initially in Unit 1. In 2021-2022, the management of damaged SNF was started in Unit 2. At the end of April 2022, the transfer of SNF from the reactor units to the ISFSF-2 was completed. In total, the storage facility stores 190 pcs. CONSTOR®RBMK1500/M2 type casks with fuel (22 of them with damaged fuel). The storage facility stores 15 553 pcs. spent fuel assemblies with an initial 235U enrichment of 2.0% - 2.8%.

ISFSF-2 also stores fresh nuclear fuel, i.e. fuel assemblies that were not used during the operation of the INPP. In total, 75 fresh fuel assemblies are stored in 8 special metal containers.

Figure 3.2-3. Cask storage hall of the SNF storage facility ISFSF-2

3.2.2 Initial treatment and packaging of the INPP operational SRW

To remove the SRW accumulated during the operation of the INPP from the existing temporary storage facilities, buildings No. 155, No. 155/1, No. 157 and No. 157/1 (see Section 3.1.1.2.2), to sort them according to the applicable classification (see Section 3.1.1.1) and the intended methods of management of the SRW, to carry out initial treatment and packaging for further processing, storage or placement in the respective repositories, a new Solid waste management and storage facility (SWMSF) has been built at the INPP.

The SWTSF consists of a series of objects, but it can be conditionally divided into two parts: the Solid radioactive waste retrieval facility (SWRF), located on the INPP site next to the existing SRW storage facilities, and the Solid Waste Treatment and Storage Facility (SWTSF), which is built on a separate site located at a distance of about 600 m from the INPP site (see Figure 2.2-4).

SWRF is designed for the retrieval of SRW from existing storage buildings No. 155, No. 155/1, No. 157, No. 157/1 and for the initial treatment of class A SRW. The SWRF consists of three waste retrieval units (RU-1, RU-2 and RU-3 respectively), the VLLW sorting unit and the control building.

RU-1, the VLLW sorting module and the control building are adjacent to storage buildings No. 155 and No. 155/1. Using RU-1 the SRW is removed from storage buildings No. 155 and No. 155/1 through openings made in their walls and transferred into the VLLW sorting module.

The VLLW sorting module processes: SRW of group G1 retrieved by RU-1, SRW of group

G1 retrieved by RU-2, placed in transport containers and transported, and Class A SRW (e.g. secondary waste) placed in transport containers and brought from other INPP objects. In the module, SRW are sorted (separating combustible from non- combustible, compactable from non-compactable), class A SRW that cannot be placed in the VLLW repository (e.g. SSS) are separated, Class A waste treatment (shredding, pressing) and characterization is performed, and packages that meet the VLLW repository waste acceptance criteria are produced (1CX containers and bales). SRW which cannot be placed in the packages for the VLLW repository, are placed in transport containers and transferred to the SWTSF for further processing, see Section 3.2.6.

Hot tests of the RU-1 and the VLLW sorting module began in 2017. The VATESI permit for the industrial operation of these facilities was granted in 2019. From the start of the hot tests until the end of 2024, all SRW from building 155/1 and a small part of SRW from building 155 were retrieved. In total, about 2300 m^3 was retrieved, i.e. about 50% of the volume of SRW planned to be retrieved by the RU-1. The retrieval of the SRW from building No. 155 is preliminary planned to be completed by 2028.

The VLLW sorting module also processed class A SRW brought from other INPP objects. SRW processing in the RU-1 and VLLW sorting module and planned activities are shown in Figure 3.2-4. In 2026, it is planned to complete the retrieval of SRW with RU-1 and continue to process in the VLLW sorting module group G1 SRW retrieved with RU-2. In 2029-2031 and 2034, it is planned to retrieve group G2 SRW, therefore processing in the VLLW sorting module will be reduced. By 2038, it is planned to process all group G1 SRW accumulated during the operation of the INPP in the VLLW sorting module.

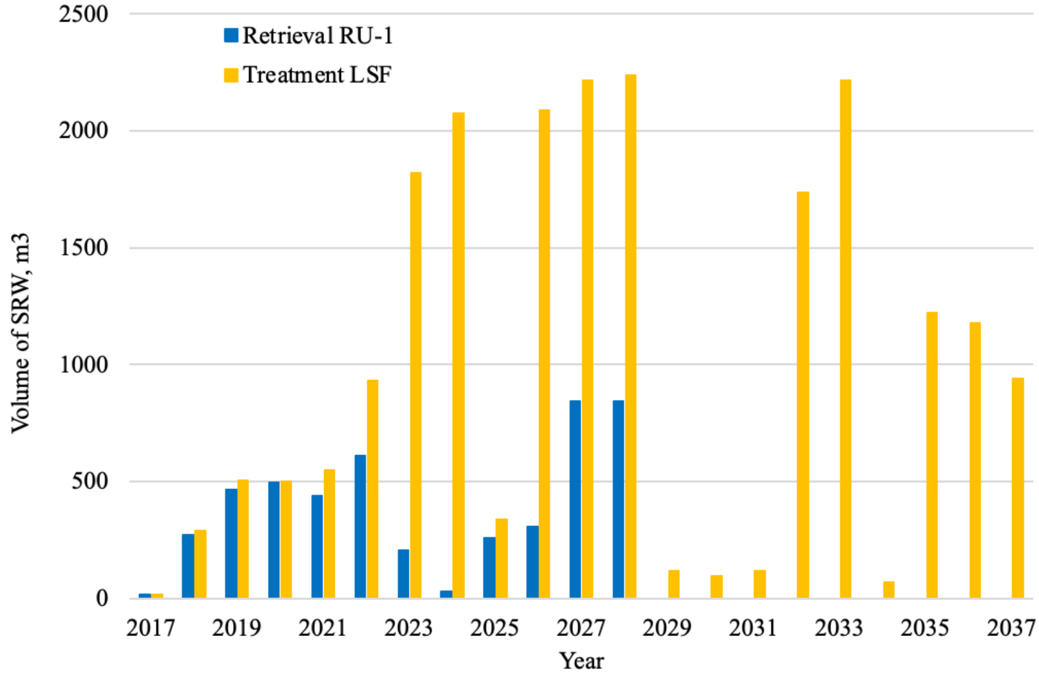

Figure 3.2-4. Group G1 SRW removal with RU-1 from buildings No. 155/1 and No. 155 and initial treatment of SRW in the VLLW sorting module

The RU-2 is a device installed on the roof of the SRW storage buildings No. 157 or No. 157/1, which can move along the rails installed for that purpose, Figure 3.2-5. This module is designed for the retrieval and placement of group G1 and G2 SRW into transport containers. Depending on the SRW group, the containers are transported to the VLLW sorting module or to the SWTF, where the treatment of the retrieved waste is performed.

Figure 3.2-5. INPP operational SRW storage building No. 157/1 with group G1 and G2 SRW retrieval unit RU-2

RU-2 hot tests started in 2017. VATESI licence to carry out the decommissioning of solid radioactive waste storage buildings No. 155, No. 157 and No. 157/1 was issued in 2024. The current and planned activities of RU-2 are shown in Figure 3.2-6. From the start of the hot tests until the end of 2024, about 3800 m^3 of groups G1 and G2 waste was retrieved from building No. 157/1, which represents about 20% of the total volume of SRW planned to be retrieved with RU-2. The rate of waste retrieval has increased since 2023. Waste retrieval using the RU-2 from building No. 157 will be carried out after all group G3 SRW have been retrieved from this building and RU-3 has been removed from the building.

The organisation of waste retrieval and management works in individual units of the SWRF depends on many factors, therefore, the actual annual volumes of the works carried out may differ from those currently planned (as shown in Figure 3.2-4 and Figure 3.2-6). It is planned to remove all SRW from storage buildings No. 157/1 and No. 157 by 2038 – 2045.

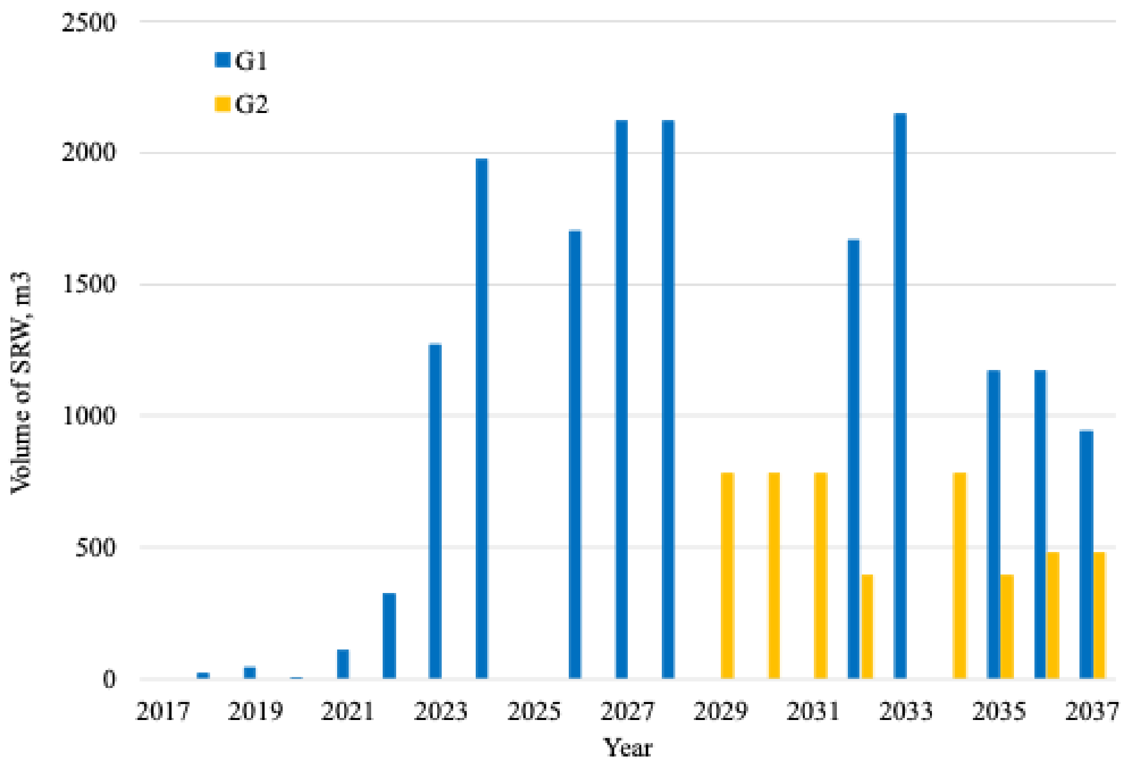

Figure 3.2-6. Retrieval of groups G1 and G2 SRW from buildings No. 157 and No. 157/1 using RU-2

The RU-3 is a device installed on the roof of the SRW storage building No. 157, Figure 3.2-7 intended for the removal of group G3 SRW from sections 1 and 4 of this building and for the placement of SRW into transport containers. The containers are transported to the SWTF, where the waste management of group G3 continues.

Figure 3.2-7. INPP operational SRW storage building No. 157 with Group G3 SRW retrieval unit RU-3

RU-3 hot tests started in 2017. SRW retrieval using RU-3 is shown in Figure 3.2-8. From the start of the hot tests until the end of 2024, about 290 m^3 of group G3 waste was retrieved from building No. 157, which is about 32% of the total volume of SRW planned to be retrieved by RU-3. It is planned to retrieve the group G3 SRW from building No. 157 by 2031.

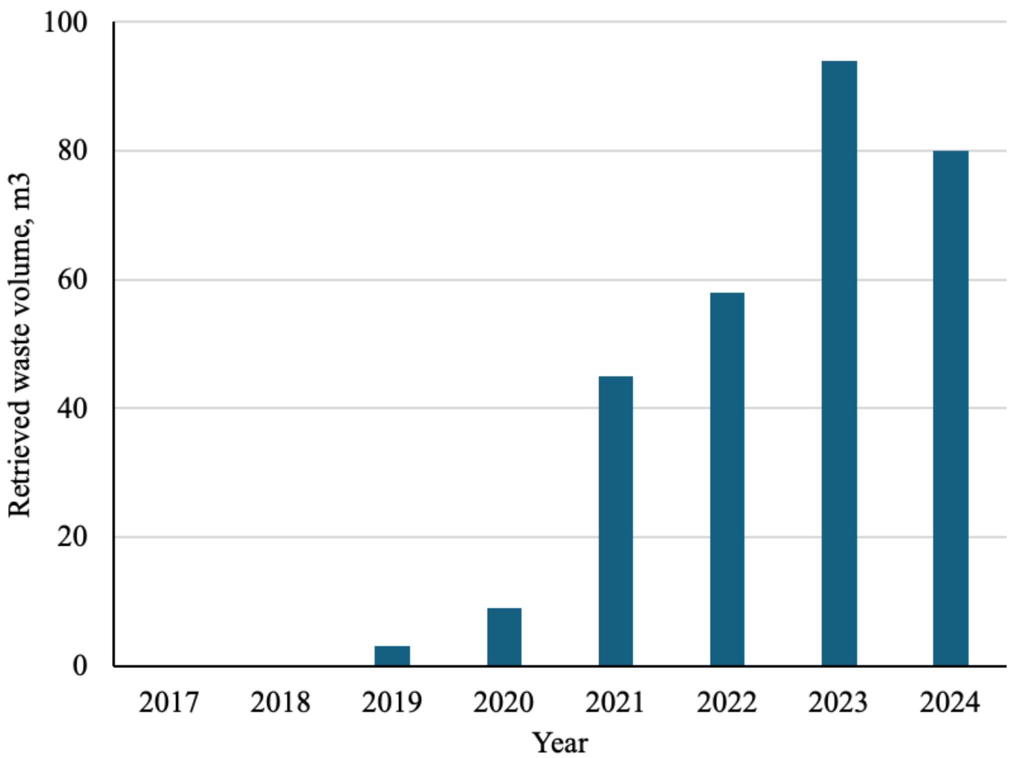

Figure 3.2-8. Unloading of G3 class SRW from building 157 with RU-3

Remotely controlled SRW retrieval equipment operates in the RU-1, RU-2, and RU-3 modules. The RU-2 and RU-3 modules have their own separate ventilation and exhaust air cleaning and monitoring systems. The RU-1 and the VLLW sorting module have common ventilation and exhaust air cleaning and monitoring systems. The LRW generated in SWRF is collected and transported for processing to the LRW treatment facility (see Section 3.2.3).

Once all SRW have been retrieved from the storage facilities, the retrieval units will no longer be needed and will have to be dismantled and their waste managed. The VLLW sorting module and the control building will continue to be used for the management of class A waste generated during the operation and dismantling of INPP facilities.

After the dismantling of equipment and system structures at the other INPP facilities is completed and the waste stream to be managed has decreased, the entire SWRF will no longer be required. The dismantling of the SWRF and the management of its waste will be carried out during the decommissioning of the Ignalina NPP.

3.2.3 Collection, storage and processing of liquid RW

Before the treatment liquid radioactive waste (LRW) generated in various controlled area buildings and processes of the INPP is collected and temporarily stored in the tanks installed in the buildings No. 151, No. 154, No. 154A and No. 154B of the LRW treatment facility. The purpose and main characteristics of the tanks are summarized in Table 3.2-1.

Table 3.2-1. Collection and storage tanks of the INPP LRW treatment facility

Purpose of the tanks	**Tank ID**	**Total volume, m^3**
Wastewater storage tank with PAM *	TW11B01	1 500
Wastewater storage tanks	TW11B02, TW11B04, TW13B01, TW13B02	13 000
Storage tanks for ion exchange resins, perlite and distillation residue	TW11B03, TW18B01, TW18B02	4 500
Clean condensate, purified water storage tanks	TW15B01, TW15B02, TW32B01, TW41B01	20 000
Total:		**39 000**

* PAM – surface active substances. PAM contaminated wastewater comes from buildings No. 156 (special laundry) and No. 159 (special machine garage and washing facility).

The LRW treatment equipment is located in the building No. 150 of the LRW treatment facility.

Wastewater from various processes and systems at the INPP is treated using distillation technology. In water evaporation units, secondary steam condensate and distillation residue are extracted. The salinity of wastewater is 0.5-5 g/l, the salinity of the distillation residue reaches up to 300 g/l. Secondary steam condensate is additionally cleaned in ion exchange filters and can be reused for INPP purposes.

The INPP operates two evaporator lines, each of which has a capacity of 30 m^3/h. During the operation of the INPP, wastewater treatment reached 250 000 m^3 per year. The cooling energy of the reactors was used to produce the heating steam necessary for the operation of the evaporation units. After the power units were shutdown, the heating steam is produced in the new steam boiler plant built at INPP observation zone (B5 project).

After the final shutdown of power units, the transfer of SNF to interim storage facilities, the gradual isolation and emptying of disused systems, SNF pools, etc., the volumes of collected and required wastewater for treatment have decreased to 36 000 – 39 000 m^3 per year, see Section 3.1.2.2 and Figure 3.1-4. From 2025, the need for wastewater treatment is expected to decrease to 15 000 m^3 per year, see Section 3.1.2.2 and Figure 3.1-5. The existing wastewater treatment plants at the INPP are becoming economically inefficient. In order to more efficiently use the energy resources (steam and cooling water) used in the treatment of LRW, INPP plans to install new modern energy-saving vacuum evaporation units (the so-called ESVA unit) and a pre-treatment unit for wastewater contaminated with surface active substances using the ozonation method (the so-called OZON unit) in the LRW treatment facility. The capacity of the ESVA unit should be at least 2 m^3/h, and the electricity consumption should not exceed 125 kW/m^3. The planned start of operation of the new LRW treatment equipment is 2026. Once the new equipment is operational, the currently used evaporation and additional condensate cleaning units will no longer be in operation.

The liquid residue of the wastewater distillation process – distillation residue, was solidified using bituminization technology until 2015. The resulting bituminized RW is stored in the bituminized radioactive waste storage facility, building No. 158. Currently, the building has accumulated about 14 400 m^3 of bituminized RW, classified as class B and C SRW. In the future, it is planned to transform the temporary storage facility for bituminized RW (by installing additional engineering structures and engineering barriers limiting the spread of radionuclides) into a surface RW repository [7], [29].

Aqueous mixtures of used filtering materials (ion change resins, perlite) have been solidified using cementation technology since 2006. The cementing unit is installed in the building No. 150 of the LRW treatment facility. LRW are cemented into 200 l drums. Cemented RW packages are classified as class C SRW. Cemented RW packages (drums) are placed in the so-called F-ANP container (8 drums per container) for storage and transfer to building No. 158/2 for temporary storage,

Figure 3.2-9.

Cemented RW temporary storage, building No. 158/2 is designed to accommodate up to 6 300 F-ANP containers. At the end of 2024, about 3 300 F-ANP containers were placed in the storage facility, i.e. the storage facility is filled to about 50% of its design volume. Since 2022, the storage facility has also stored F-ANP containers with graphite (class D) RW. Graphite waste is generated during the dismantling of reactor channels. The storage of graphite in building No. 158/2 is a temporary measure until the construction of the interim reactor waste storage facility (IRWSF). Then the packages with graphite RW will be transferred to the IRWSF for further storage until they can be placed in the Lithuanian deep geological repository. From a radiological point of view, graphite waste is less active than the cemented RW stored in the storage facility and meets waste acceptance criteria for RW storage in the interim storage facility No. 158/2.

The progress of the storage filling in the period 2010-2024 and the filling forecast are shown in Figure 3.2-10. When assessing the volumes of LRW planned to be processed in 2025-2034, see Section 3.1.2.2 and Figure 3.1-7, in 2030 the storage facility will be filled with about 90% of the storage facility's design volume. Once the LILW-LL repository is put into operation (planned for 2030), the waste packages accumulated in the storage facility will be transported to the LILW-LL repository site, where they will be finally treated (cemented) and placed in the LILW-LL repository vaults, see Section 3.2.7.2.

Figure 3.2-9. F-ANP container

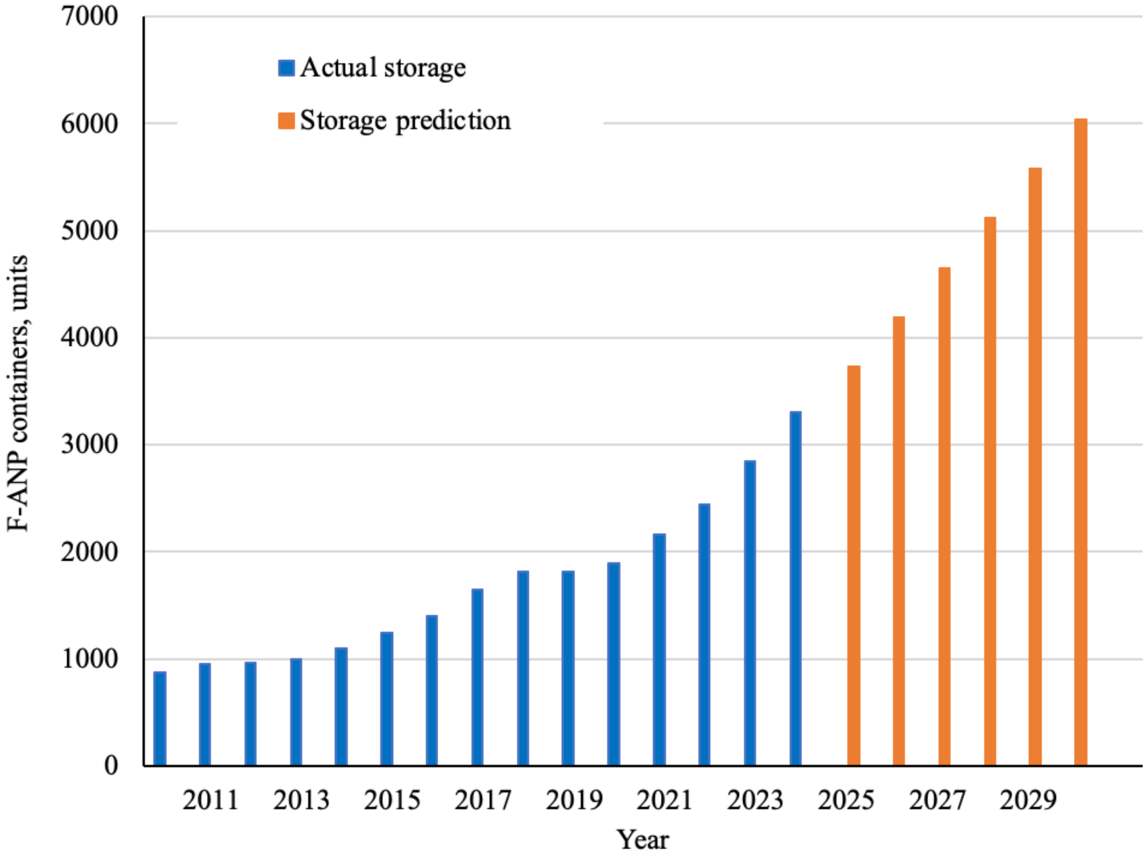

Figure 3.2-10. Progress and forecast of filling of the temporary storage facility of cemented RW (building No. 158/2)

3.2.4 Dismantling and initial treatment of equipment and structures

3.2.4.1 Dismantling

About 83% of the total mass of the equipment and structures to be dismantled and, among them, about 95% of the total mass of the equipment and structures to be dismantled (classes A, B, C, D, E) and not contaminated with radionuclides (class 0), is located in the Unit 1 and Unit 2 buildings that are in the controlled area (see Section 3.1.1.2.5). The layout of the power unit buildings is shown in Figure 2.2-3, the designation and purpose of the most important buildings located in the controlled area is summarized in Table 3.2-2.

Table 3.2-2. Marking and purpose of the most important buildings of the INPP power units located in the controlled area

Power unit	Building No.	Building block	Name of the building
Unit 1	101/1	A1	Reactor unit with ventilation stack
		B1	Special Chemical Water Treatment Block Unit
		V1	Auxiliary Technological Systems Block Unit
		G1	Turbine Hall Unit
		D1	Deaerator Unit
		D0	Auxiliary block unit

	119	-	Cogeneration Unit Facility
	117/1	-	Reactor Emergency Cooling System Tank Building
	135/1	-	Gas storage chamber (underground structure)
	152/1A, 1B	-	Low salinity water storage tanks
Unit 2	101/2	A2	Reactor unit with ventilation stack
		B2	Special Chemical Water Treatment Block Unit
		V2	Auxiliary Technological Systems Block Unit
		G2	Turbine Hall Unit
		D2	Deaerator Unit
	117/2	-	Reactor Emergency Cooling System Tank Building
	135/2	-	Gas storage chamber (underground structure)
	152/2A, 2B	-	Low salinity water storage tanks

The dismantling of the equipment of the INPP power units began in 2010 with the dismantling of the emergency cooling system of the Unit 1 reactor located in building No. 117/1, see Section 2.3. Since then, the INPP has been carrying out the works of isolation, modification, dismantling and initial waste treatment of technological equipment that is no longer necessary for further operation and decommissioning, in accordance with the strategy of carrying out dismantling works, according to which "buildings are dismantled in turn, one building after another", starting with "the least contaminated buildings" and then dismantling "increasingly contaminated".

The location and scope of the dismantling works are defined by the individual decommissioning projects, see Section 2.3. During the stage of the final shutdown of the INPP power units (2010-2024), the following major decommissioning projects were implemented or started to be implemented, each of which has been assessed by a separate EIA study:

- D&PT works in building 117/1: dismantling and initial treatment of the storage tanks and piping of the emergency cooling system of the Unit 1 reactor [31];
- D&PT works in building 119: dismantling and initial treatment of the cogeneration plant system [32];
- D&PT works in G1 block: dismantling and initial treatment of the turbine hall systems and equipment of the Unit 1 reactor [33];
- D&PT works in V1 block: dismantling and initial treatment of the reactor gas circuit, exhaust gas cleaning system, reactor emergency cooling system and related auxiliary equipment, first phase [34];
- D&PT works in building 117/2: dismantling and initial treatment of the storage tanks and piping of the emergency cooling system of the Unit 2 reactor [35];
- D&PT works in G2 block: dismantling and initial treatment of the turbine hall systems and equipment of the reactor of the Unit 2 reactor [36];

- D&PT works in D0 and D1 block: dismantling and initial treatment of electricity, control equipment and deaerators of power unit 1, their power supply systems and transit conditionally clean steam and conditionally clean steam condensate pipelines, fresh steam, supply water, etc. [37];
- D&PT works in D2 block: dismantling and initial treatment of the deaerators of the Unit 2 reactor, their supply systems and transit pipelines for conditionally clean steam and conditionally clean steam condensate, fresh steam, supply water, etc. [37];
- D&PT works in A1 block, Phase 1: Dismantling and initial treatment of the equipment of the reusable forced circulation circuit piping, main circulation pumps, etc. of the Unit 1 reactor [38];
- D&PT works in Reactor Zones R1 and R2 of Unit 1: Dismantling and initial treatment of the upper and lower piping of the reactor unit [39];
- D&PT works in A2 and V2 block, Phase 1: dismantling and initial treatment of the multiple forced circulation circuit piping, main equipment of circulation pumps and other equipment and reactor gas circuit system, exhaust gas cleaning system, reactor emergency cooling system and related auxiliary equipment of the of the Unit 2 reactor [40].

The progress of decommissioning projects carried out and ongoing in individual reactor units is summarised Figure 3.2-11 and Figure 3.2-12. These figures also show the unloading of SNF in the units together with the dismantling works (see Section 3.2.1) and decontamination (see Section 3.2.4.2) activities.

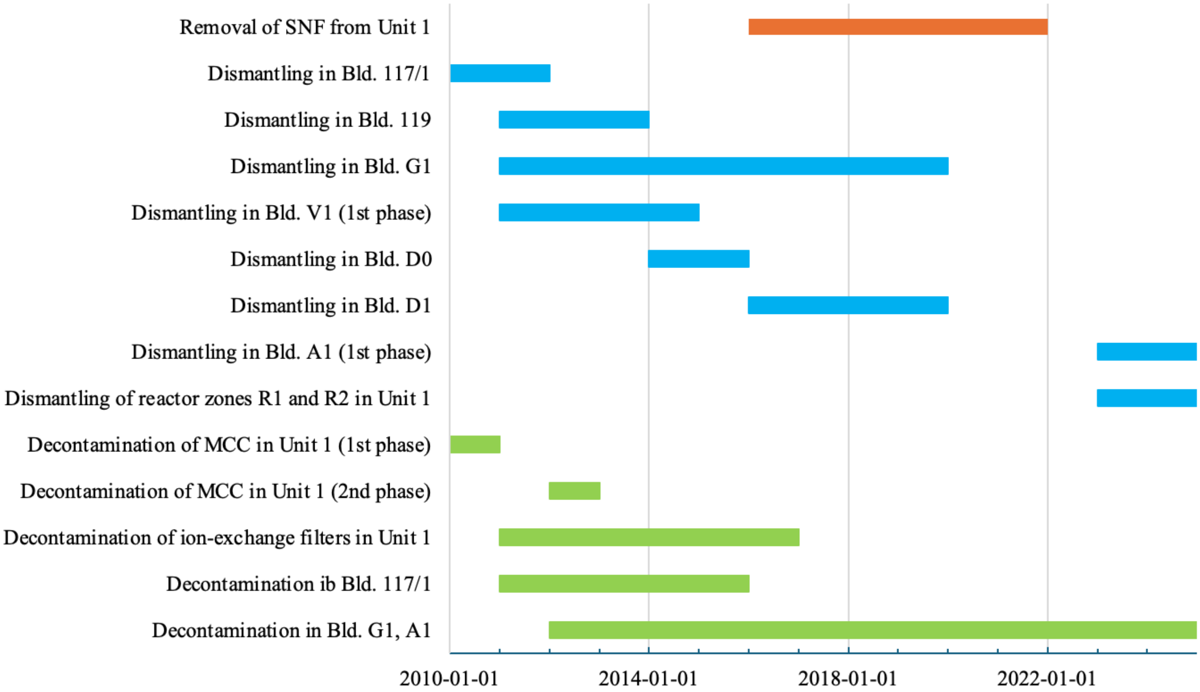

Figure 3.2-11. Decommissioning activities in Unit 1

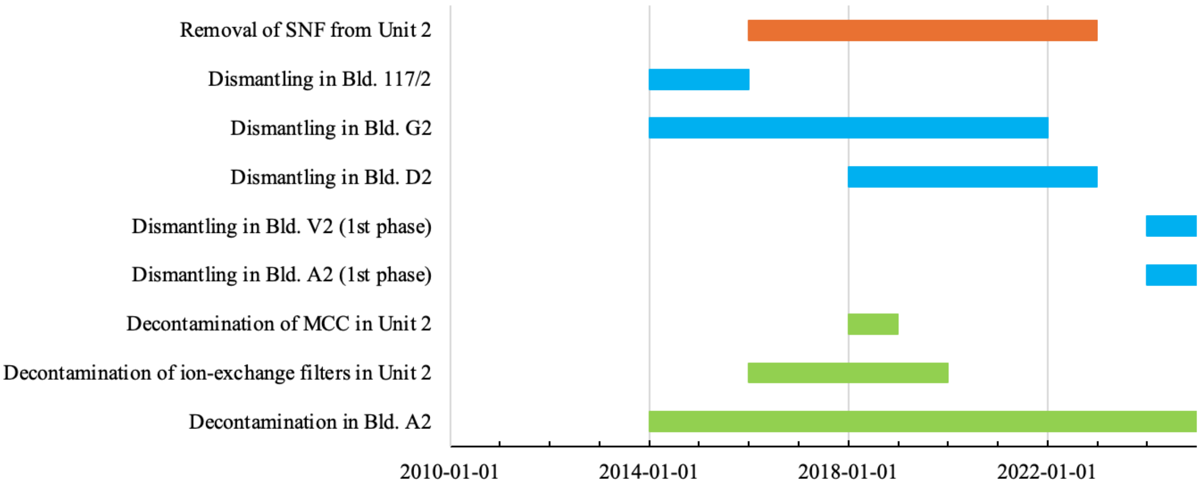

Figure 3.2-12. Decommissioning activities in Unit 2

The mass of equipment and systems dismantled in units in individual years is summarized in Figure 3.2-13. In individual years, the mass of materials to be dismantled varies within quite wide limits and depends on many factors that determine the specifics of individual dismantling projects. In 2014 and 2015, the peak mass to be dismantled in the Unit 1 is related to the dismantling of the low-contaminated equipment in G1 block. As the dismantling works progressed, an average of about 4000 to 4500 tons of materials were dismantled in both units per year. A small amount of class A SRW was dismantled in building No. 130/2 in CA, preparing the site for the installation of new metal waste treatment equipment.

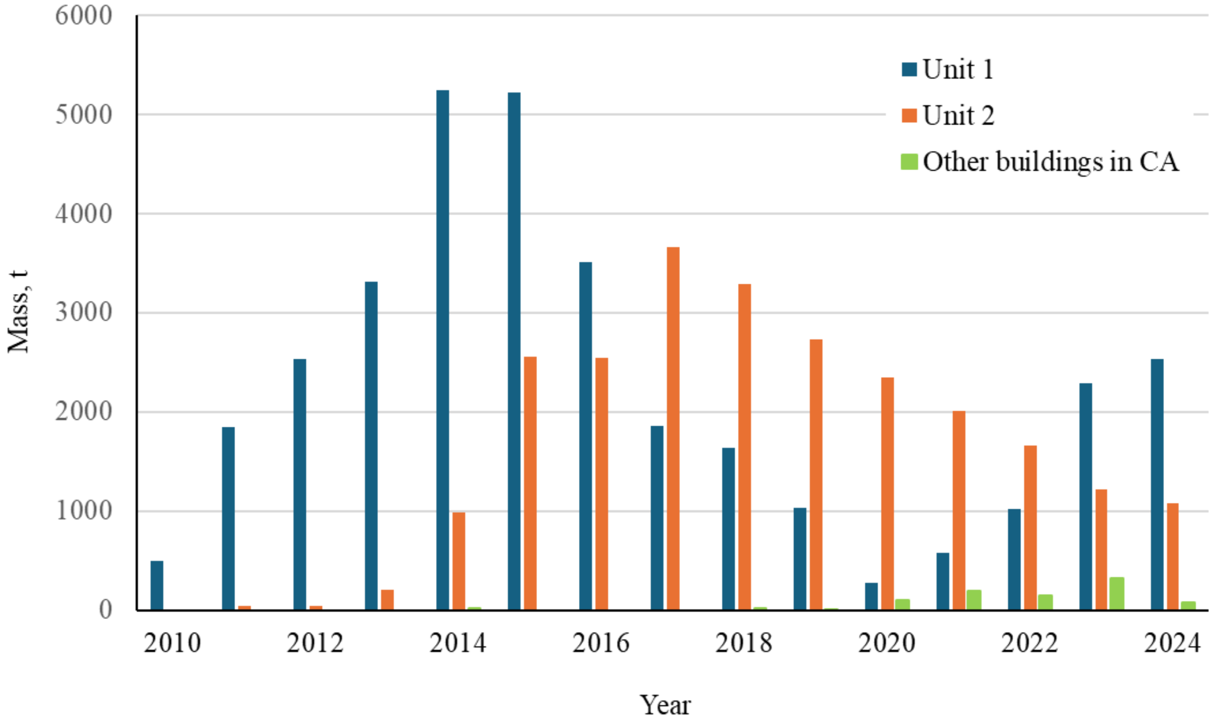

Figure 3.2-13. Mass of equipment and systems dismantled in individual units and other buildings in the controlled area

Along with the dismantling works in the controlled area, during this period, equipment and systems that are no longer needed in the supervised area (SA) and outside the INPP site were also dismantled. The total mass of equipment and systems dismantled in individual years is shown in Figure 3.2-14. From 2010 to the end of 2024, a total of about 74 000 tons of equipment and systems have been dismantled, which represents about 42% of the total mass of equipment and systems planned to be dismantled during decommissioning. The equipment dismantled observation zone and outside the INPP site is not contaminated with radionuclides, the materials dismantled in the observation zone are classified as class 0 waste.

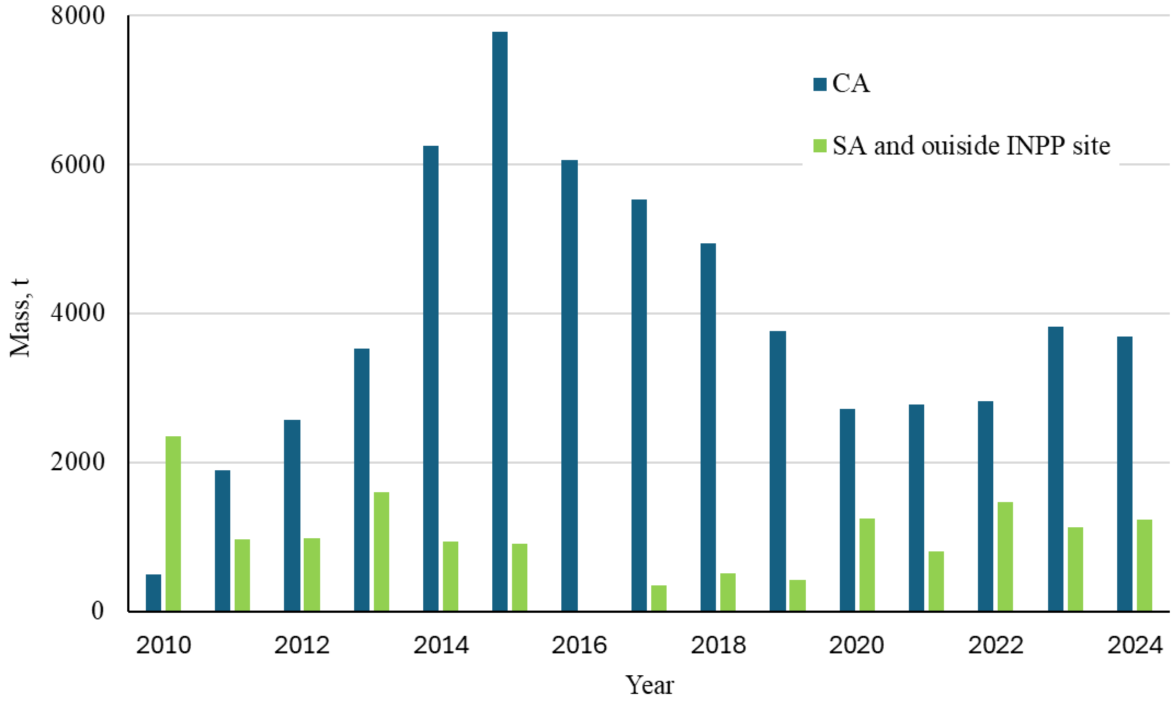

Figure 3.2-14. Mass of equipment and systems dismantled during decommissioning

The distribution of the mass of the equipment and systems to be dismantled by SRW classes is shown in Figure 3.2-15. By 2024, most of the materials of class 0 and A were dismantled. The dismantling of materials more contaminated with radionuclides will start to increase from 2024, with the dismantling of the equipment closer to the reactor (in A1 and A2 blocks) and the R1 and R2 zones of the reactor of the Unit 1.

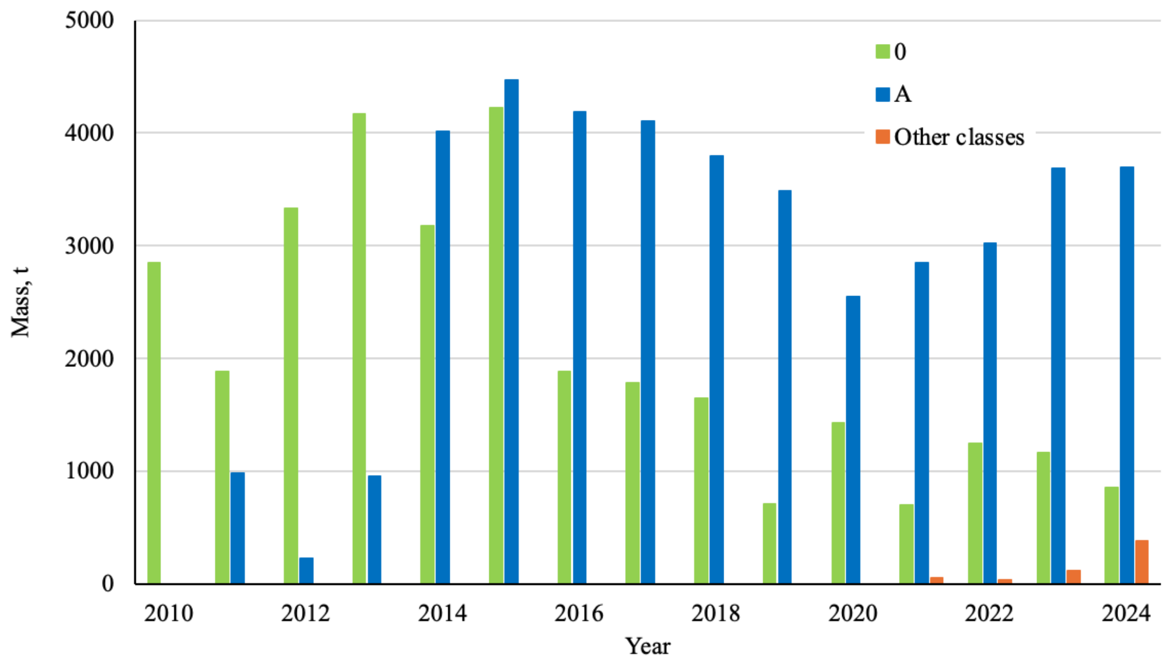

Figure 3.2-15. Mass distribution of dismantled equipment and systems by SRW classes

The dismantling of equipment and systems is carried out by disassembling them (where possible) and cutting them by mechanical and/or thermal methods:

- equipment containing mechanical connections (pumps, valves, measuring devices, electrotechnical equipment, etc.) that can be dismantled is dismantled using conventional tools;
- cutting mechanically, as a rule, is used for pipelines of small diameter (D ≤ 100 mm), sheet steel, cables. The tools used are pipe cutters, angle grinders with abrasive discs, hydraulic shears, etc. Bulky components are cut with abrasive (diamond) wire;
- Thermal cutting is used for cutting large diameter pipes and bulky components of complex geometry, and in cases where for some reason mechanical cutting tools cannot be used. For cutting carbon steel, gas (oxygen – acetylene) cutters are used, for cutting stainless steel – plasma ones;
- Construction structures are dismantled (if it is necessary to make access to the dismantled equipment, install places for initial processing and storage, transport routes) using concrete pickaxes, concrete splitters, etc.

For dismantling work, the aim is to use instruments and equipment that have already been tried and proven. The planning of works takes into account the experience of other organisations carrying out projects of a similar nature: the first technological projects for the dismantling of the INPP were prepared by a group of companies led by the UK company UKAEA Ltd., therefore the experience of projects carried out in the United Kingdom (Dounreay NPP, Windscale AGR (pile 1)) was based; the experience of the Greifswald NPP (Germany) adapted to the organisation of dismantling works; The suitability of waste management and dismantling methods is based on the experience of similar works in Swedish nuclear power plants. When planning new dismantling projects, the experience gained in dismantling works is taken into account, the equipment installed during previous projects and the tools purchased are used.

INPP decommissioning projects, the implementation of which started in 2025 or will start later:

- D&PT works in reactor zones R1 and R2 of Unit 2: dismantling and initial treatment of the upper and lower piping of the reactor unit [41];
- Residual equipment D&PT works in building 119, blocks G1, D0 and D1: dismantling and initial treatment of the engineering systems of the buildings of the Unit 1 (radiation protection, ventilation, electricity, water supply, sewerage, compressed air, etc.), equipment, lifting mechanisms and equipment of the initial waste treatment bars [42];

- Residual equipment D&PT works in blocks G2 and D2: dismantling and initial treatment of the engineering systems of the buildings of the Unit 2 (radiation protection, ventilation, electricity, water supply, sewerage, compressed air, etc.), equipment, lifting mechanisms and equipment of the pre-treatment bars of the buildings of the Unit 2 [42].
- D&PT works in buildings 152/1A,B and 152/2A,B: dismantling and initial treatment of low-salinity water storage tanks and related technological treatment of the reactors of the Unit 1 and Unit 2 [43];
- D&PT works in blocks B1 and B2: dismantling and initial treatment of the cooling and cleaning of the multiple forced circulation circuits of the Units 1 and 2, intermediate circuit equipment, various water filtration equipment, etc.;
- D&PT works in blocks A1 and A2: dismantling and initial treatment of reactor drum separators of the Units 1 and 2;
- D&PT works in R3 zones of reactors of the Units 1 and 2: dismantling of graphite formwork, metal structures of reactors, removal of structures and cavity fillers;
- D&PT works in blocks A1, A2 and V2, stage 2: dismantling and initial treatment of the elements of the spent fuel management and storage system elements of the Units 1 and 2 in the central hall and the equipment of the fuel storage pools;
- D&PT works of residual equipment in blocks A1, A2, B1, B2, V2: dismantling and initial treatment of the engineering systems of the buildings of the Units 1 and 2 – ventilation, electricity, water supply, sewerage, etc., dismantling of the initial treatment equipment;
- D&PT works of other installations of the Units 1 and 2: dismantling and initial treatment of the equipment of the gas storage chambers of the Units 1 and 2 (in buildings No. 135/1 and No. 135/2), special laundry room (in building No. 156), sanitary laundries (in buildings No. 140/1 and No. 140/2a).

During the decommissioning of the INPP, the solid and liquid radioactive waste management facilities located at the INPP site will also be dismantled:

- Equipment for the initial treatment (shredding, decontamination) of class A metal SRW located in the controlled area of the repair shop (building No. 130/2);
- bitumen, cementing, evaporation equipment and communication pipeline between buildings No. 101/1 and No. 150 (communication overpass, building No. 175) located in the LRW treatment facility (building No. 150);

- LRW and treated water storage tanks (buildings No. 151, 154, 154a,b);
- SRW storage facilities (building No. 155, 155/1, 157, 157/1) and SWRF facilities;
- Devices for measuring the radioactivity levels of materials that are no longer controlled (located in B10 facility and building No. 159B)

The scope of dismantling projects, the sequence and timing of their implementation shall be specified in the INPP's final decommissioning plan [7], which must be periodically reviewed and, if necessary, updated [11]. The dismantling procedure is planned and adjusted taking into account:

- accessibility to dismantling sites: equipment to be operated or to be dismantled at a later stage must not interfere with the safe execution of dismantling works;
- the possibility of waste management – the radioactive waste management infrastructure must be prepared for the management of the waste generated;
- carrying out preparatory works – the infrastructure necessary for dismantling (waste pre-treatment equipment, ventilation systems, etc.) must be prepared before the start of dismantling works;
- planning and execution of other INPP decommissioning activities – availability of resources necessary for dismantling works (personnel, waste storage, removal and further management, etc.), taking into account the need for all works carried out at the INPP at the same time.

The INPP decommissioning projects, the implementation of which has not yet begun, cover (without the dismantling of the reactors) about 37% of the total mass planned to be dismantled in the controlled area. The mass of the solid and liquid radioactive handling facilities and other activities to be dismantled shall comprise approximately 5% of the total mass to be dismantled in the controlled area. For the most part, these are very low levels of radioactive material (Class A) and potentially uncontrolled substances (Class 0). To carry out these dismantling works, already tried and tested instruments will be used, the experience gained during previous dismantling projects, equipment and purchased tools will be used. For the dismantling of relatively small and moderately low and intermediate-level active radioactive materials (classes B, C), it will be necessary to use solutions that reduce the impact of ionizing radiation (shielding, limitation of working hours) and remotely controlled equipment.

In technological and organizational terms, the most complex is the dismantling of reactors. Reactor installations account for about 20% of the total mass of equipment and systems to be dismantled in the controlled area, see Table 3.1-10. About 80% of the total mass of class B, C materials dismantled during the INPP decommissioning and 100% of the mass of class D, E materials are concentrated in the reactors, see Figure 3.1-10. Due to the possible significant exposure to ionizing radiation, it will be necessary to use remotely controlled equipment for the dismantling of the R3 zones of the reactors.

The dismantling of reactors is divided into two separate projects, Figure 3.2-16.:

- Dismantling of reactor zones R1 and R2;
- Dismantling of reactor zone R3.

Zone R1 consists of the steam-water pipeline at the top of the reactor and other technological communications and their elements installed in the reactor shaft above the scheme. Zone R1 also includes the fuel ducts, reactor control and protection channels located in the reactor. Zone R2 consists of the water supply pipeline at the bottom of the reactor and other technological communications and their elements.

Ionizing radiation conditions allow workers to access and dismantle zones R1 and R2 without using remotely controlled equipment. The removal and pre-treatment of the reactor fuel ducts, reactor control and protection channels (Class D and E SRW) is carried out using existing equipment and procedures that are applied when replacing channels during reactor operation. Part of the reactor's technological channels (reflector cooling channels, temperature, gas sampling) that do not have processing procedures will be removed and placed in the pools of the SNF pools hall. In the pools, these channels will be cut, placed in containers and taken for treatment to the SWTSF. The dismantling of other components is carried out in the sequence opposite to their assembly sequence. In order to reduce and optimize personnel exposure, the use of remotely controlled equipment is preferred when dismantling the R1 and R2 zones and handling the dismantled materials. The environmental impact of the dismantling of zones R1 and R2 has been assessed in separate EIA studies [39], [41]. The dismantling works of the Unit 1 reactor R1 and R2 zones began in 2023.

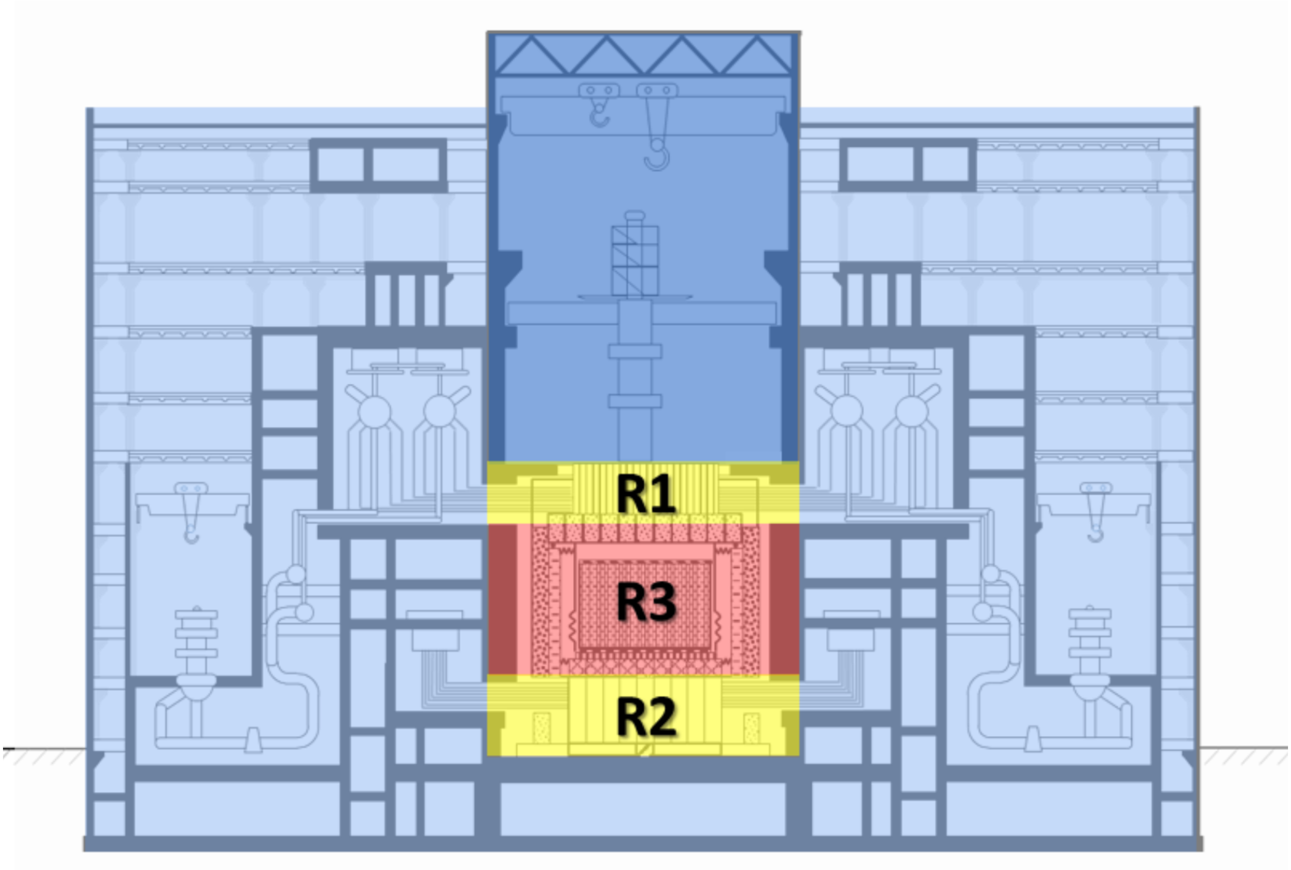

Figure 3.2-16. Reactor dismantling zones R1, R2 and R3

From a structural point of view, reactor zone R3 consists of metal structures (so-called schemes E, G, D, L, etc.) installed in the reinforced concrete reactor shaft (21x21 m in cross section and 25 m high), part of which are filled with various bulk (sand, serpentinite, metal shot) or liquid (water) fillers, Figure 3.2-17.

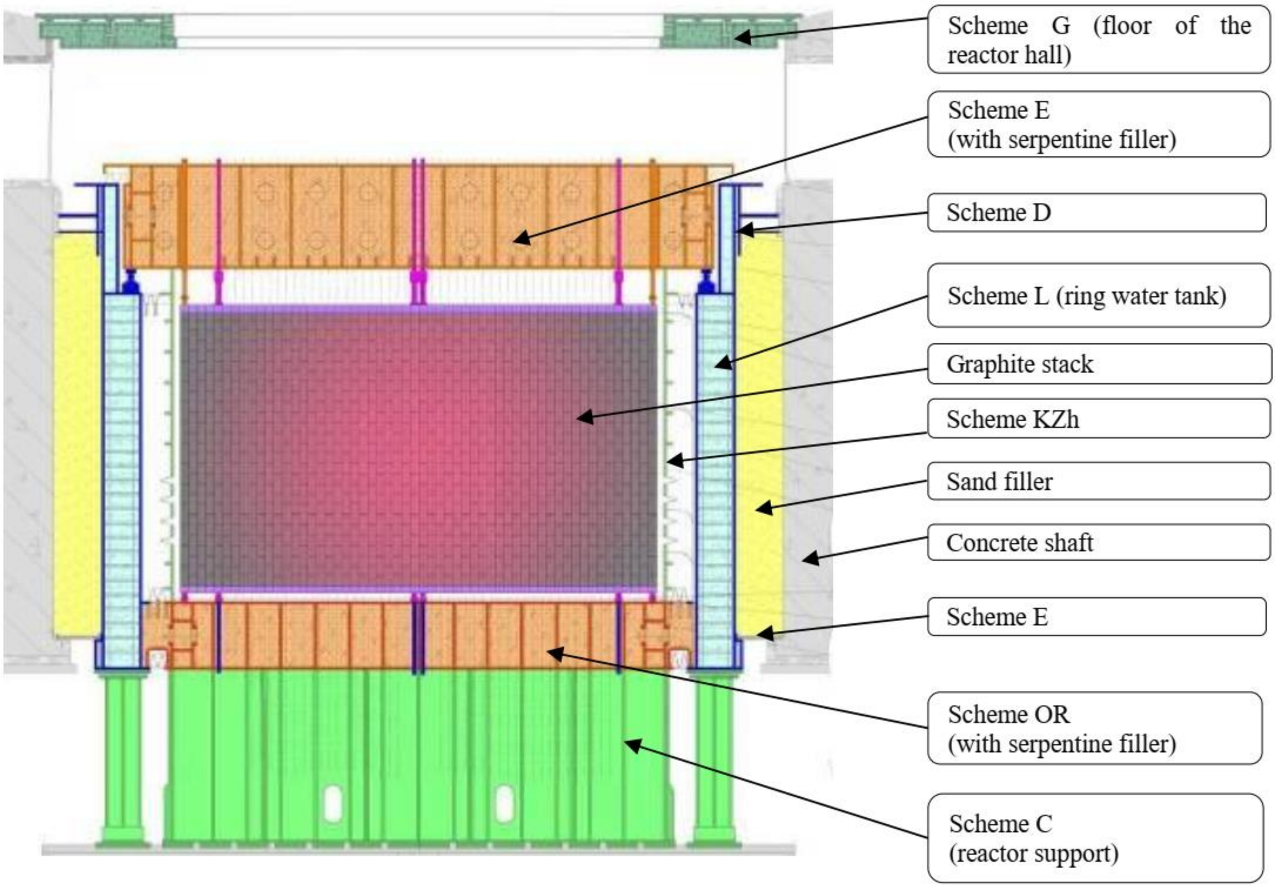

Figure 3.2-17. Main components of the reactor

The composition of the materials to be dismantled in the reactors is summarized in Figure 3.1-12, Section 3.1.1.2.5. Metals make up about 33% of the mass of the materials to be dismantled, graphite about 13%. The largest mass consists of fillers of various structural schemes and spaces (serpentinite, sand, gravel, crushed stone, metal shots), about 55% of the total mass of the reactors. The reactors also contain 1,600 tonnes of water filler (800 tonnes each), which will be treated as an LRW. The classification of reactor materials is shown in Table 3.2-3.

Table 3.2-3. Classification of SRW in reactor zones R1, R2 and R3

RW Class	**In reactor zones, tones**		**Both reactors, tons**
	R1, R2	**R3**	
0	0	9 700	9 700
A	3 300	7 300	10 600
B, C	400	200	600
D (graphite)	200	3 500	3 700
D, E	300	3 300	3 600
Total:	**4 200**	**24 000**	**28 200**

The most important planned design solutions for the dismantling of the R3 zone are as follows:

- Dismantling of zone R3 is carried out in a dry, atmospheric air environment;
- The internal components of the reactor are accessed through the top of the reactor, first dismantling the upper E circuit;
- The dismantling direction is from the top of the reactor downwards, dismantling the structures below and on the sides, consistently removing the materials between the structures and the fillers in the cavities of the structures. The stability of the individual structural parts (schemes) of the reactor is maintained throughout the dismantling;
- The metal structures (schematics) inside the reactor are dismantled using remote-controlled mechanical and thermal cutting tools. The tools are installed on a special platform, from the reactor hall by crane lowered into the reactor shaft;
- The graphite formwork is dismantled layer by layer, the graphite blocks are removed in the reverse order of their composition. Vacuum suction technology, mechanical or pneumatic expansion grippers, etc. can be used to grip graphite blocks. Graphite blocks are not broken. Any gripping technology must do maximum damage to the graphite block (although it is not excluded that it may not be possible to remove part of the graphite, e.g. edge blocks, without completely damaging it);
- The water filler in schemes D and L is pumped out or discharged using existing filling and drainage piping;
- Fillers are removed using vacuum suction systems and mechanical means (grippers, buckets);
- Existing containers and facilities at the INPP (including new workshops for R1 and R2 dismantling projects and new characterisation facilities in the reactor hall) are used for the initial treatment and packaging of waste. If necessary, other types of containers and waste management facilities may also be used;
- For transport to the IRWSF, the container with intermediate-level radioactive waste is placed in a special transport container that provides shielding against ionizing radiation.

Specific technical solutions for the dismantling of equipment and structures, as well as dismantling technologies, are selected when preparing technological projects for individual D&PT works. The safety of technical solutions, including environmental protection (prevention of releases into the environment, monitoring, and compliance with established requirements), is assessed and justified when preparing safety analysis reports for technological projects. The experience gained during the implementation of previous D&PT projects and the best world practices in the field of decommissioning other NF are used when selecting dismantling and initial treatment methods.

3.2.4.2 Decontamination

Decontamination is the elimination or reduction of radionuclide contamination of materials, equipment, systems and building surfaces by washing, heating, chemical or electrochemical methods, mechanical cleaning or other methods [11]. When carrying out the decommissioning of the INPP and the management of the RW, decontamination is applied in order to:

- reduce pollution of equipment, systems and work areas prior to dismantling or RW management, thus creating safer working conditions for personnel, reducing the risk of pollution spreading, and enabling simpler and faster dismantling methods. Decontamination before dismantling is one of the ways in which the ALARA concept is implemented;
- reduce the amount of materials added to the VLLW repository by deactivating short-lived Class A RW to uncontrolled levels;
- reduce the amount of materials placed in the LILW-SL repository by deactivating short-lived Class B and C RW to Class A or no longer controlled levels;
- reduce the surface of work tools, equipment, premises, etc. in order to reuse these tools, while ensuring the radiation safety of personnel and reducing the generation of secondary waste. Continuous decontamination of work tools, equipment, and premises was carried out during the operation of the INPP. Existing decontamination measures and technologies are also used during the decommissioning of the INPP.

The application of decontamination, as well as any other RW management technology, must be justified and optimised, i.e. the benefits derived from decontamination (reduction of irradiation, pollution, amount of more hazardous waste, etc.) must be greater than the negative effects caused by decontamination (labour and resource costs, impact of secondary waste generation and management, exposure of personnel carrying out decontamination works, etc.). The decommissioning works planned and carried out during the decommissioning of the INPP can be conditionally divided into:

- decontamination before dismantling;
- decontamination after disassembly during the initial RW treatment.

During the INPP decommissioning preparation period, several independent decontamination projects before dismantling were carried out:

- In 2010 and again in 2012, the circuit of multiple forced circulation in the Unit 1 was decontaminated by washing it with chemical reagents and water;

- In 2018, the circuit of multiple forced circulation in the Unit 2 was decontaminated by washing it with water;
- In 2011-2016, ion exchange resins in the condensate treatment plants of the Unit 1 were decontaminated. The decontaminated and dried resins (approx. 360 m^3) were unloaded from the facilities, placed in FIBC containers and further processed as Class A SRW;
- In 2016-2019, ion exchange resins in the condensate treatment plants of the Unit 2 were decontaminated. The decontaminated and dried resins (approx. 360 m^3) were unloaded from the facilities, placed in FIBC containers and further processed as Class A SRW.

Decontamination after dismantling aims to reduce the amount of RW placed in the VLLW and LILW-SL repositories. The distribution of the masses of the equipment and system structures to be dismantled in the activities of the INPP decommissioning according to RW classes is shown in Figure 3.1-9 (see Section 3.1.1.2.5). More than 57% of the mass of RW to be dismantled consists of class A waste, a greater part of which can be decontaminated up to Class 0. The distribution of the masses of the equipment and system structures to be dismantled in the activities of the INPP decommissioning according to RW classes after dismantling and initial treatment (shredding, decontamination) is shown in Figure 3.1-10. Decontamination is intended to reduce the mass of class A RW by more than double, up to 21% of the initial mass of the dismantled equipment and system structures.

Part class B and C waste (metals) could also be decontaminated to class A or 0. However, there is not much such waste and a substantial change in the amount of class B and C waste due to decontamination is not expected.

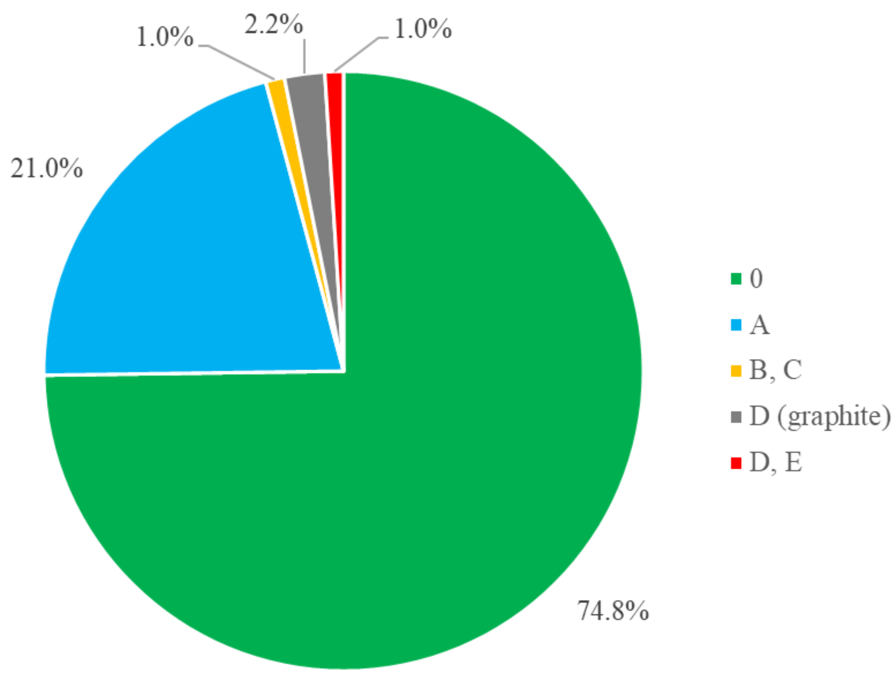

Figure 3.2-18. Distribution of masses of equipment and system structures to be dismantled in INPP decommissioning activities according to RW classes after initial treatment (decontamination)

The choice of decontamination method is determined by the nature of the surface to be decontaminated and the radioactive contamination properties, as well as the type and dimensions of the waste to be decontaminated. Depending on the strength of the interaction of pollutants with the surface, pollutants are divided into non-fixed, weakly fixed and strongly fixed. The nature of the surface and the retention strength of radioactive contaminants determine the choice of methods and methods of decontamination. In accordance with the Nuclear Safety Requirements BSR-1.5.1-2019 [11], when choosing a decontamination method, it is necessary to evaluate its effectiveness. The decontamination organisation program implemented by the INPP [48] provides for procedures for the organisation, justification (feasibility, cost-benefit analysis) and optimisation of the decontamination process.

The locations and technologies of decontamination of dismantled materials and equipment applied during the decommissioning of the INPP are summarized in Table 3.2-4. The INPP uses decontamination devices and technologies of various types and capacities. Decontamination by means of dry blast flow devices was applied during the decommissioning, during the decommissioning of the dismantled equipment in building No. 117/1. Later, during the expansion of dismantling works in the reactor units, these facilities were moved to building No. 101/1. The number of shotgun flow cleaning devices has increased as the volume of pre-treatment work has increased.

During the operation of the INPP, decontamination works were carried out in building No. 130/2 by applying both mechanical and chemical decontamination methods. These technologies are still used today. In 2019, the decontamination bar was expanded by installing additional decontamination measures for the shredding of class A metal waste.

Table 3.2-4. Places and technologies for decontamination of materials and equipment dismantled at the INPP

Building No.	**Block**	**Decontaminated RW class**	**Decontamination technology**
101/1	A1	A, B, C	High-pressure water jet washer Conveyor blast flow cleaning unit Individual devices for cleaning shotgun flow
		A, B	Parts washing chamber and washing tank
	G1	A	High-pressure water jet washer Conveyor blast flow cleaning unit Individual devices for cleaning shotgun flow Grinding equipment
101/2	A2	A, B, C	High-pressure water jet washer Individual blast flow cleaning device
		A, B	Parts washing chamber and washing tank
130/2	-	A, B	Devices for high-pressure water jet washing Conveyor blast flow cleaning unit Individual blast flow cleaning device Grinding equipment Turning equipment Chemical decontamination equipment

The progress of decontamination of materials dismantled by the INPP is summarized in Figure 3.2-19. By 2025, about 29 000 tons of the mass of dismantled materials have been decontaminated, i.e. about 43% of the amount planned to be decontaminated. The decontamination works in most of them took place in building No. 101/1 and are associated with the deactivation of the equipment dismantled in blocks G1, G2, D1 and D2.

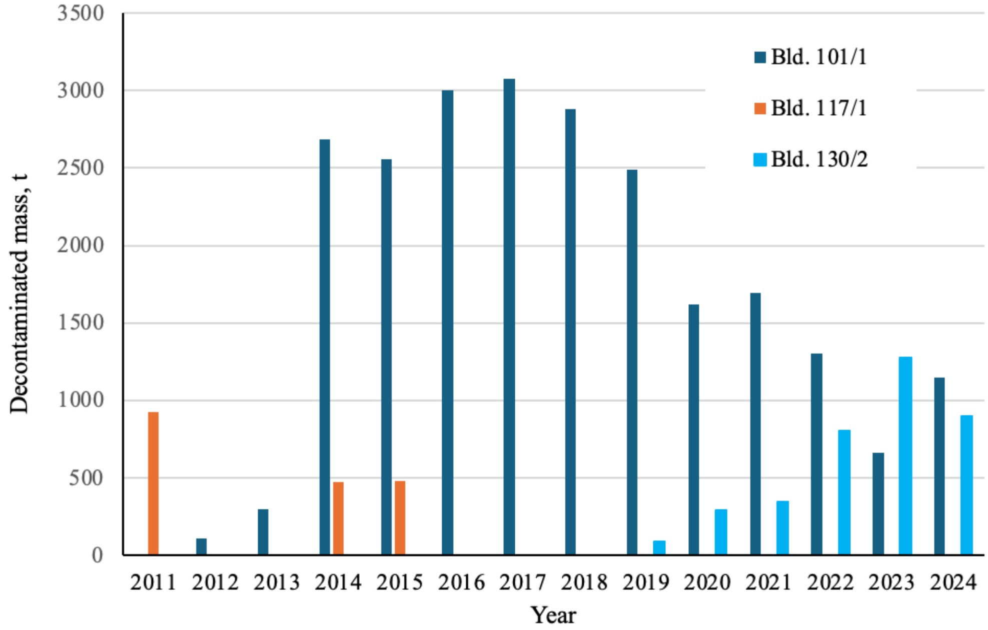

Figure 3.2-19. Decontaminated mass of equipment and structures dismantled at the INPP

The mass of the dismantled equipment decontaminated (by 2025) and planned to be decontaminated in individual INPP buildings is shown in Figure 3.2-20. The distribution of the masses planned to be decontaminated in buildings No. 101/1 and No. 130/2 shown in the figure is quite conditional and may change in the real course of planning and execution of decontamination works (increase in one building and decrease in another, respectively).

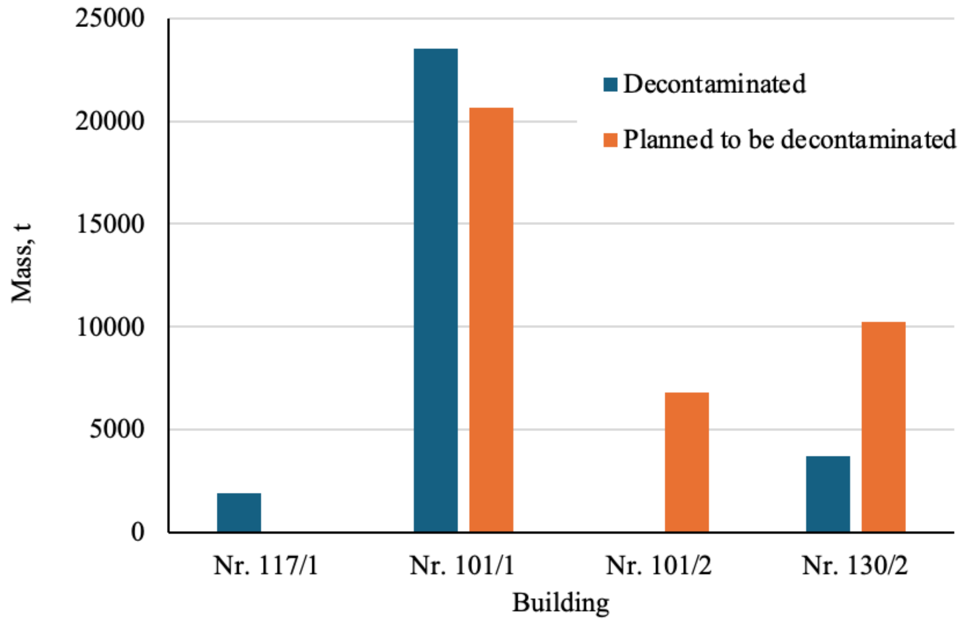

Figure 3.2-20. The mass of dismantled equipment has been decontaminated in individual buildings and is planned to be decontaminated

Structures of buildings that are demolished or left in the ground (see Section 3.2.9) is intended to be carried out using industrial concrete cutting tools (e.g. milling cutters) to remove the contaminated layer of the structure of the building or the area of local pollution before the final radiological examinations are carried out.

3.2.4.3 Temporary storage

In the buildings No. 101/1 and No. 101/2 of the INPP energy units, after the dismantling of the equipment and systems, if necessary, waste storage sites of the INPP may be installed.

In 2018, when the accumulative storage facility of the VLLW repository was completely filled with waste and the repository modules were not yet built, the Class A SRW packages generated during the decommissioning activities of the INPP began to be accumulated in block G1. In this block, after the dismantling of the equipment of the turbine hall, special places for waste storage were installed. By the time the first company placed waste in the VLLW repository in 2022, a total of about 11 000 m^3 of Class A waste packages had been formed and accumulated in block G1.

If necessary, packaging formed by the INPP may also be temporarily stored in the buildings No. 101/1 and No. 101/2 of the INPP units.

3.2.5 Transport

Dismantled and packaged materials and other radioactive and relatively uncontrolled waste are further managed (treated, stored, placed into repositories, etc.) INPP industrial site and adjacent RW treatment facilities. A simplified waste stream management scheme is shown in Figure 3.2-21.

Conditionally uncontrolled (potentially class 0) SRW are transported to B10 facility or building 159B, where their compliance with material Class 0 is confirmed by the measuring equipment in these buildings. Uncontrolled waste is removed from the INPP site and further treated as non-radioactive materials.

Very low level radioactive short-lived (Class A) SRW are transported to the SWRF VLLW sorting module for final packaging and characterization. The sorting module forms suitable packaging for placement in the VLLW-SL repository, which is further transported for temporary storage to the accumulative storage facility of the VLLW-SL repository. After accumulating a sufficient number of packages, campaigns are carried out to put them in the VLLW-SL repository. Class A SRW packages are then transported from the storage facility to the VLLW-SL repository module site, see Section 3.2.7.1.

Suitable packages for placement in the VLLW repository, if RW processing in the VLLW sorting module is not necessary, can be formed at the dismantling and initial treatment sites (i.e. in energy block buildings or in building No. 130/2). Such packaging may be characterised (its compliance with the criteria of acceptance of the VLLW repository is confirmed) by the measuring devices located in the intermediate storage facility of the VLLW-SL repository.

Low- and intermediate-level radioactive short-lived (Class B and C) SRW removed from existing storage facilities or dismantled in energy units in buildings are transported for final treatment to the SWTF located on a separate site. In this facility, suitable packaging for disposal is prepared in the LILW-SL repository and placed in the SWSF SL repository. After the installation of the LILW-SL repository, the packaging from the SWSF SL repository will be transported to the LILW-SL repository site, see Section 3.2.7.2.

Low-radioactive long-life (class D) graphite SRW generated during the dismantling of reactor zones R1 and R2 are transported to building 150, where they are placed in containers suitable for storage in building 158/2 and transported for temporary storage to building 158/2. After the construction of the interim reactor waste storage facility (IRWSF), Class D SRW will be transported from building No. 158/2 to IRWSF.

Liquid RW from all INPP structures, where they are generated, are transported to building No. 150, where LRW is processed. Using cementation technology, the packaging of hardened SRW is transported for temporary storage to building No. 158/2. After the LILW-SL repository is installed, the packaging from the storage facility will be transported to the LILW-SL repository site.

Low- and intermediate-level radioactive long-lived (Class D and E) SRW retrieved from the existing storage facility building No. 157 and generated during the dismantling of reactor zones R1 and R2 are transported to the SWTF facility. In this facility, SRW are sorted, placed in long-term storage containers and placed in the SWSF-LL storage.

Low- and intermediate-level radioactive (Class D and E) SRW resulting from the dismantling of reactor R3 zones will be transported to IRWSF.

Highly radioactive waste (G class) - spent nuclear fuel - has already been transported from reactor units to ISFSF-1 and ISFSF-2, see Section 3.2.1.

Transportation of INPP between various INPP structures and RW management facilities is carried out by roads located in the INPP controlled and monitored zones and by the technological road connecting the INPP and SWTSF sites. There is no entrance to public roads when transporting RW. For the transportation of containers with SNF, closed railway tracks are used, connecting the INPP site with the ISFSF-1 and ISFSF-2 sites

RW transportation is carried out on established routes, the speed of car transport is limited to 20 km/h. For RW transportation, most diesel-powered cars, tractors and tractors are used, as well as electric trucks are used.

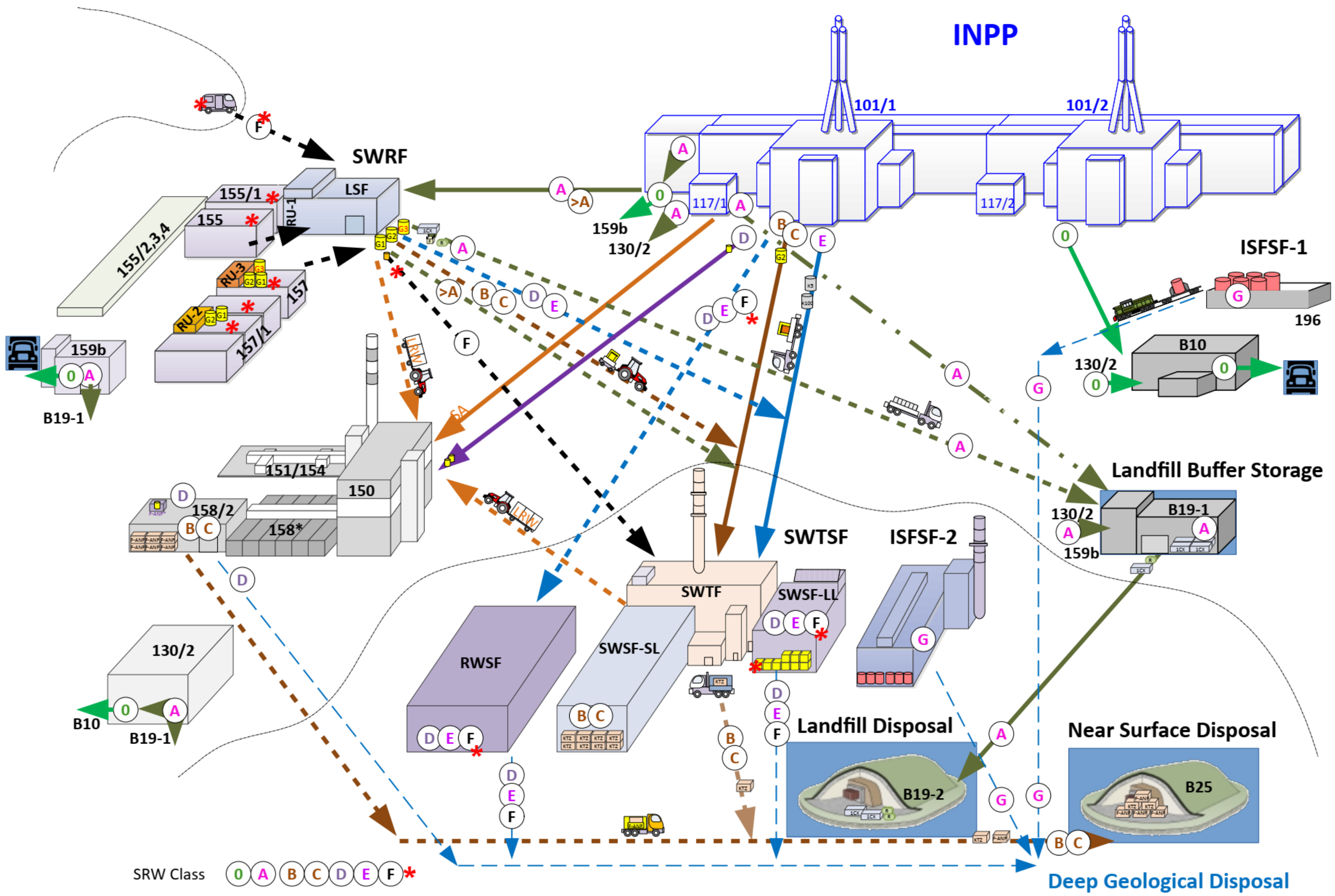

Figure 3.2-21. Scheme for the management of major waste streams at the INPP

3.2.6 Main and final treatment of solid RW

During the decommissioning of the INPP, short-lived low- and intermediate-level radioactive waste (Class B and C SRW) is finally treated. During the main and final treatment, SRW waste packages is produced that meets the waste acceptability criteria of the LILW-SL surface repository (project B25).

Long-lived low- and intermediate-level radioactive waste (Class D and E SRW), as well as spent sealed sources (Class F SRW) are not subject to final treatment. These SRW are sorted by classes and types of materials (graphite, metals). The sorted SRW are placed in containers for long-term storage until a deep repository is built in Lithuania and waste acceptability criteria are established for it.

The main and final treatment of short-lived SRW, management of long-lived SRW and temporary storage of manufactured packaging is carried out at the INPP Solid radioactive waste treatment and storage facility (SWTSF). The facility is built on a separate site located about 600 m from the perimeter of the INPP site in the southern direction. The INPP and SWTSF sites are connected by a technological road - radioactive materials are transported between the INPP and the SWTSF in transport containers without leaving the INPP protected territory and the observation zone.

The SWTSF consists of three interconnected buildings (Figure 3.2-22): a solid radioactive waste treatment facility in SWTF (project B3) and two storage facilities (project B4) for the storage of SRW packages produced by SWTF:

- Storage for short-lived waste (SWSF-SL storage facility),
- Storage of long-lived waste (SWSF-LL storage facility).

In the planning of the Solid Waste Storage Facility (SWSF) and the assessment of its impact on the environment [45] it was envisaged that, if necessary, additional storage facilities for LL and SL could be built on the site of the SWTSF.

Figure 3.2-22. INPP Solid Radioactive Waste Treatment and Storage Facility (SWTSF)

Short-lived SRW sorting is carried out in the SWTF G2 sorting chamber, Figure 3.2-24. Waste is sorted into streams according to the materials managed by further processing technologies (metals, wood, thermal insulation, construction waste, plastics, filters, etc.), as well as those that have entered the SL waste stream, but must be managed as LL waste (graphite, SSS). The following technologies shall be applied to the treatment and final treatment of SRW in the SWTF:

- Shredding in the G2 chamber with various remote-controlled mechanical processing tools: saws, hydraulic shears, concrete crusher, etc. The capacity of the G2 chamber is about 780 m^3/year;
- Pressing with a high-power (15 000 kN) hydraulic press. The waste suitable for pressing is placed in 200 l barrels in the G2 sorting chamber. In the pressing machine, the drums are compressed into briquettes, the initial volume of waste is reduced from 4 to 8 times;
- Incineration of flammable solid and liquid waste. Solid waste suitable for incineration consists of paper, fabrics, wood. Before incineration, the waste is prepared – crushed, mixed, packed in 5 kg packages. The capacity of the incinerator is about 100 kg/h of solid waste or 40 kg/h of liquid waste. The resulting ash is unloaded from the incinerator into 200 l drums, which are further pressed with a high-power press;
- Storage of non-pressed and compressed waste in reinforced concrete LILW-SL containers (also referred to as containers of type KTZ-3.6), Figure 3.2-23. The loading

of waste into containers is managed in order to optimise the filling of containers, also meeting the acceptability criteria of the surface LILW-SL repository;

- Cementation of containers. The waste in the LILW-SL container is immobilized and the voids between the waste are filled with cement mortar. The average design productivity of container cementation is 11 containers per week. About 70 m^3 of waste packages are prepared for the LILW-SL repository, containing about 24 m^3 of waste.

The manufactured packages are transported to the LILW-SL storage facility by a closed conveyor. The storage facility can store 1344 LILW-SL (KTZ-3.6 type) containers with a capacity of about 2500 m^3 of waste. By cementing packages with design efficiency, the LILW-SL storage can be filled within two years. Current storage filling progress is shown in Figure 3.2-25. By 2025, the repository will be filled to about 19% of the design volume.

Figure 3.2-23. LILW-SL container (type KTZ-3.6)

Figure 3.2-24. SWTF G2 Hot-Chamber

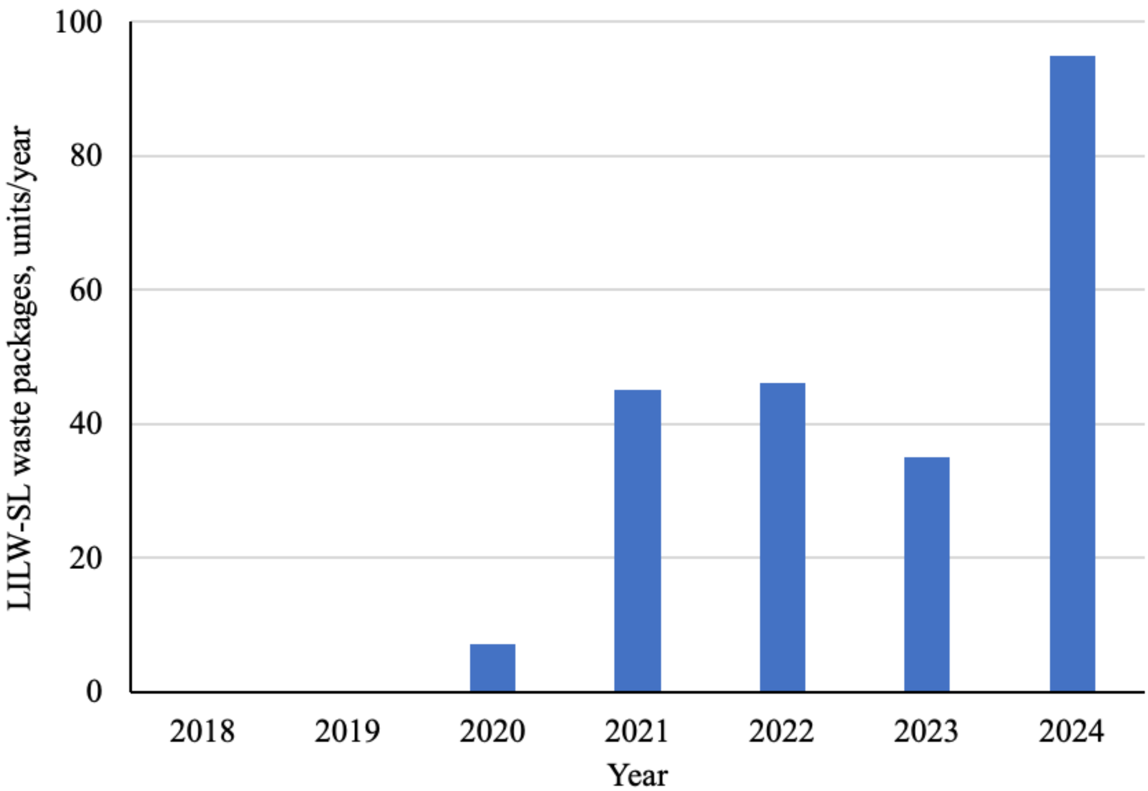

Figure 3.2-25. Filling the SWSF-SL repository

Long-lived SRW are sorted in the SWTF G3 hot chamber into three streams:

- Metals (various metal products activated in the reactor and shredded in the INPP hot chamber, metal filters of the INPP hot chamber);
- Graphite;
- SSS.

These waste groups are placed in separate metal LILW-LL containers. Also separated are those that have entered the LL waste stream, but must be treated as SL waste (PVC bags-inserts of G3 waste transport containers). This waste is shredded with a shredder in the G3 chamber, placed in a 200 l barrel and pressed with a high-power press. Filled LILW-LL containers are transported by closed conveyor to a long-lived waste storage facility, see Section 3.2.8.1.

SWTSF shares the main engineering systems (ventilation, wastewater collection and management, monitoring, etc.). Releases into ambient air are filtered, measured and carried out through a 50 m high ventilation chimney. The resulting solid low- and intermediate-level radioactive secondary waste is managed in the SWTSF itself, while other SRW (class 0, A) are transported for treatment to the respective INPP RW treatment facilities. The resulting liquid waste is transported for treatment at the INPP LRW treatment facility, building No. 150.

SWTSF hot tests were carried out in 2017-2021. In 2022, VATESI issued a permit for the industrial operation of SWTSF. The environmental impact of the SWMSF has been assessed in a separate EIA study [45]. Transboundary environmental impact assessment procedures were also carried out for this study.

3.2.7 Disposal of short-lived RW in repositories

Packages of short-lived SRW from the INPP operation and decommissioning will be placed in two repositories built at a distance of about 1 km from the INPP site, see Figure 2.2-4:

- Very low radioactive waste (VLLW) repository (project B19),
- Low- and intermediate-level short-lived radioactive waste (LILW-SL) repository (project B25).

3.2.7.1 VLLW Repository

The VLLW repository technologically consists of two separate NF:

- the buffer storage facility of the VLLW repository, located at the site of the INPP and intended for the accumulation of finally treated class A SRW packages for one campaign of placing in the modules of the VLLW repository,

- The modules of the VLLW repository, located at a distance of about 800 m from the INPP site, where class A SRW packages are placed during the laying campaign and the structure of the VLLW repository and protective engineering barriers covering waste packages are formed.

The capacity of VLLW repository buffer storage facility (Figure 3.2-26) is about 4 000 m^3 of waste packages, of which about 3000 m^3 is 1CX containers and about 1000 m^3 is bales/FIBC packages. The VLLW repository buffer storage facility stores the packages brought from the VLLW sorting module (see Section 3.2.2) and packages brought from other buildings of the INPP with Class A SRW dismantled during decommissioning activities. The packages, if necessary, shall be characterised in the storage facility and their compliance with the criteria for the acceptance of waste disposal in the VLLW repository shall be confirmed. The storage facility has separate ventilation and air purification and monitoring systems. The generated secondary solid and liquid waste is collected and transported for treatment to the respective INPP waste management facilities.

Figure 3.2-26. The building of the VLLW repository buffer storage facility

In 2013, VATESI issued a licence to operate the VLLW repository buffer storage facility and a permit to start industrial operation of this repository. In 2018, the storage facility was fully filled with waste packages, see Figure 3.2-27. As the modules of the VLLW repository have not yet been built, the class A SRW packages formed during the decommissioning activities of the INPP have started to be accumulated in block G1, see Section 3.2.4.3.

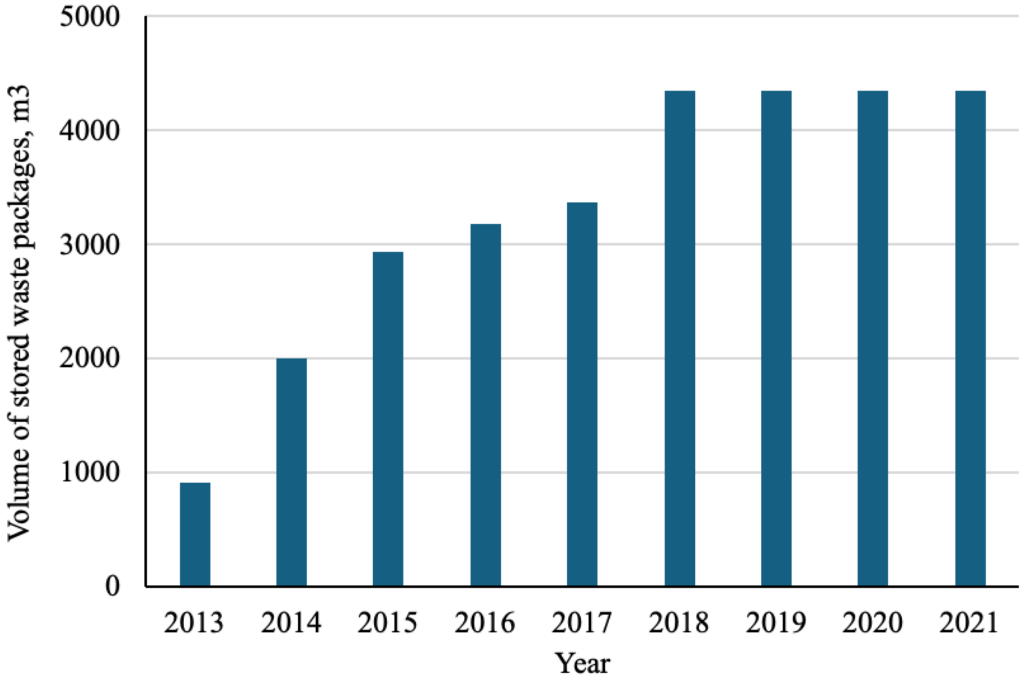

Figure 3.2-27. Volume of class A SRW packages stored in the VLLW repository buffer storage facility (the storage facility was fully filled in 2018)

The VLLW repository module site is located next to the ISFSF-2 and SWTSF sites. A total of three modules of the VLLW repository are installed, accommodating about 60 000 m^3 of waste packages. The waste disposal module is a above-ground structure – a reinforced concrete slab on which waste packages are placed. 1CX containers are tightly stacked in five layers, forming a hill shape from compressed bales and FIBC packages, Figure 3.2-28. In order to separate the environment and waste and protect it from mutual influences, the waste packages are covered with several layers of engineering barriers made of artificial and natural materials from above. The module is supplemented by campaigns by bringing waste packages accumulated in the VLLW repository buffer storage facility. Campaigns should be carried out at least every two years. During the period between campaigns, the waste packages placed in the module is additionally covered with a protective wall, Figure 3.2-29.

Figure 3.2-28. The structure of the VLLW repository module consists of waste packages and the formation of protective engineering barriers covering it

Figure 3.2-29. VLLW repository module with engineering barriers and protective wall formed after a particular loading campaign

The hot tests of the modules of the VLLW repository (the first waste disposal campaign) were started in 2022 after receiving the permission of VATESI to transfer radioactive waste into the modules of the VLLW repository and to carry out tests of the module systems of this repository using radioactive waste for the first time. Waste disposal companies were carried out in 2023 and 2024. In total, at the end of 2024, about 11 470 m^3 of waste packages were placed in the first module of the VLLW repository, which accounts for about 19% of the design volume of the VLLW repository, see Figure 3.2-30. Until 2029, annual campaigns for placing in the VLLW repository can be carried out, until the packages that has already been produced and is made from the already dismantled and planned to be dismantled Class A SRW is placed. Later, with the reduction of the flow of Class A waste, landfill campaigns will be less frequent and smaller.

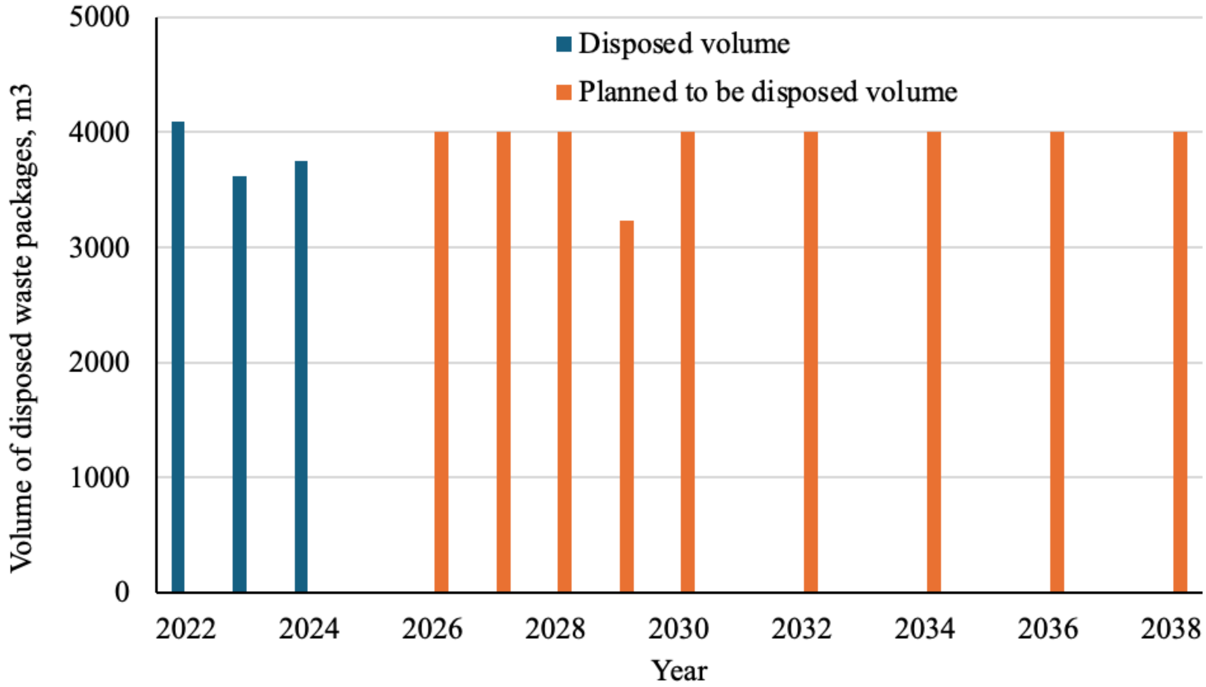

Figure 3.2-30. Progress and forecast of placing class A SRW packages in the VLLW repository

The VLLW repository will be filled during the entire period of decommissioning of the INPP. After the completion of the decommissioning of the INPP and placing the decommissioning waste, the VLLW repository can be closed. The VLLW repository will be used until the modules of the VLLW repository are filled. The closure of the modules of the VLLW repository and the decommissioning of the VLLW storage facility will be carried out at the end of the INPP decommissioning or after the completion of the decommissioning of the INPP. The long-term environmental impact of the VLLW repository objects throughout the life cycle (during the periods of institutional supervision and beyond) has been assessed in a separate EIA study [46]. Transboundary environmental impact assessment procedures have been carried out for this study.

3.2.7.2 LILW-SL repository

The selected site for the LILW-SL repository is located at a distance of about 1 km southeast of the INPP site and about 1.5 km from Lake Drūkšiai. It is planned that the repository, its protective areas and buildings necessary for operation will occupy an area of about 45 hectares.

The concept of the repository is based on international practice and experience. Similar repositories are in operation in Spain (El Cabril, Figure 3.2-31), France (Centre L'Aube), Slovakia (Mochovice).

Figure 3.2-31. El Cabril Near Surface Repository (https://www.enresa.es)

The LILW-SL repository will consist of up to 3 groups of disposal modules (cellars), which will be built and operated sequentially, Figure 3.2-32. The separately built and operated group of cellars will consist of 12 cellars. The basement is an above-ground monolithic reinforced concrete rectangular structure with a base size of 26.3x23.3 m, a height of about 6.4 m. The thickness of the basement walls is 400 mm. In the basement, F-ANP and LILW-SL containers are placed in layers. In total 484 pieces of waste packages are placed in one cellar occupying a volume of about 2 600 m^3. The design capacity of the basement group is about 33 000 m^3, the capacity of the entire repository is about 100 000 m^3 of waste packages. It is planned to fill and close two cellars per year – to put 968 waste packages into the repository, about 7-8 packages per day.

It is also planned to place (after completing all necessary safety justification measures and coordinating them with VATESI, taking into account the initiated procedures for amending the Law of the Republic of Lithuania on Radioactive Waste Management [50] and the Law of the Republic of Lithuania on Nuclear Safety [10] – after receiving positive approval results) finally treated RW packages with hazardous properties in the LILW-SL repository, see Section 3.1.1.2.7.

The basement to be filled is protected from atmospheric effects (precipitation) by a mobile roof, which also covers the technological area of filling the basement (access site, gantry crane). After placing a layer of waste packages, it is poured with concrete mortar. The basement filled with waste packages is closed by installing a reinforced concrete roof of the basement. The roof of the basement is covered with waterproofing material and additionally protected from the effects of precipitation with a temporary metal roof. Then the gantry crane and the mobile roof are moved to another basement. Newly built basements are also protected by temporary roofs. Permanent long-term engineering barriers of the repository (basement heap) are formed after the group of cellars is fully filled, see Figure 3.2-32.

The number of cellars to be built in the LILW-SL repository will depend on the amount of LILW-SL waste needed to be disposed of and may be smaller. Currently, the FDP is planned to [7] that approximately 64 000 m^3 of RW packages will need to be placed in the LILW-SL repository.

The site of the LILW-SL repository will have a dozen auxiliary buildings: control posts, an administrative building, a technological building and other small objects necessary for the functioning and maintenance of the LILW-SL repository. The technological building is intended for cementing of hardened LRW packages brought from the INPP site building No. 158/2 (see Section 3.2.3), for inspection, verification and temporary storage of cemented packages before placing them in the cellars.

For the transportation of RW packages from the SWTSF site, it is planned to install a special fenced technological road or to transport RW packages placed in an additional container that ensures the safety of transportation on public roads [49].

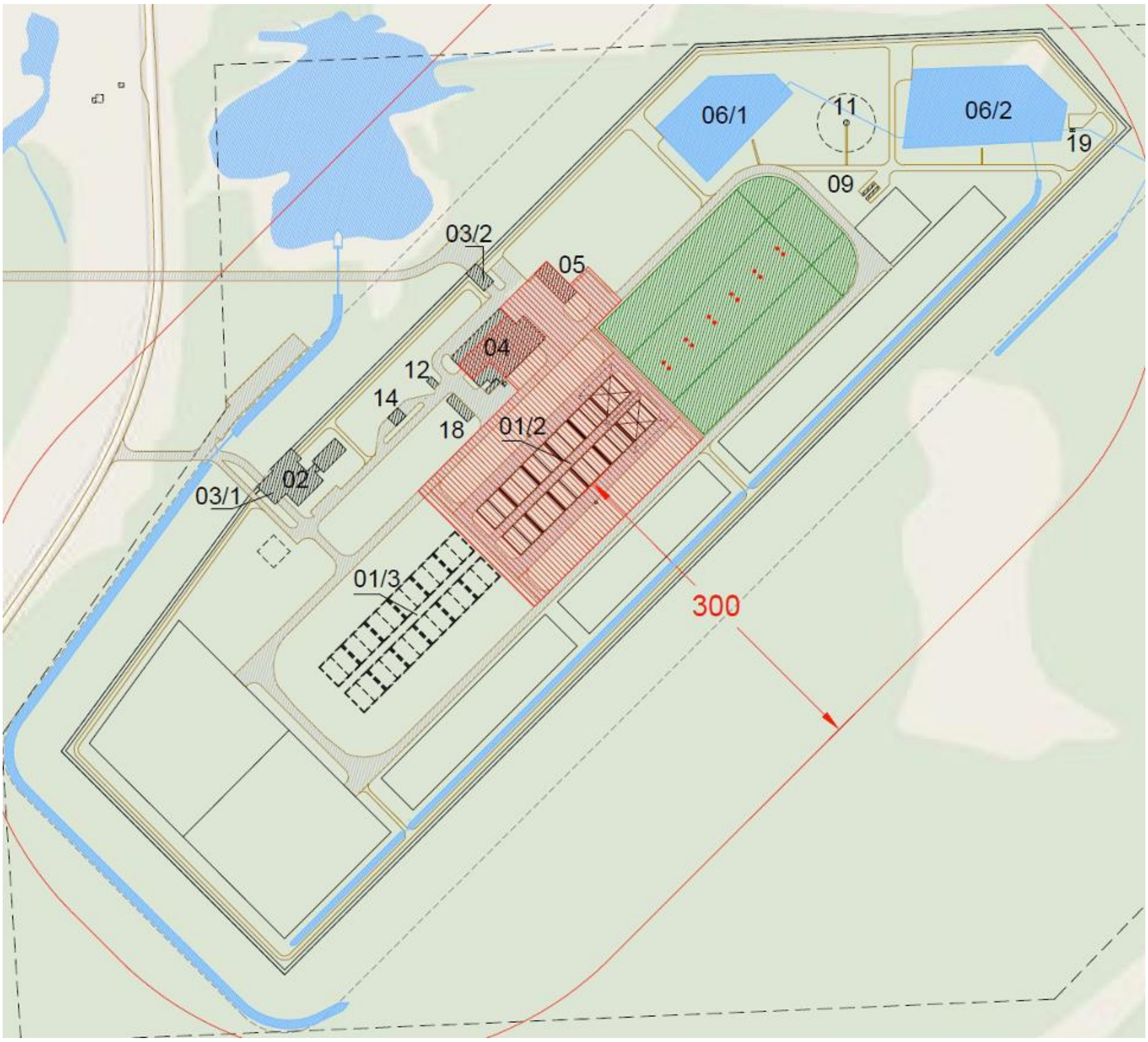

Figure 3.2-32. LILW-SL site and equipment during the operation of the second group of basements. The controlled area is marked in red. The second group of basements (01/2) is being operated and the third group of basements (01/3) is being built. The long-term engineering barriers (pile) formed above the first group of basements are marked in green. The repository has a SPZ of 300 m.

The LILW-SL repository is planned to be built and hot tested in 2029. The industrial operation of the LILW-SL repository is expected to start in 2030. The LILW-SL repository will be filled during the entire period of decommissioning of the INPP. After the completion of the decommissioning of the INPP and placement of decommissioning waste, the LILW-SL repository can be closed. The SWSF-SL storage facility will be used until the modules of the LILW-SL repository are filled. The closure of the modules of the LILW-SL repository and the decommissioning of the SWSF-SL storage facility will be carried out after the completion of the decommissioning of the INPP. The long-term environmental impact of the LILW-SL repository throughout its life cycle (during periods of institutional supervision and beyond) was assessed in a separate EIA study [47]. Transboundary environmental impact assessment procedures have been carried out for this study.

3.2.8 Storage of long-lived RW

Long-lived low-level radioactive (class D) waste, intermediate-level radioactive (class E) waste and SSS (class F) waste from the decommissioning of the INPP will be placed in the deep geological repository to be installed in Lithuania. It is planned that a deep geological repository could be installed and that long-lived waste could be deposited no earlier than 2068 [28]. Until then, the long-lived radioactive waste from the INPP decommissioning will be stored in several storage facilities built next to the INPP industrial site.

3.2.8.1 SWSF-LL Storage Facility

The Solid Waste Storage Facility for Long-Lived Radioactive Waste (SWSF-LL) is part of the Solid Waste Treatment and Storage Facility (SWTSF) [45]. In the G3 hot cell of the solid waste treatment facility, long-lived waste is sorted (see Section 3.2.6) and placed in stainless steel long-term (up to 50 years) storage containers LILW-LL, Figure 3.2-33. The external volume of the container is about 4.1 m^3, the average effective filling of metal SRW is about 2.5 m^3. The container can also hold four 200 l drums with SSS. Filled containers are closed with a lid. The containers are transported by closed conveyor to the adjacent SWSF-LL building and placed in three storage zones:

- A metal (class E) waste storage area, accommodating about 880 LILW-LL containers,
- Graphite (class D) waste storage area, accommodating 10 LILW-LL containers,
- SSS (class F) waste storage area, accommodating 20-30 LILW-LL containers. Four drums with a capacity of 200 l with SSS are stored in a separate container.

All transport and stacking operations of SRW packages performed in the SWSF-LL storage facility are operated remotely. The gamma radiation dose rate from the surface of the loaded LILW-LL container can reach up to 40 Sv/h, therefore, environmental protection from the effects of ionizing radiation (radiation shielding) is ensured by the structure of the storage building. The ventilation system of the SWSF-LL storage facility is integrated into the general ventilation and monitoring systems of SWTSF.

Figure 3.2-33. LILW-LL containers

The SWSF-LL storage facility will store group G3 SRW, graphite waste and SSS accumulated during the INPP operation and preparation for decommissioning of the INPP and retrieved from the existing storage facility buildings No. 157 and No. 157/1. The storage facility will also store class E waste from the reactor's fuel channels and reactor control and protection channels, which were removed from the reactor and shredded during the dismantling of the R1 and R2 zones. The annual filling of the SWSF-LL storage facility is shown in Figure 3.2-34. By 2025, the storage facility will be filled to about 20% of the design volume.

The filling of the storage facility depends on the progress of the retrieval of the group G3 SRW from building No. 157/1. This waste is planned to be retrieved by 2038, see Section 3.2.2.

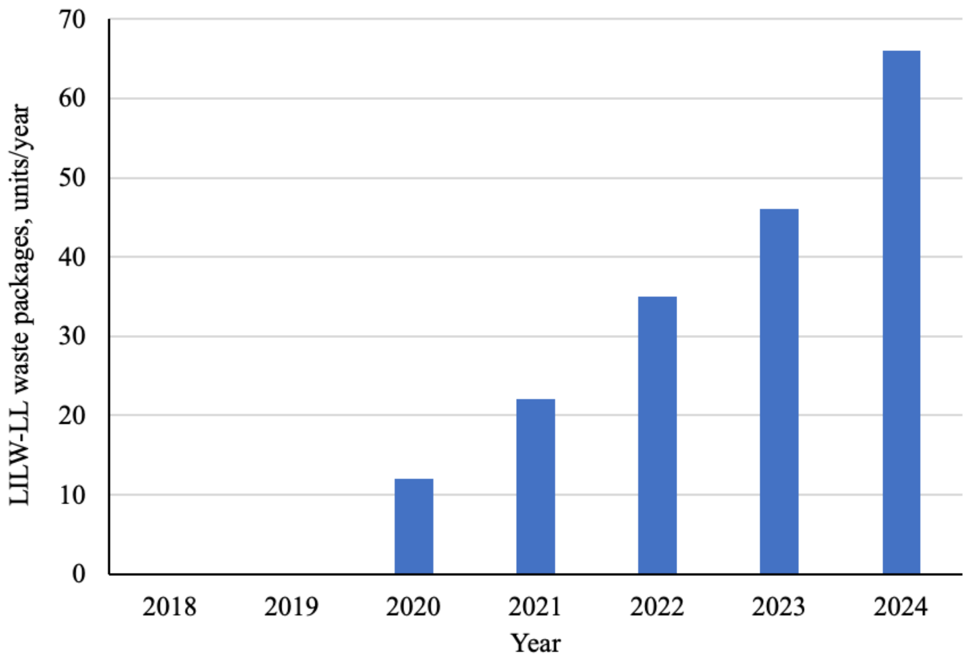

Figure 3.2-34. Filling the SWSF-LL storage facility

3.2.8.2 Interim Reactor Waste Storage Facility

The SWSF-LL storage facility operated at the SWTSF site (see Section 3.2.8.1) is not sufficient to accommodate all long-lived decommissioning waste of the INPP. The SWMSF design solutions [45] provided that, if necessary, the LILW-SL and LILW-LL storage facilities constructed at the SWTSF site will be able to be expanded. The existing LL storage capacities are planned to be developed by expanding (reconstructing) the SWTF building located at the SWTSF site and installing an additional LILW-LL waste storage facility - the Interim Reactor Waste Storage Facility (IRWSF). The IRWSF will be installed at the LILW-SL storage module expansion site (planned at the IRWSF design stage) and connected to the existing SWTF building by a pedestrian gallery, see Figure 3.2-35.

The IRWSF is planned to temporarily store the reactor dismantling waste:

- about 2200 tonnes of carbon and stainless steel waste (D and E classes);
- about 3800 tonnes of graphite waste (D and E classes), including 230 pcs F-ANP containers containing graphite waste from the dismantling of reactor zones R1 and R2 and brought from building No. 158/2 (see Section 3.2.3);

It is also planned to store other LL in the IRWSF:

- about 83 m^3 of concrete waste (class E) that will be generated during the dismantling of the group G3 waste sections of the existing SRW storage facility building No. 157;
- about 235 tons of SSS (Class F) that will be removed from the existing storage facilities and separated from other SRW.

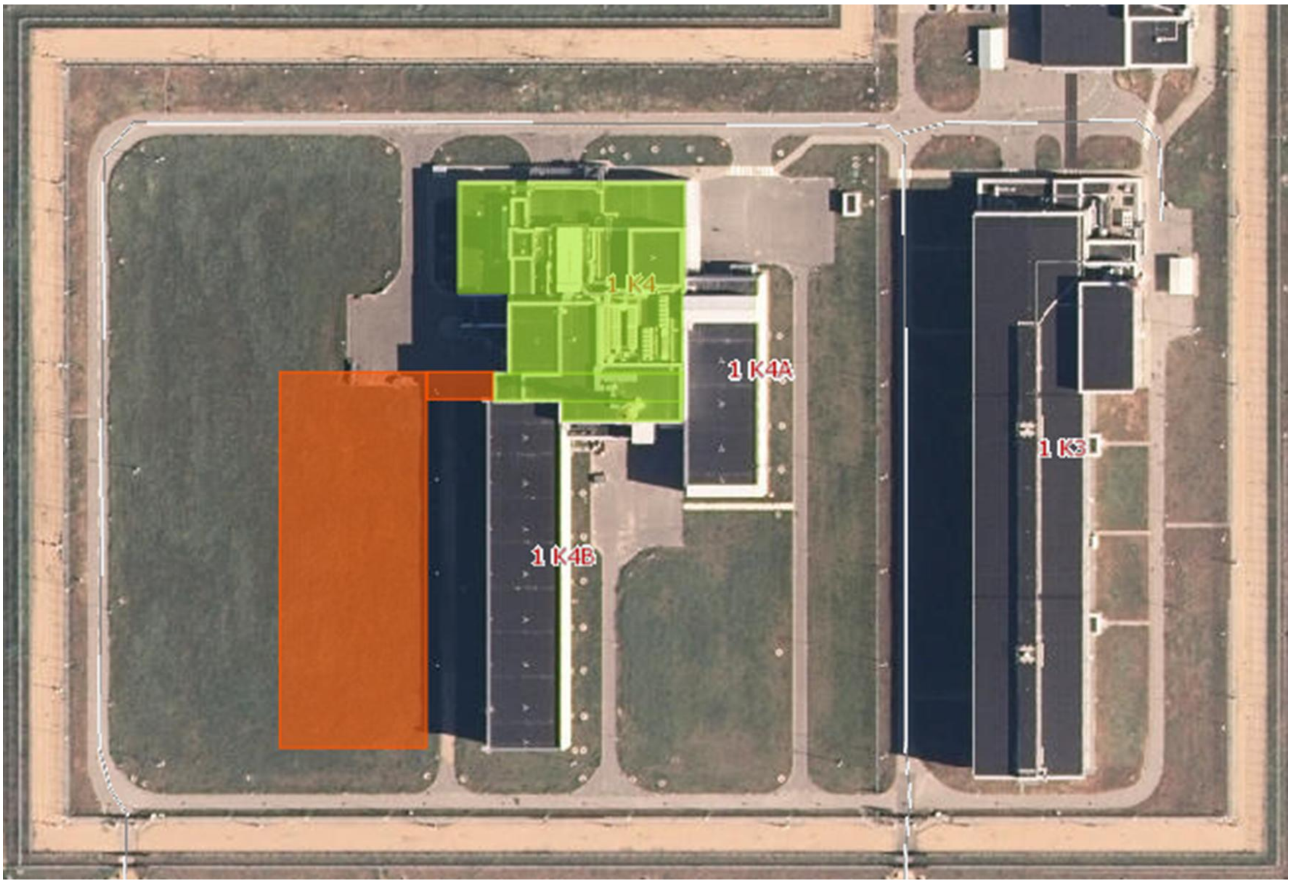

Figure 3.2-35. The planned location of the IRWSF in the SWTSF site. The location of the IRWSF is marked in pink, the building of the SWTF is marked in green

The IRWSF design documentation has not yet been prepared and detailed design solutions are not known. However, in terms of principled solutions, the newly planned IRWSF will be similar to the existing LILW-LL repository. Planned design solutions of the IRWSF:

- RW will be brought in and stored in containers used by the INPP. The planned design concepts envisage the use of (1) metal LILW-LL containers or (2) concrete LILW-SL (KTZ-3.6 type) containers. In both cases, a small number of additional shielded containers will be required; in both cases, the storage facility will contain 230 pcs. F-ANP containers brought from building No. 158/2;
- The number of packages required to place the RW and the area occupied by the packages will depend on the selected type of packages for the storage of the RW. The design concept (1) envisages that 1619 LILW-LL containers (including 37 additional shielded LILW-LL containers) and 230 F-ANP containers will be needed to load IRWSF waste. A total of 1849 packages with RW will be produced. The area of the IRWSF package storage hall would be about 1940 m^2. The design concept (2) envisages that 2252 LILW-SL containers, 242 additionally shielded containers and 298 F-ANP containers will be need to store reactor waste. In total, 2792 RW packages

will be generated. The area of the IRWSF package storage hall would be about 3830 m^2. Both design concepts envisage a building with a similar height for the IRWSF storage hall, approximately 18 m.

- Environmental protection from the effects of ionizing radiation (radiation shielding) will be ensured by the structure of the storage building. The handling of RW packages (unloading from the vehicle, placing it in the storage place, removing it from the storage area, etc.) will be carried out using remotely controlled equipment (cranes, package grabs);
- RW packages are delivered to the IRWSF placed in a shielded transport container;
- IRWSF will have a separate ventilation system complying with nuclear safety requirements (with HEPA filtration of air releases from the controlled area) and monitoring of releases into the environment;
- IRWSF will be able to operate independently of the activities of the adjacent SWTSF. RW packages will be delivered directly to the IRWSF building. The IRWSF building will have administrative and technical premises for the personnel servicing the storage facility, packaging reception and inspection, building engineering systems (ventilation, heating) and technical maintenance of equipment.

The IRWSF will have to be built and put into operation before the start of dismantling of long-lived RW located in the R3 zones of the reactors. The IRWSF design documents will have to assess and, if necessary, revise the sanitary protection zone currently established for SWTSF (see Figure 2.2-4).

3.2.9 Demolition of buildings and management of their waste

Demolition of structures is one of the types of construction that requires a building permit. The provisions on permits for the demolition of a nuclear facility building (NF) are provided in the Rules for the Issuance of Permits for the Construction or Reconstruction of a Nuclear Energy Facility, approved by the Resolution of the Government of the Republic of Lithuania [21].

The structures of the Ignalina NPP will be demolished only when all the equipment in them has been dismantled, if necessary, the structures of the building will be cleaned of contamination with radioactive materials (decontaminated) and it will be proven that the contamination of the building structures does not exceed the levels that are no longer controlled, i.e. such a structure is basically no longer a NFB and can be demolished like any other structure after obtaining the established permit for demolition works in accordance with the Construction Technical Regulation STR 1.05.01:2017 [22]. When demolishing structures that meet clearance levels of radionuclides for the materials, structures located above the ground surface (up to a depth of 0.5 m below the surface, in accordance with the legislation regulating construction) will be removed. Underground parts deeper than 0.5 m from the ground level will be left, the basements of the buildings will be filled with concrete rubble, which will be made from demolished buildings/structures of structures.

Structures contaminated with radionuclides, the contamination of the structures of which exceed the clearance levels of radionuclides for the materials, will be demolished as NFB and the permit for demolition works will be issued in accordance with the rules approved by the resolution of the Government of the Republic of Lithuania [21].

An estimate of the amount of buildings and structures to be demolished during the decommissioning of the Ignalina NPP is provided in Section 3.1.2.2.

The demolition of buildings and structures of the INPP will be carried out in accordance with the description of the Procedure for the Management of the Construction and Demolition of Structures [24], and construction waste is managed in accordance with the Construction Waste Management Rules [17]. Demolition projects (in the case of special structures) or demolition descriptions will be prepared for the demolition of buildings, which will describe in detail the management of the waste generated, the procedure for organising demolition works, and measures to minimise factors such as noise and dust that may have an impact on the environment and which are common for demolition works.

Once the demolition of individual buildings has been completed, in accordance with the provisions of the [25] and after it has been confirmed in accordance with the established procedure that the site where the building was located, or a part thereof and the adjacent territories are not contaminated with radionuclides and its radiation control may be abolished, the recultivation works of that site will be carried out.

As part of the decommissioning activities, demolition projects or descriptions have been prepared, a number of structures and buildings have already been demolished at the INPP site. Usually, the demolition work area is fenced off with a fence to prevent unauthorized persons from entering the territory. Hazardous areas where hazardous agents may occur shall be fenced off with signal fencing and marked with safety and health signs.

Cranes and excavators with special hydraulic equipment for cutting, breaking, dismantling, crushing, electromagnetic metal separation and other equipment are used for dismantling above-ground reinforced concrete and metal structures of structures. A mobile reinforced concrete scrap crushing and fractionation device with reinforcement removal equipment can also be used. The equipment used is equipped with special pulverization equipment for dust deposition.

The demolition of buildings is carried out in the sequence planned in the demolition project.

First, household waste is collected from the structures, wooden and glass structures are dismantled, windows and doors are dismantled. Glass shards and wooden frames are removed from the demolition work area so that they do not mix with construction scrap. Waste is sorted on site and transported in containers or dump trucks for further management. Later, the roof covering and thermal insulation layer are dismantled (construction waste is loaded into metal containers). Usually, the demolition of a structure is carried out from top to bottom, moving according to the perimeter from the outside side and moving deeper into the building when the internal partitions and covering panels are dismantled. Dismantling structures are constantly watered with water so that they do not cause dust.

The resulting construction scrap is stored at the object, then loaded and transported for recycling or storage. The stacked scrap is watered with water so that it does not cause dust. Waste that is not suitable for recycling is handed over to specialized waste managers. The pits created during the demolition works are filled with crushed stone or clean imported soil. After the completion of the demolition works, the territory of the plot is leveled.

3.2.10 Site management and state at the end of the activity

The goal of the INPP decommissioning is to clean up and transfer for reuse the largest possible part of the Ignalina NPP site, i.e. to grant the status of a “green field” to that part [7]. “Green field” means the final state of NF at which the concentrations of radionuclide activity in buildings and on the site (or part thereof) do not exceed unconditional clearance levels of radionuclides for the materials [44] and the use of the buildings and site of this object are not subject to any restrictions due to the possible exposure to ionizing radiation.

After the completion of the decommissioning of the INPP, the entire INPP site will not be able to be turned into a "green field", as separate NF and other controlled objects will still remain in it:

- Bituminized radioactive waste repository installed by transforming the bituminized radioactive waste storage facility (building No. 158) located at the INPP site into a surface repository of the short-lived intermediated level radioactive waste [29];
- VLLW repository buffer storage facility (see section 3.2.7.1), which will be operated for as long as the VLLW repository is in operation, i.e. until the management of all SRW that have generated during the decommissioning and meeting the acceptance criteria for the VLLW repository;
- Industrial waste repository installed by transforming the industrial waste storage places at the INPP site (the so-called "industrial waste landfill", INPP buildings No. 155/2, No. 155/3, and No. 155/4) into a repository that meets modern environmental

requirements, where the conditional clearance levels of radionuclides for the materials are applied for the waste [44].

There is also uncertainty regarding the dismantling of INPP buildings in the controlled area, the concrete of which is contaminated with radionuclides (see Section 3.1.1.2.6), preparation for demolition and management of the generated waste. According to the radiological studies carried out, some of the structures of these buildings are contaminated with radionuclides much deeper (50 cm deep / through the entire thickness of the structure) and it may not be possible to deactivate them to unconditional levels that are no longer controlled. Therefore, it is planned to prepare a feasibility study for the decontamination of the power units and part of the building structures of the radioactive waste management facilities. Possible options for the management of contaminated concrete waste, in order of priority, are as follows:

- Removal of contaminated concrete and placing it in a new repository;
- Determination of conditional clearance levels of radionuclides for the materials for the reuse of concrete. If concrete is to be used in the INPP site, then certain parts of the site would be classified as a "brown" site. The status of the "brown field " means the final state of the NF/its site, upon reaching which the concentration of radionuclide activity in the buildings and/or site (or part thereof) exceeds the unconditional clearance levels of radionuclides for the materials, and the use of the buildings and the site (or part thereof) of this object due to the possible exposure to ionizing radiation is possible only with restrictions – in this case, safety during the further use of the site is ensured by administrative measures. Restrictions on the use of the "brown site" may be established only by knowing the actual ways of using the "brown site" (as well as the buildings and structures located therein);
- Installation of a contaminated concrete repository at the INPP site, e.g. on the site of energy units buildings. In this case, a new NF would appear on the INPP site, but there would be no need to dismantle the underground parts of the buildings, they could be used as cavities for placing concrete scrap of above-ground structures. However, such a decision can be made only after making sure that such a repository construction will allow the installation of appropriate engineering barriers limiting the spread of radionuclides and will ensure the safety of the population and the environment in the long term.

The decision on the management of contaminated concrete in the main structures of energy units must be made taking into account legal, radioactive waste management, radiation safety and environmental protection requirements, as well as economic and social factors.

The planned condition of the INPP site [7] with the existing NF and industrial waste repository remaining on the site is shown in Figure 3.2-36. If a contaminated concrete repository was additionally installed at the site of the energy unit buildings, the planned condition of the INPP site is shown in Figure 3.2-37.

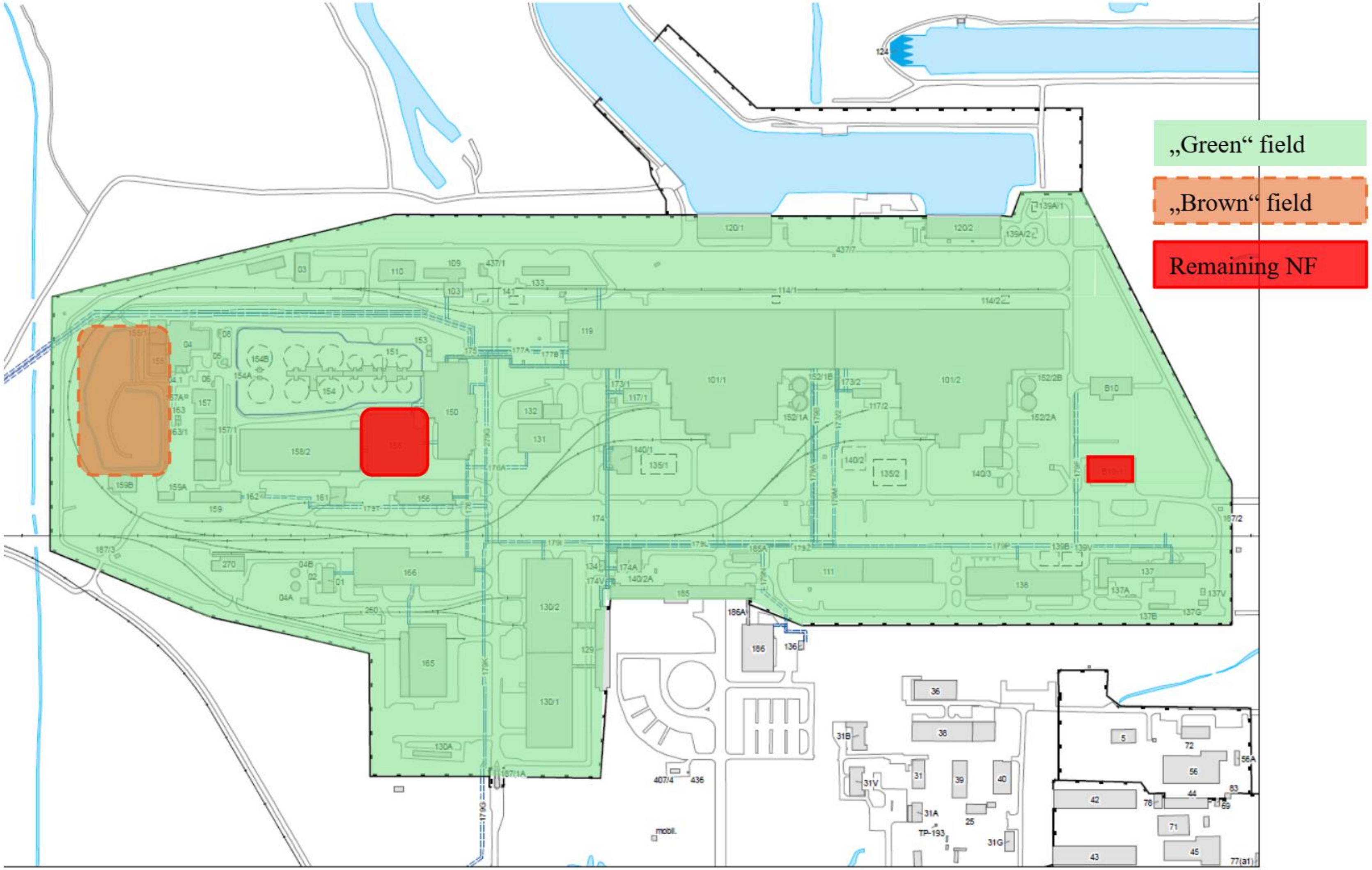

Figure 3.2-36. Planned condition of the INPP industrial site after completion of decommissioning

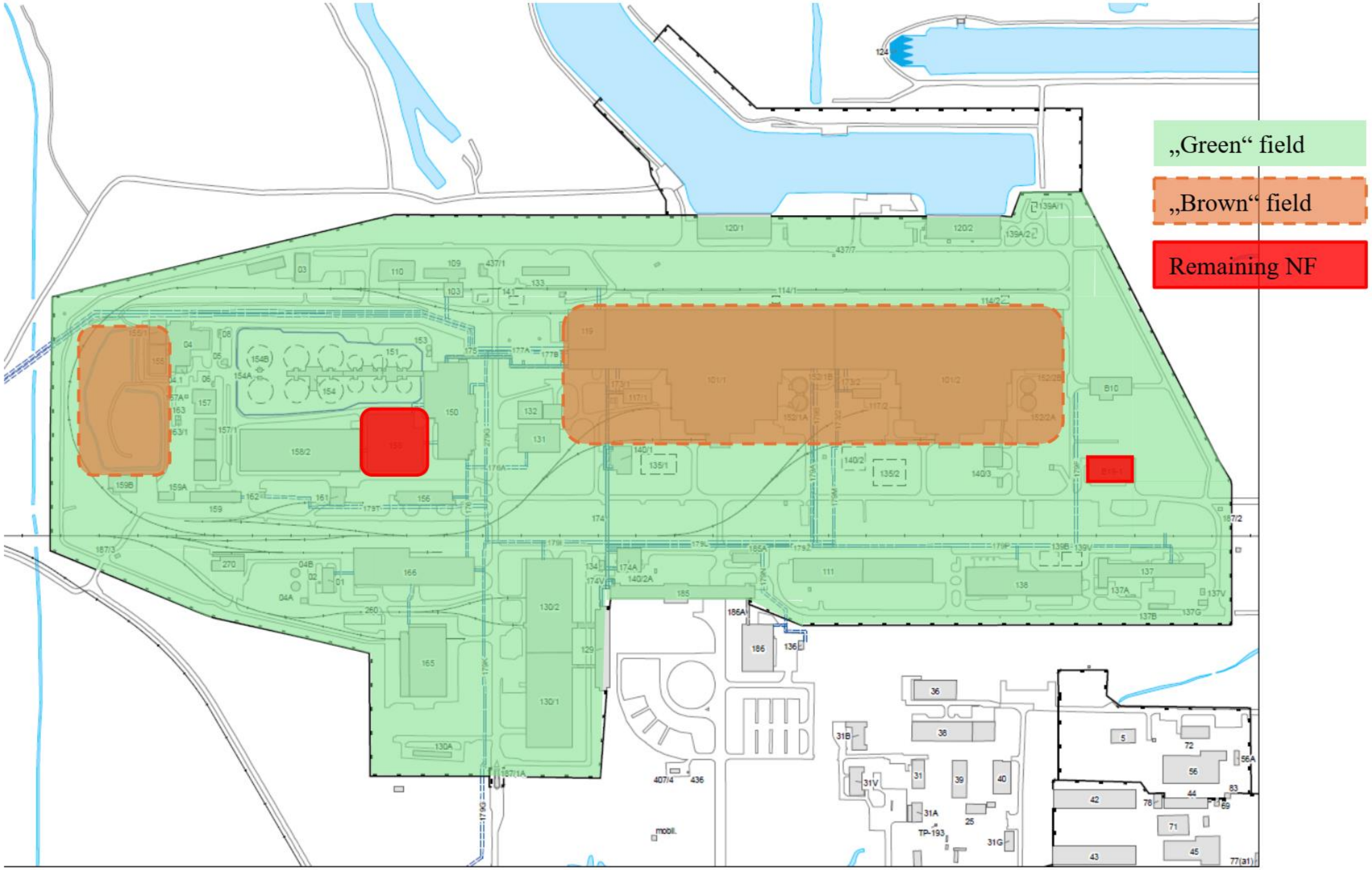

Figure 3.2-37. Expected state of the INPP industrial site after completion of decommissioning, if conditional uncontrolled levels were established for the location of the reactor unit buildings ("brown field").

For the needs of INPP operation and decommissioning, NF have been and new ones will be built near the INPP industrial site. The following NF will be operated long after the INPP decommissioning is complete:

- Interim SNF dry storage facility ISFSF-1 (see Section 3.2.1);
- Interim SNF dry storage facility ISFSF-2 (see Section 3.2.1);
- Solid radioactive waste treatment and storage facility SWTSF (see Section 3.2.6);
- Very low-level activity short-lived waste (VLLW) repository (see Section 3.2.7.1);
- Low and intermediate-level radioactive short-lived waste (LILW-SL) near surface repository (see Section 3.2.7.2).

An environmental impact assessment of all these new NF has already been carried out, including transboundary environmental impact assessment procedures [27], [45], [46], [47], with the exception of ISFSF-1, since at that time it was not required to carry out an EIA prior to the construction of the object. The safety of ISFSF-1 from an environmental point of view was justified in the safety justification of ISFSF-1.

SPZ with a 3 km radius was established for the INPP operational period. During the decommissioning of INPP, while the retrieval of group G3 SRW from the existing storage facility is being carried out, the waste is intensively transported between the individual waste management and disposal facilities, until the reactors are dismantled and the waste is placed in the LL storage facilities, it is recommended to maintain the existing 3 km radius SPZ. The population exposure assessments carried out in EIAR both during normal operation and in case of accidents are based on the assumption that the existing SPZ is maintained. During the decommissioning of INPP, it may be necessary to change and optimize the existing barriers ensuring environmental safety, e.g. in order to optimize the operation of the ventilation systems of the power units and reduce energy consumption, it may be appropriate to fully or partially dismantle the existing 150 m high ventilation stacks before preparations are made for the dismantling of the reactor R3 zones and to organize releases into the ambient air through lower ventilation stacks. Therefore, maintaining the existing SPZ is considered a conservative and ALARA measure that ensures low exposure of the population.

Upon completion of the decommissioning of the INPP, the status of the INPP as a NF will be abolished. At the same time, the existing 3 km radius SPZ of the INPP will be able to be abolished. However, the special conditions of land use in individual areas of the SPZ will be repealed.

The SPZ assigned to the NF located near the INPP site and continuing to operate after the decommissioning of the INPP (see Figure 2.2-4) and the special conditions of land use applied therein will remain.

Special land use conditions will remain in part of the existing INPP site, as separate SPZ will be established for the NF remaining on the site. Special land use conditions will also be established for objects whose radiation control has been lifted by applying conditional clearance levels of radionuclides for the materials. The radiation safety control of the remaining part of the INPP site may be lifted after assessing the residual radioactive contamination and its possible impact on the environment or after proving compliance with the indicators set by the competent authority (e.g. compliance with the clearance levels of radionuclides for the materials [44]). When making a decision on the abolition of radiation control, it will be necessary to take into account not only the pollution of the surface layers of the site, but also the pollution of groundwater. By abolishing the INPP SPZ and determining where necessary, special conditions of land use, it will be necessary to assess the actual pollution situation that will arise at the end of the decommissioning of the INPP.

There has been no precedent in Lithuania where, upon completion of the NF decommissioning licence, the special land use conditions established for NF's activities would be abolished and the NF site would be put into use without applying radiation protection control. Such a precedent will be created by completing the decommissioning of the Maišiagala Radioactive Waste Storage Facility and abolishing the radiation control of the SPZ and its site. The experience gained will be used in planning and implementing the completion of the decommissioning license of the Ignalina NPP.

4 ENVIRONMENTAL COMPONENTS LIKELY TO BE AFFECTED BY THE PLANNED ECONOMIC ACTIVITY

4.1 Water

4.1.1 Current state

4.1.1.1 Groundwater

From a hydrogeological point of view, the territory of the INPP is located in the eastern part of the Baltic artesian basin – in the area of its nutrition. In the hydrogeological section of the district, active, slowed down and slow hydrodynamic zones of water circulation are distinguished. The zones of active and slowed water circulation are separated by the Middle Devonian Narva regional watershed (clay, domerite, and clayey dolomite). The clay rocks of Narva subside at a depth of 180 – 200 m, the thickness of which reaches 85 – 89 m.

The hydrodynamic zones of slowed and slow water circulation in the section are separated by the Silurian-Ordovician regional watershed, which subsides at a depth of 270 – 295 m. This watershed consists of carbonate clayey rocks 170 to 200 m thick – dolomite, domerit, limestone and virgin [51].

In the hydrodynamic zone of active water circulation, the aquifer complexes of the Quaternary and the upper – middle Devonian Šventoji – Upininkai subside, which are hydraulically connected and form a common hydraulic system. The water of these complexes is fresh, according to the chemical composition, it is most often of the carbonate-magnesium-calcium type.

The aquifer complex of the Quaternary, the thickness of which varies from 85 to 100 m, and in places in the paleospheres reaches up to 260 m, consists of groundwater and 6 pressure (sub-pressure) intermoraine aquifers. The groundwater aquifer is widespread throughout the territory and consists of sediments from the late Pleistocene and Holocene ages. It is moraine loam or sandy loam, consisting of sand, pebbles, gravel and peat of various coarseness. This aquifer is fed by atmospheric precipitation moisture through the surface of the earth (aeration zone) that is not saturated with water that recedes above. The water level of the groundwater layer is higher than the subsidence aquifers, i.e. the latter are fed by groundwater.

The pressurized (sub-pressure) aquifers of the Quaternary aquifer complex subside in the section between glacial (moraine) low-permeable layers of various ages, which contain local watersheds, the thickness of which varies from 15 to 30 m, in some places only 0.5 m or grow to 50 – 70 m.

In a detailed stratigraphic diagram of the Quaternary formations, these layers are divided into Baltic-Grūda, Grūda-Medininkai, Medininkai-Žemaitija, Žemaitija-Dainava, Dainava-Dzūkija intermoraine and Dzūkija pomoric aquifers. The thickness of the intermoraine aquifers varies from

0.3 m to 2 m or from 20 m to 40 m, and in the paleocrets reaches up to 100 m and more [52].

The Šventoji-Upninkai aquifer complex lies beneath the Quaternary Complex, which consists of fine and fine sand, weakly cemented sandstone, silt and clay. The thickness of the complex is 80-110 m.

The water of the Šventoji-Upninkai aquifer complex is used for the needs of the INPP and other users of Visaginas municipality. The facilities and wells of the watershed operated by CJSC Visagino energija are located approximately 3 km southwest of the INPP site (Figure 4.1-1). The flow of the watershed is formed by a powerful flow of groundwater flowing through the exploited complex itself, which creates relatively small areas of captaja in the exploited and interacting aquifers. The width of the area of the captage calculated for a period of 25 m (from the fence of the watershed) in the operated complex is 1.5-2 km, and in the groundwater layer it is 0.3-1.0 km.

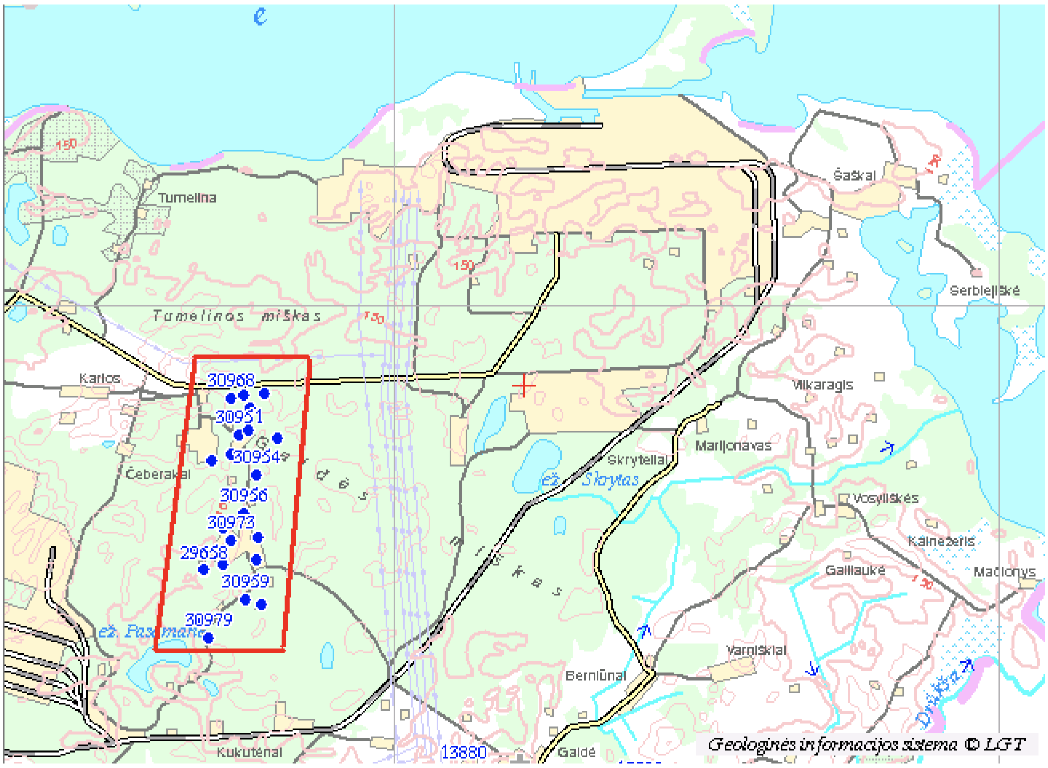

Figure 4.1-1. Location of artesian wells operated by CJSC "Visagino energija"

4.1.1.2 Lake Drūkšiai

Lake Drūkšiai, the water of which was used to cool the electrical technological equipment during the operation of the INPP, is the largest lake in Lithuania. It is located in the northeastern part of Lithuania, 141.6 m above sea level. The total volume of water in the lake is about 370 × 10^6 m^3. The total surface area of the lake, including 9 islands, is about 49 km^2 (of which 6.7 km^2 is in the territory of Belarus, 42.3 km^2 is in Lithuania). The maximum depth of the lake is 38.3 m, the average depth is 7.6 m. The length of the lake is 14.3 km, the maximum width is 5.3 km, and the perimeter is 60.5 km. The lake is characterized by a relatively slow water circulation [54, 55].

Lake Drūkšiai has 11 tributaries, the main of which are the Apyvardė, Ričianka and Smalva rivers. The water flows from the lake into the Prorva River in the southeastern part of the lake and reaches the Baltic Sea via a hydrographic network with a length of more than 550 km (Lake Drūkšiai → Prorva → Drūkša → Dysnai → Daugava→ Gulf of Riga). The coastline is winding, its length is 60.5 km. The shores are mostly dry, in places there are swampy places.

The Lake Drūkšiai basin (564 km^2) is located on the territory of three countries: Lithuania – 282 km^2 (50%), Latvia – 102 km^2 (18%) and Belarus – 180 km^2 (32%) [52]. The diagram of the water basin of Lake Drūkšiai is presented in Figure 4.1-2.

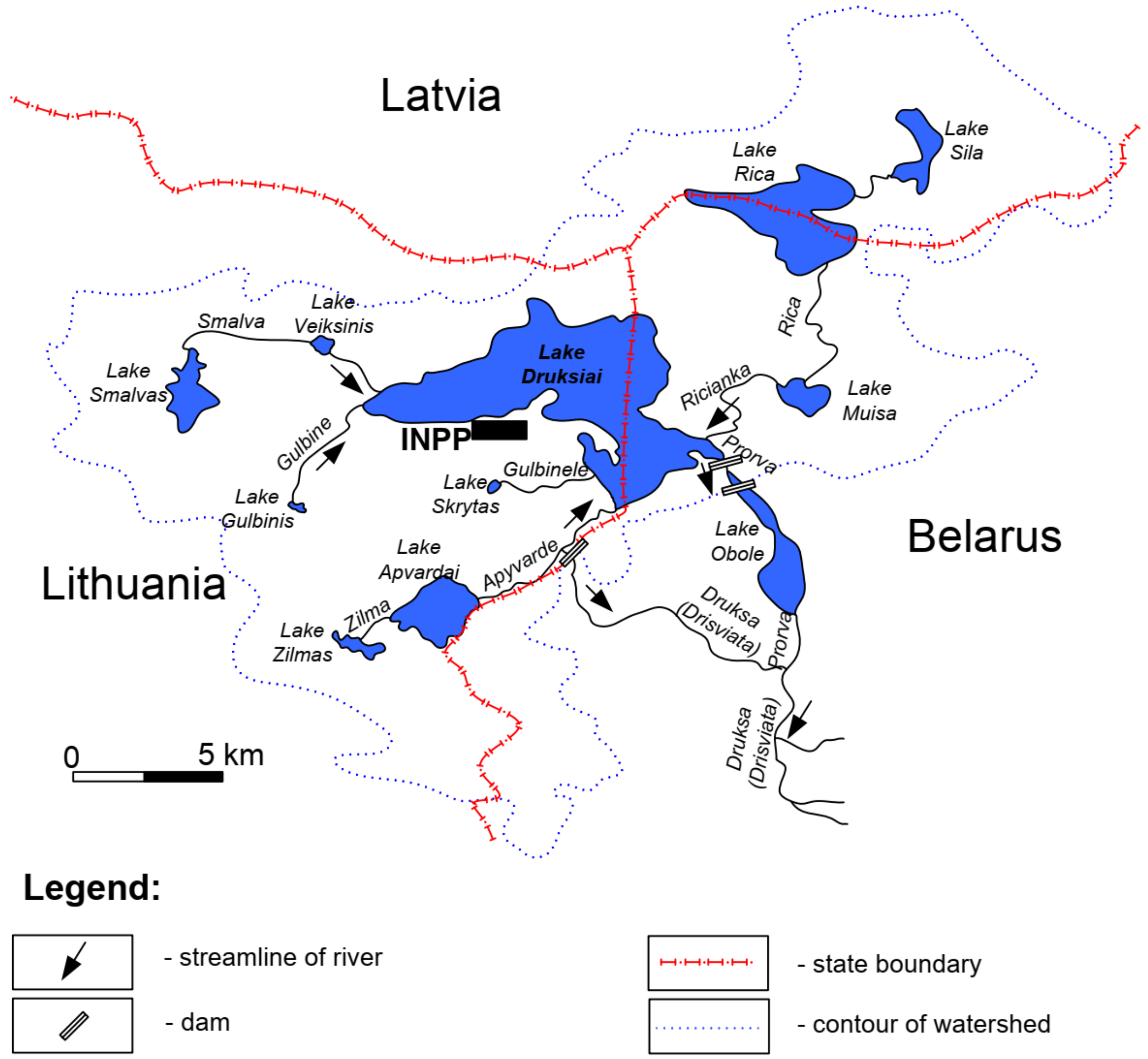

Figure 4.1-2. Diagram of the hydrographic network of Lake Drūkšiai

4.1.1.3 Water quality

The INPP uses surface and groundwater (artesian) water for its own needs.

Artesian water is used for technological processes that require water of special quality (decontamination, cementation of radioactive waste), as well as for meeting the household needs of employees (drinking water, water for hygiene purposes). Artesian water is supplied to the INPP by CJSC "Visagino energija", which operates the complex of facilities of the Visaginas city watershed. The water is extracted from the Šventoji-Upininkai aquifer (80-100 m deep). Groundwater is of good quality, except for the excessive concentration of iron [53]. Excess iron is removed by the water supplier. Water quality is constantly checked by a certified laboratory of chemistry and bacteriology. The safety and quality indicators of prepared drinking water comply with the requirements of Hygiene Standard HN 24:2023 [56].

Surface water is used in various technological processes (directly, as a cooling medium, etc.). The source of surface water is Lake Drūkšiai. The INPP extracts surface water itself in accordance with the Integrated Pollution Prevention and Control Permit (IPPC) [57]. In 2019, the IPPC permit was replaced by the Pollution permit [58].

The ecological status of surface water bodies, including lakes, is assessed according to physico-chemical, hydromorphological and biological quality elements. The indicators of the quality elements and the values of the indicators used to identify the quality of the lake (from "very good" to "very bad") are determined by the methodology [59]. INPP, in accordance with the "Environmental Monitoring Program of the Ignalina NPP" [117], performs the monitoring of discharges and the monitoring of effects on surface water. Reports on the results of the monitoring are prepared every year. Values of the main physico-chemical parameters of Lake Drūkšiai and the values of the applied quality indicators [59] summarized in Table 4.1-1. Lake Drūkšiai is classified as a type 3 lake [60]. According to physico-chemical indicators, Lake Drūkšiai in 2010-2024 is classified as very good or in good ecological status.

Table 4.1-1. Values of physico-chemical parameters of Lake Drūkšiai in 2010 – 2024 and values of applied quality indicators

Indicator	**Average annual value**		**Quality indicator values**	
	Lowest	**Largest**	**Very good**	**Good**
Total nitrogen, mg/l	0.37	0.81	< 1.00	1.00 - 2.00
Total phosphorus, mg/l	0.015	0.049	< 0.030	0.030 - 0.050
BOD_7, mgO_2/l	0.94	2.64	< 1.8	1.8 - 3.2

In 2010 – 2024, Lake Drūkšiai is measured according to the "Requirements for the protection of surface water bodies where freshwater fish can live and breed" [61], the values of physico-chemical parameters (BOD_7, ammonium nitrogen, nitrite nitrogen, phosphate phosphorus, etc.) meet the requirements of the quality indicators applicable to water bodies for carps.

4.1.1.4 Radioactive contamination

In artesian water extracted by CJSC "Visagino energija", the tritium volumetric activity is less than 1 Bq/l, the total alpha volumetric activity varies from 0.0005 Bq/l to 0.023 Bq/l, the total beta volumetric activity (excluding H-3, Rn-222 and its decay products) varies from 0.013 Bq/l to 0.18 Bq/l. The radiological indicators of drinking water are about 10-100 times lower than the limit values set by the requirements of the Hygiene Standard HN 24:2023 [56].

The volumetric activity of radionuclides in the water of Lake Drūkšiai is low, the measured activities of individual radionuclides are often lower than the minimum detectable activity. Monitoring results for 2010-2024 summarized in Table 4.1-2. The measured volumetric activity values in individual areas of the lake vary little.

Compared to other Lithuanian water bodies that are not in the INPP impact zone and where state radiological monitoring is carried out (Kaunas Reservoir, Lake Plateliai), the volumetric activities of radionuclides Cs-137 and Sr-90 in Lake Drūkšiai are not exceptional and correspond to the values measured in other places.

Table 4.1-2. Average volumetric activity of radionuclides in the water of Lake Drūkšiai in 2010-2024

Radionuclides	**Volumetric activity, Bq/l**	**Note**
Mn-54	< 0.008	In the period 2010-2024, volumetric activity changes little.
Co-60	< 0.011	
Fe-59	< 0.027	
Nb-94	< 0.007	
Cs-134	< 0.007	
Cs-137	< 0.010	
Sr-90	0,004	In the period 2010-2024, the activity of Sr-90 consistently decreased from 0.01 Bq/l to 0.001 Bq/l.
H-3	< 4.5	In the period 2010-2024, H-3 activity increased from 3 Bq/l to 6-9 Bq/l.
Total alpha	< 0.005	The results of 2010-2017 and volumetric activity do not change much.
Total beta	< 0.028	

The results of the measurements of the specific activities of radionuclides in the sediments of the bottom of Lake Drūkšiai in 2010-2024 are summarized in Table 4.1-3. Cs-137 accumulates in the bottom sediment, and small specific activities of Co-60 and Sr-90 are measured. The specific activities of other radionuclides are below the minimum detectable activity.

Compared to other Lithuanian water bodies that are not in the INPP impact zone and where state radiological monitoring is carried out (Kaunas Reservoir, Lake Plateliai), the specific activities of radionuclides Cs-137, Co-60, Sr-90 in the sediments of Lake Drūkšiai are several times higher.

Table 4.1-3. Average specific activities of radionuclides in the sediments of the bottom of Lake Drūkšiai (dry mass) in 2010-2024

Radionuclides	**Specific activity, Bq/kg**	**Note**
Mn-54	< 1.3	There are no clear trends in specific activity changes in the period 2010-2024. The radionuclide activity in bottom sediments is a consequence of the INPP activities and the globally dispersed Cs-137 and Sr-90 (due to the Chernobyl NPP accident).
Co-58	< 1.5	
Co-60	< 1.8	
Fe-59	< 5.4	
Sr-90	3,5	
Nb-95	< 2.3	
Zr-95	< 3.0	
Cs-134	< 1.4	
Cs-137	29	

The average annual volumetric activities of radionuclides Cs-137, Mn-54 in the water of the monitoring wells of the INPP site are lower than in the water of Lake Drūkšiai. The average annual volumetric activities of radionuclides Co-60 and Sr-90 in the water of the monitoring wells of the INPP site are similar or slightly higher than in the water of Lake Drūkšiai. The average annual volumetric activity of all measured radionuclides is less than Hygiene standards HN 24:2023 [56] limit values set out in the requirements of the drinking water. The exception is tritium, the increased values of the volumetric activity of which are measured in the western part of the INPP site, in the water of the existing SRW storage facilities No. 157/1, No. 157, No. 155, No. 155/1 and the monitoring wells located in the area of the industrial waste landfill (see Figure 4.1-3). In individual years, the volumetric activity of tritium can reach 5000 Bq/l (see Figure 4.1-4). Activity values above the maximum permissible concentration in drinking water, per 100 Bq/l [56], up to 50 times. The volumetric activity of tritium in the water surrounding the industrial waste storage site, reaching a peak of 14,000 Bq/l since 2011-2012, has consistently decreased to 2,000 Bq/l in 2024. The increasing and decreasing values of tritium volumetric activity in the direction of groundwater flow in individual years are a consequence of the release and dispersion of tritium by groundwater that occurred during the operation of the INPP. The source of the pollution is not unequivocally clear, there may be several of them, both in the industrial waste landfill and in the existing storage facilities. Tritium is a short-lived beta emitter and its radiological effect at such concentrations is not very significant during the decommissioning of the INPP. During the decommissioning, SRW will be removed and processed from the existing storage buildings, the storage buildings will be decontaminated and subsequently demolished. The residual pollution of the INPP site and the groundwater pollution will have to be assessed at the end of the decommissioning of the INPP, regulating the status of individual zones of the INPP site and the size of the sanitary protection zone, see Section 3.2.10.

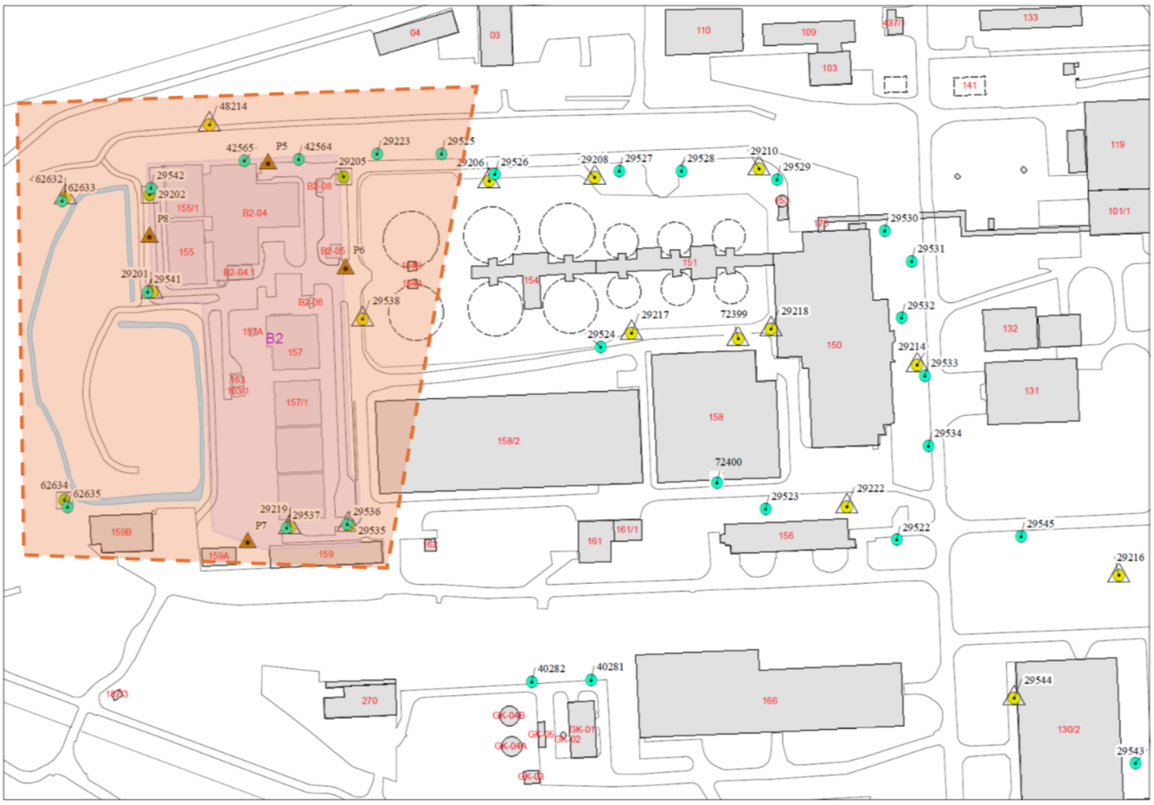

Figure 4.1-3. The area of the INPP site where increased tritium volumetric activity was measured in the water of monitoring wells in 2010-2024 (marked in pink)

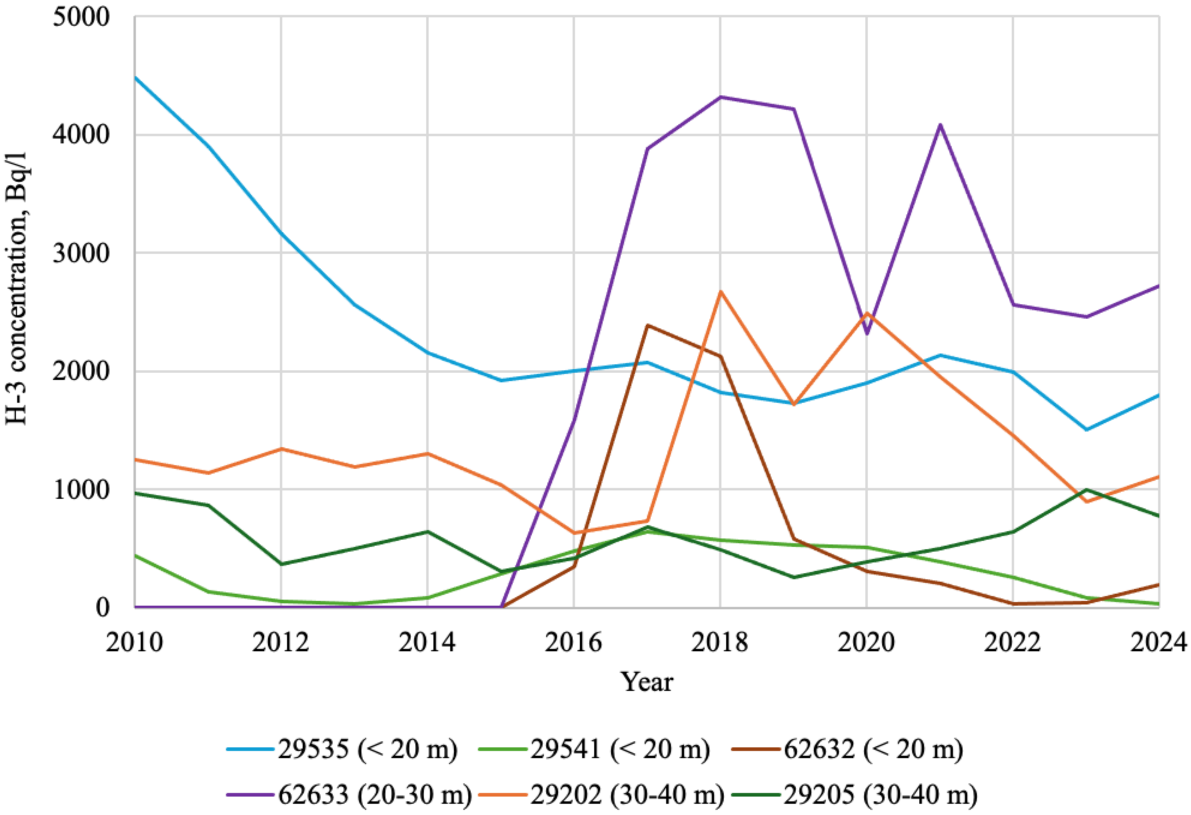

Figure 4.1-4. Variation of tritium enhanced volumetric activity in individual groundwater monitoring wells. The legend indicates the well number and well depth.

4.1.2 Planned pollution

4.1.2.1 Sources of pollution

Domestic wastewater from the INPP is collected by the wastewater collection system and handed over to CJSC Visagino energija for management. CJSC "Visagino energija" also manages wastewater for residents of Visaginas city and other consumers of Visaginas municipality – services are provided to almost 11 000 household consumers and more than 300 industrial and commercial consumers, more than 1 000 000 m^3 of wastewater is treated per year [62]. Wastewater is treated with mechanical and biological treatment plants, and treated wastewater is discharged into Lake Drūkšiai.

The amount of domestic wastewater generated by the INPP depends on the size of the staff. After the completion of operation, the number of INPP employees is steadily decreasing. After the shutdown of the second reactor in 2010, the INPP staff was reduced from 2 900 to 2 100 employees. In 2024, the INPP employed about 1 500 employees. A significant increase in the number of INPP personnel is not expected during the decommissioning works.

The INPP releases the following into Lake Drūkšiai through separate outlets:

- surface wastewater collected from the territory of the INPP site, adjacent individual NF sites and buildings adjacent to the INPP site, from a total of 165 ha of the total area;
- industrial wastewater – technological and surplus (so-called "unbalanced") waters.

A generalized scheme of discharge of anthropogenic wastewater into Lake Drūkšiai, which includes wastewater from the INPP and Visaginas city, is presented at Figure 4.1-5. INPP wastewater is discharged into Lake Drūkšiai through the INPP cooling water discharge channel and three outlets.

A brief description of the discharges is given in Table 4.1-4. Compared to the INPP operational period, the maximum permissible discharge of mixed wastewater for discharges set in the Integrated Pollution Control and Prevention Permit [57] valid for 2010-2023 has decreased to 30-40% of the discharge during the former INPP operational period. The maximum permissible discharge of equipment cooling water is about 4% of the discharge during the former INPP operational period. The discharge of wastewater during the decommissioning of INPP is lower than the maximum permissible values and is constantly decreasing, from 8.4E+7 m^3/year in 2010 to 1.8E+6 m^3/year in 2024, Figure 4.1-6. After the installation of new LRW evaporation units and the closure of the steam boiler plant, the maintenance of the LRW accumulated during operation (see Section 3.2.3) the discharge of industrial wastewater will decrease.

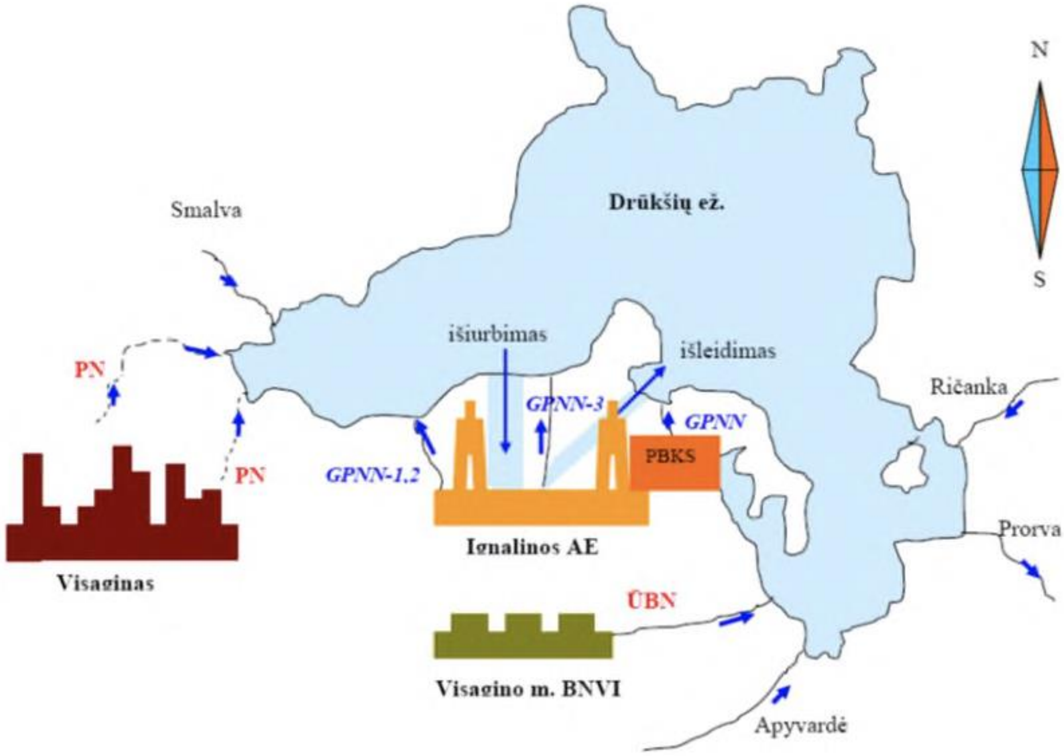

Figure 4.1-5. Scheme of discharge of wastewater into Lake Drūkšiai. PN – surface wastewater in Visaginas city, GPNN - industrial and surface wastewater wastewater, BNVĮ and ŪBN – Visaginas municipal wastewater treatment plants and discharge of treated farm and domestic wastewater

Table 4.1-4. INPP surface wastewater discharges

Release	**Maximum permitted amount of waste water**		**Surface wastewater collection area, ha**	**Wastewater type**	**Wastewater treatment plant**
	m^3/day	**m^3/year**			
Discharge channel	219 178	8.00E+7	0	Industrial	No
GPNN-1,2	31 800	1.16E+7	97.3	Mixed (industrial and surface)	Mechanical type oil product trap
GPNN-3	1 515	5.53E+5	5.6		
GPNN-PBKS	Not regulated		61.9		
Total:	**252 493**	**9.22E+7**	**164.7**		

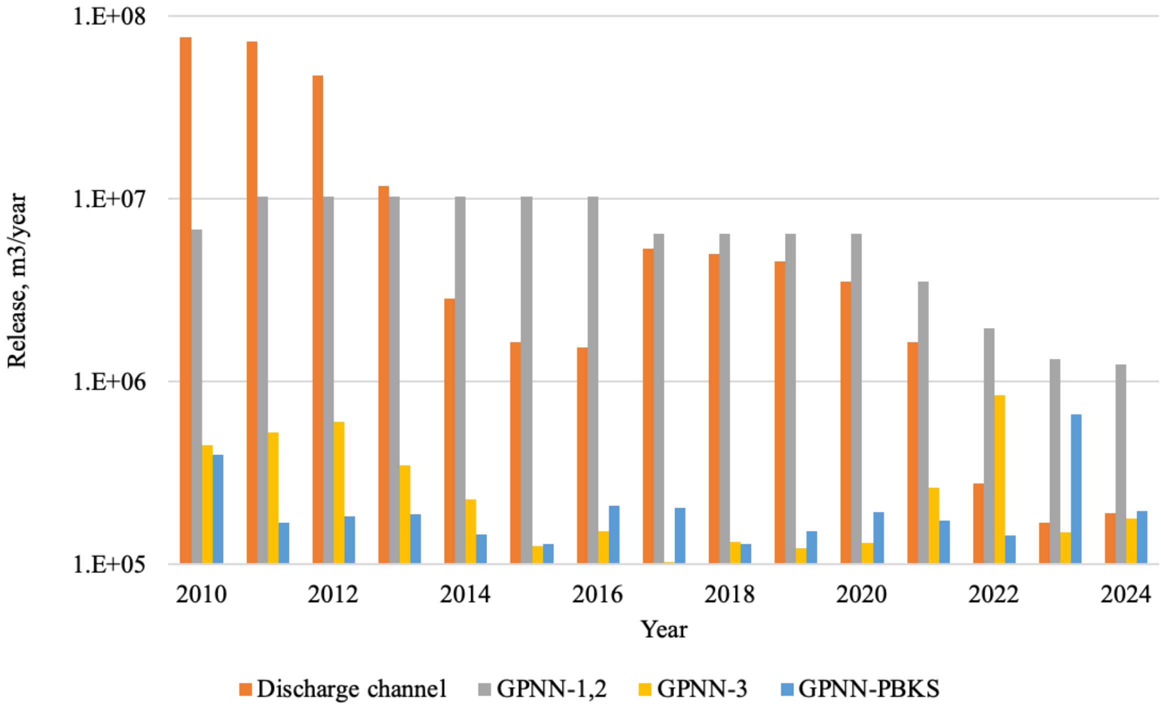

Figure 4.1-6. Total release of technological and excess water through separate channels into Lake Drūkšiai

Surface wastewater collection will not change much during the decommissioning of INPP. The formation of surface wastewater is determined by natural conditions (precipitation, evaporation, infiltration) and the size of the territory from which it is collected. Surface wastewater in the territory belonging to the INPP accounts for about 1E+6 m^3 per year. After the construction of the LILW-SL repository, the surface wastewater collection area will increase by about 30 ha, i.e. about 13%. Accordingly, surface wastewater into Lake Drūkšiai may increase.

IPPC 2019 edition [57] replaced by an release permit [58]. The pollution permit does not provide for a restriction on the amount of wastewater discharge. Wastewater monitoring and pollution limitation is carried out in accordance with the requirements of the applicable legislation: Wastewater Management Regulation [63], the Surface Waste Water Management Regulation [64], the environmental monitoring program of the State Enterprise Ignalina NPP [117], prepared in accordance with the Regulations on the Monitoring of the Environment of Economic Entities [65].

During the decommissioning activities of the INPP, demolition works of existing structures that are no longer needed are being carried out on the INPP site and adjacent to it, reconstruction works of objects left on the site after decommissioning (construction of additional engineering barriers) and recultivation works of the site territory will be carried out. At the beginning of the decommissioning of the INPP, new radioactive waste management and storage facilities were built at the INPP site and adjacent to it: ISFSF-2, SWRF, SWTSF, VLLW buffer storage facility and

VLLW repository modules. The construction of new objects is planned – the LILW-SL repository and the IRWSF. During the dismantling and demolition of buildings, the construction of new buildings, the recultivation of the site, the formation of additional wastewater is possible, as well as the pollution of surface wastewater by demolition or construction waste (e.g. small sinking materials) and pollutants from the construction machinery used (e.g. oil products).

4.1.2.2 Sources of radioactive releases

Radionuclides enter Lake Drūkšiai with the discharges of INPP industrial wastewater and surface wastewater, which are carried out through the following channels:

- Cooling water discharge channel, into which process water is discharged from reactor block buildings No. 101/1 and 101/2;
- GPNN-1,2, into which process water and excess water are discharged from building No. 150 and surface wastewater is collected at the INPP industrial site;
- GPNN-3, into which process water is discharged from buildings No 120/1,2 and drainage water from reactor unit buildings Nos 101/1 and 101/2;
- GPNN-PBKS, into which the surface wastewater collected at the ISFSF-1 site enters.

In the releases during the INPP decommissioning, increased volumetric activities of radionuclides H-3, Co-60, Cs-134 and Cs-137 are measured (compared to those measured in the water of Lake Druksiai, see Table 4.1-2). The volumetric activities of other radionuclides, which are theoretically possible according to individual nuclide vectors, are not measured or are lower than the minimum detectable limits. Annual releases of individual radionuclides into Lake Drūkšiai in 2010-2024 are shown in Figure 4.1-7.

H-3 releases account for about 1E+10 - 1E+11 Bq/year. Almost all H-3 (about 98% of the total emitted activity) is released through GPNN-1,2, with technological and excess water from building No. 150.

Cs-137 releases are about 1E+6 - 1E+7 Bq/year, Figure 4.1-8. At the beginning of the decommissioning, the Cs-137 was released from the reactor units with process water through the cooling water discharge channel. These releases account for about 19% of the total activity released after 2010. Releases decreased in 2016-2021, and since 2020 the Cs-137 is no longer released through the cooling water discharge channel. Cs-137 is constantly discharge from building No. 150 (via GPNN-1,2) with technological (38% of total discharged activity) and excess (19% of total released activity) waters. Cs-137 is also released from reactor block buildings No. 101/1,2 (via GPNN-3) with technological (6% of total released activity) and drainage (19% of total released activity) waters. Cs-137 releases through the GPNN-PBKS are not significant.

Co-60 releases account for about 1E+6 - 1E+7 Bq/ year, Figure 4.1-9. Co-60 is released from building No. 150 (via GPNN-1,2) with technological (23% of total released activity) and excess (44% of total released activity) waters. Co-60 is also released from reactor block buildings No. 101/1.2 (via GPNN-3) with drainage water (33% of the total released activity). Co-60 releases through GPNN-3 with process water and through GPNN-PBKS are not significant.

Cs-134 was released episodically from reactor block buildings No. 101/1,2 via GPNN-3 with excess water in 2011 and with technological and surplus water in 2015.

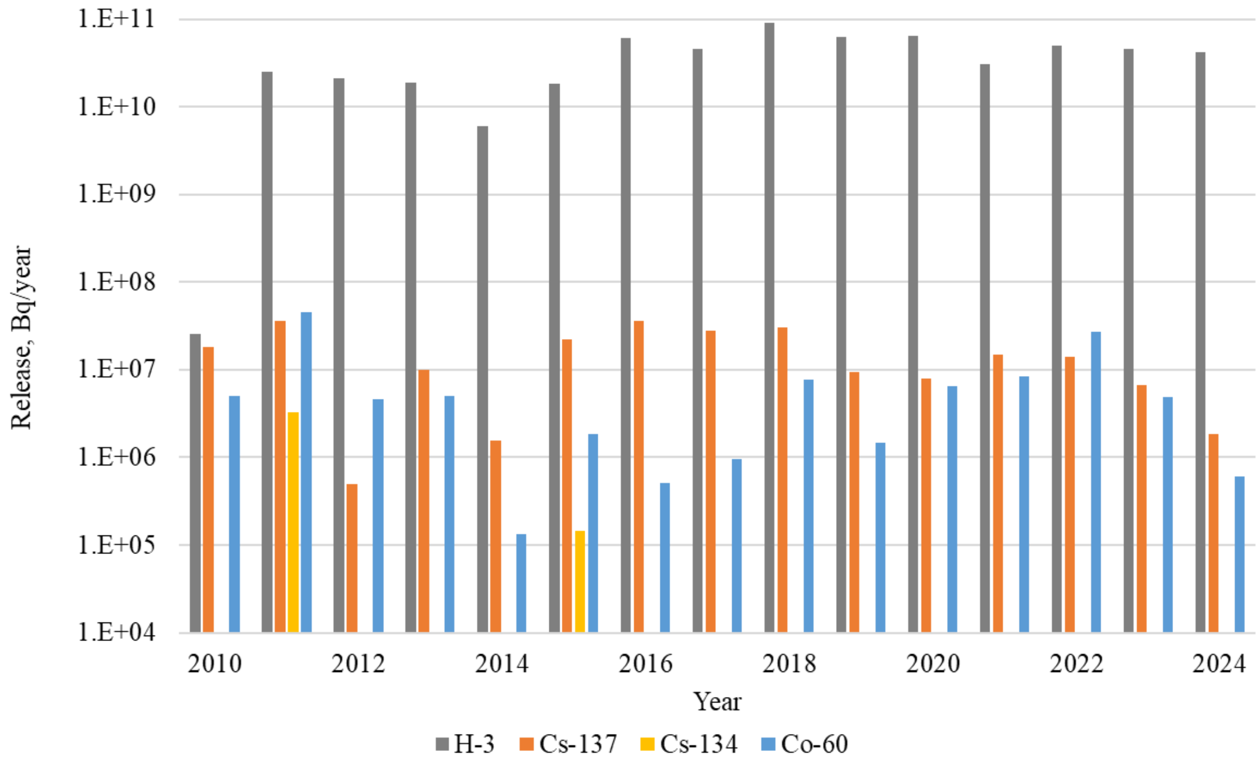

Figure 4.1-7. Annual releases of individual radionuclides with wastewater from the INPP to Lake Drūkšiai

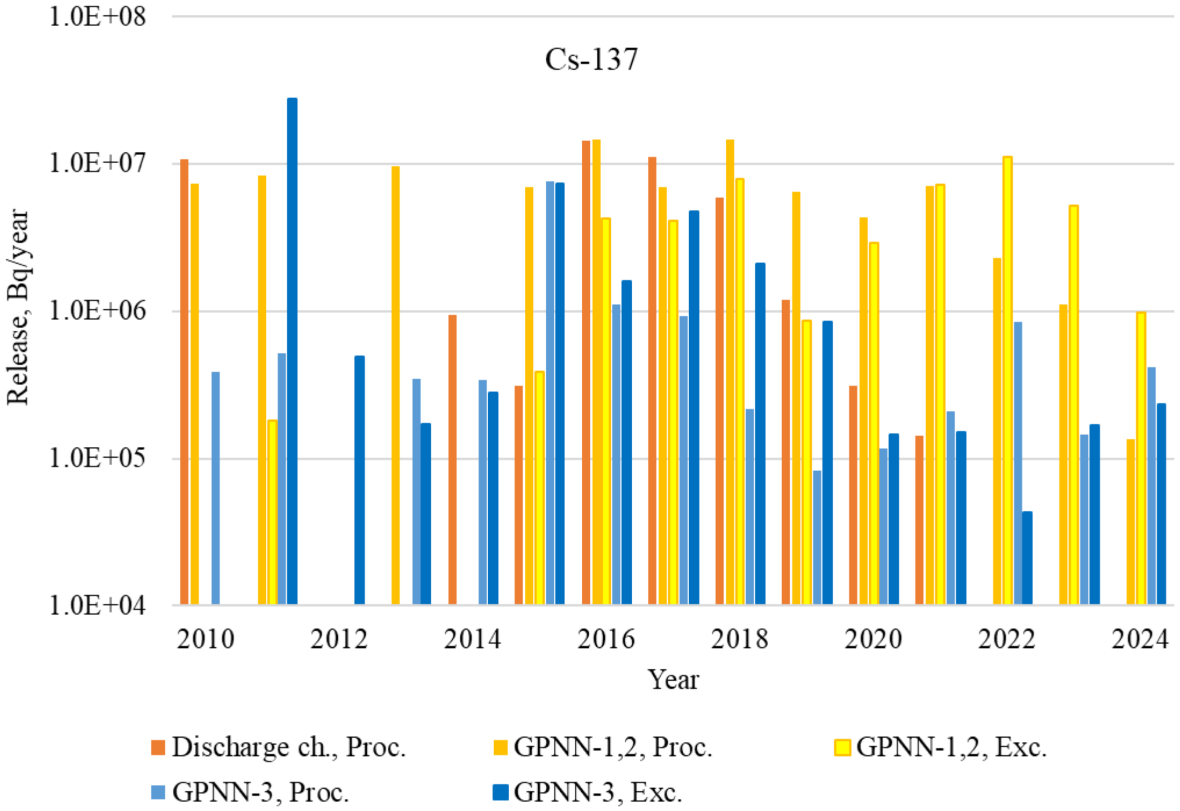

Figure 4.1-8. Cs-137 annual releases with technological and excess wastewater through separate channels from the INPP to Lake Drūkšiai

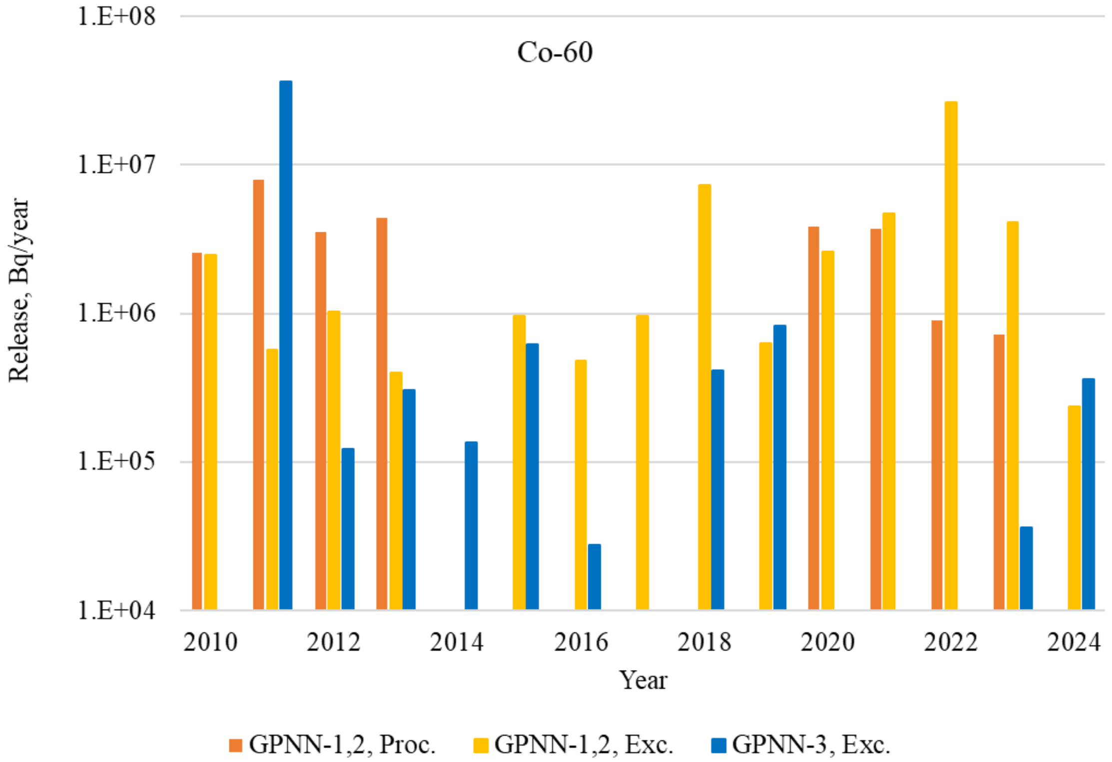

Figure 4.1-9. Co-60 annual releases with technological and excess wastewater through separate channels from the INPP to Lake Drūkšiai

During the 2010-2024 decommissioning period, the largest part of the activity released from the INPP into the ambient waters consisted of radionuclide releases from building No. 150 via GPNN-1,2, i.e. it accounted for about 98% of the total H-3, 67% of Co-60 and 56% of the total Cs-137 released activity. Releases into ambient waters are to a greater extent related to the treatment of LRW in building No. 150, including both the LWR accumulated during the operation of the INPP and the LRW generated during the decommissioning and collected from all INPP structures and technologies in which the LRW is generated.

Releases from reactor block buildings No. 101/1.2 through GPNN-3 accounted for about 33% of Co-60 and 25% of Cs-137's total released activity. Most of the Cs-137 and Co-60 from the reactor units are released with drainage water. Released with process water are lower and decreasing. The volumetric activities of radionuclides in the water collected by the drainage systems of buildings released directly into Lake Drūkšiai are not high. In case of increased activity, such water is not released into the environment but is transferred for treatment to building No. 150 as LRW.

Radionuclide releases from the INPP into the ambient waters are controlled and limited according to the established limit releases in such a way that the annual effective dose constrain to the resident due to the releases of radionuclides into the ambient waters does not exceed 0.1 mSv.

There are also restrictions on uneven increases in pollution: radionuclide releases in a single month must not exceed 25% of the established annual release limits and radionuclide releases in a single day must not exceed 1% of the established annual release limits [66]. In cases where several radionuclides are released into ambient waters from several sources, the following condition must be met [66]:

$$\sum_i \sum_j \frac{Q_{ij}}{A_j} \leq 1$$

here:

Q_i – j radionuclide released from i source into ambient waters, Bq/year;

A_j - threshold activity of j radionuclide, Bq/year.

The release limit values shall be determined in the permits for the release of radionuclides into the environment [67], [68] and in the plans for the release of radionuclides from the INPP into the environment which subsequently replaced them [69], [70], [71]. Plans shall be prepared and coordinated with the responsible authorities in accordance with nuclear safety requirements [66]. The limit annual releases to ambient waters applied during the decommissioning of the INPP have been summarized in Table 4.1-5. Since 2020, the minimum release limit values have been set and this is related to the INPP's updated methodology for calculating the radiation doses of the population [71], which is based on simpler and, consequently, much more conservative models of radionuclide dispersion and the parameters used in them [72].

Table 4.1-5. Annual release limits to ambient waters apply during the decommissioning of INPP

Radionuclide	**Release limits for individual periods, Bq/year**			
	2010-2012	**2013-2014**	**2015-2019**	**from 2020**
H-3	8.79E+14	8.86E+14	1.71E+14	1.50E+13
Mn-54	1.43E+11	1.46E+11	1.83E+10	1.15E+08
Co-60	5.67E+09	7.75E+09	5.00E+09	4.64E+08
Sr-90	7.89E+08	8.42E+08	8.42E+08	1.73E+07
Cs-134	2.69E+09	2.70E+09	2.70E+08	1.21E+06
Cs-137	8.38E+09	8.75E+09	3.33E+10	3.00E+09
Total alpha	-	-	-	8.00E+05

The comparison of releases in 2010–2024 with the limit releases is shown in Figure 4.1-10. As can be seen, annual radioactive releases to environmental waters do not exceed 1% - 10% of the established limit releases, i.e. annual releases do not exceed the permissible daily limit releases. In 2012, 2014 and 2019, releases were less than 1% of the established limit releases. Such releases can be assessed as small and in accordance with the ALARA principle. The increase in releases seen since 2020 is not related to physically larger releases (see Figure 4.1-7, Figure 4.1-8, Figure 4.1-9), but to a changed methodology for assessing population exposure. This methodology can be updated by replacing conservative dose assessment models with more realistic radionuclide dispersion models that more broadly assess the specifics of Lake Drūkšiai [73].

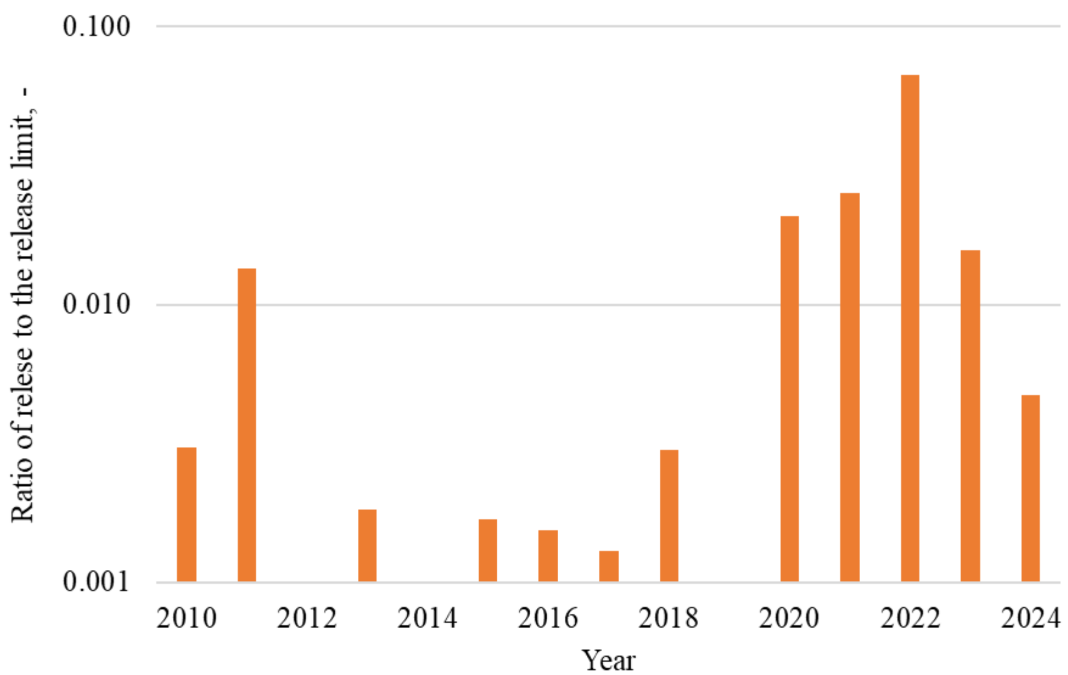

Figure 4.1-10. Comparison of releases from INPP to ambient waters with established release limits

4.1.3 Potential impact

Under normal operating conditions of the INPP, no uncontrolled discharges of wastewater into the environment are foreseen.

The generation of domestic and industrial wastewater in the INPP during the decommissioning activities in 2010-2024 has been steadily decreasing. This is associated with both the decrease in INPP personnel and the decrease in technological processes, the execution of which requires water. A significant increase in wastewater is not expected in the future compared to the past. Technological wastewater from building No. 150 will be reduced after the introduction of new LRW management technologies and the closure of the steam boiler plant, see Section 3.2.3. Accordingly, the planned demand for surface water and artesian water is decreasing, see Section 2.4.

During the preparation of technological demolition or construction projects, design solutions were envisaged and implemented, ensuring the prevention of uncontrolled formation of wastewater, as well as the prevention of leakage of aquatic media contaminated with petroleum products and other pollutants into the environment. Surface wastewater, before entering Lake Drūkšiai, passes through mechanical traps of oil products, see Table 4.1-4.

Assessing the results of environmental water monitoring, the decommissioning activities of the INPP did not have a significant negative impact on the environmental waters (Lake Drūkšiai).

The release of radionuclides into ambient waters is not significant and is significantly lower than the established limit releases to ambient waters. The wastewater generated during the decommissioning process is collected and treated, and wastewater treated from radioactive contamination is discharged into the environment. The formation of higher activity LRW, which could not be processed by existing or newly planned LRW processing facilities, is not foreseen, including in the planning of the dismantling of reactor R3 zones. The INPP is conservative about the possible impact of radioactive releases on the exposure of the population. A more realistic impact assessment would, if necessary, justify higher marginal discharges into ambient waters.

4.1.4 Mitigation measures

The demolition projects (in the case of special buildings) or demolition descriptions prepared for the demolition of buildings must include measures to minimize the potential impact of the planned works on the environment. Storage sites for the resulting demolition waste must be selected and installed in such a way as to prevent contamination of groundwater and surface water.

The low releases of radionuclides into the environment ensured by LRW treatment technologies must be maintained.

4.2 Ambient air

4.2.1 Current state

4.2.1.1 Meteorological and climatic conditions

Climate of Lithuania is characterized as climate of moderate climatic zone. Since maritime and continent air masses changes occur often, the climate of the region is intermediate – between West European maritime climate and Eurasian continental climate.

On a regional scale, climatic conditions in Lithuania depend on the distance from the Baltic Sea. Due to airflow invasion from neighbouring geographic zones, eastern regions of Lithuania (i.e. INPP region), in comparison to western parts, are characterized by greater annual temperature range, colder and longer winters with a greater snowfall and warmer but shorter summers.

Meteorological parameters at the INPP have been measured since 1987. The INPP meteorological station is located about 6 km west of the INPP site.

In the INPP region, the average annual air temperature can change quite sharply, see Figure 4.2-1. As in the whole of Lithuania, the coolest year in the INPP region was 1996, when the average annual air temperature was only 5 °C. The warmest year (due to the relatively warm winter) was in 1991, when the average annual air temperature rose to 9 °C. In the last 25 years (2000-2024), the fluctuations in the average annual air temperature are smaller, but there is a general trend of increase in the average annual air temperature. The increase in the average annual air temperature is observed throughout Lithuania [74].

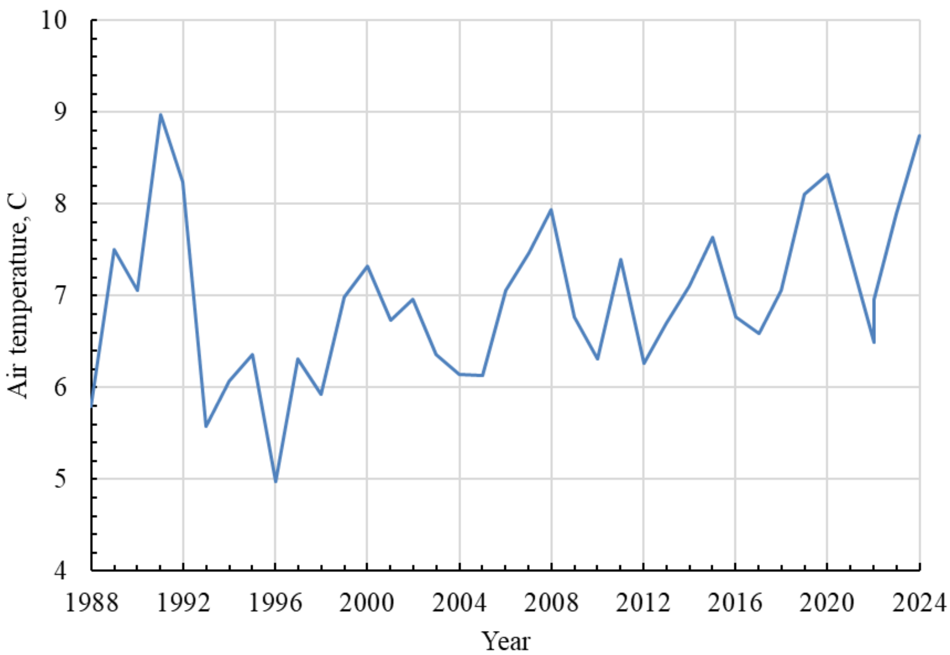

Figure 4.2-1. Change of average annual air temperature in the INPP region in 1988-2024 (measurements of the INPP meteorological station)

The average, average minimum and average maximum air temperatures of individual months in the INPP region during the period 1998-2024 are shown in the Figure 4.2-2. The coldest months are December, January and February. The lowest average monthly air temperature of -11.9 °C is in January 2010. The warmest months are June, July and August. The maximum average monthly air temperature of +23 °C is in July 1992.

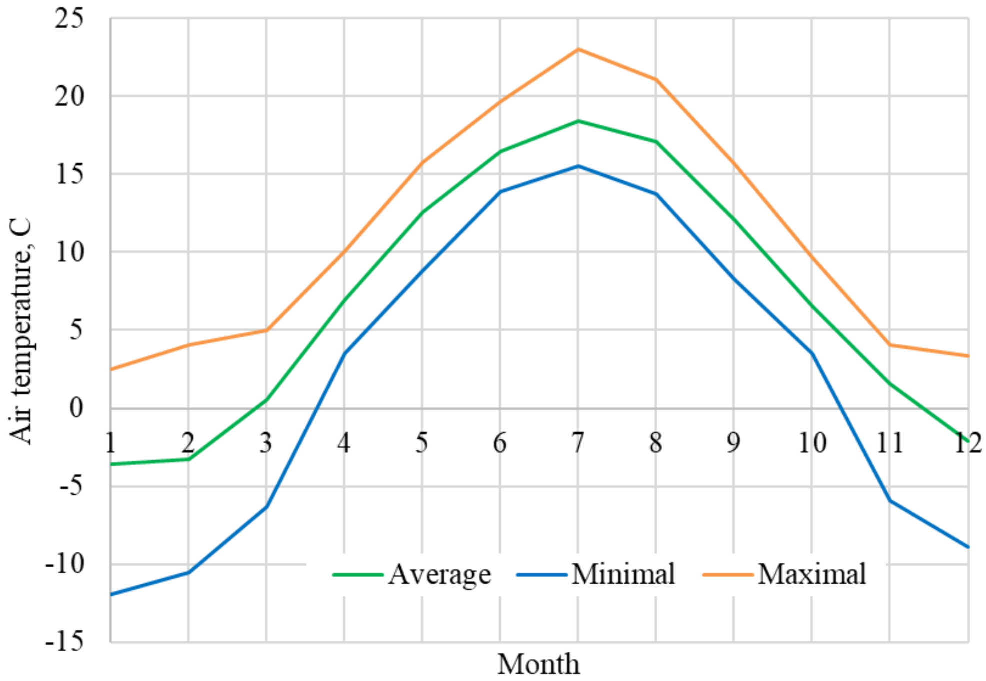

Figure 4.2-2. Average, average minimum and average maximum air temperatures of individual months in the INAE region for the period 1998-2024 (measurements of the INPP meteorological station)

During the entire observation period of 1972-2023, the maximum air temperature measured at the Dūkštas Meteorological Station (18 km southwest of the INPP site) is 34.9 ºC, while the minimum air temperature is -33.3 ºC. [74].

The average annual rainfall in the INPP region in 1988-2024 is shown in Figure 4.2-3. In the period 1998-2009, the average drop was 668 mm/year. In the period 2010-2024, the average rainfall was 754 mm/year, i.e. the annual rainfall increased by an average of 86 mm/year. Also, in 2010, 2017 and 2023, precipitation fell by more than 900 mm/year. About 65% of precipitation falls in the warm period of the year (April-October), the remaining 35% falls in the cold period of the year (November-March). The maximum monthly rainfall is 228 mm/month. dropped in July 2010.

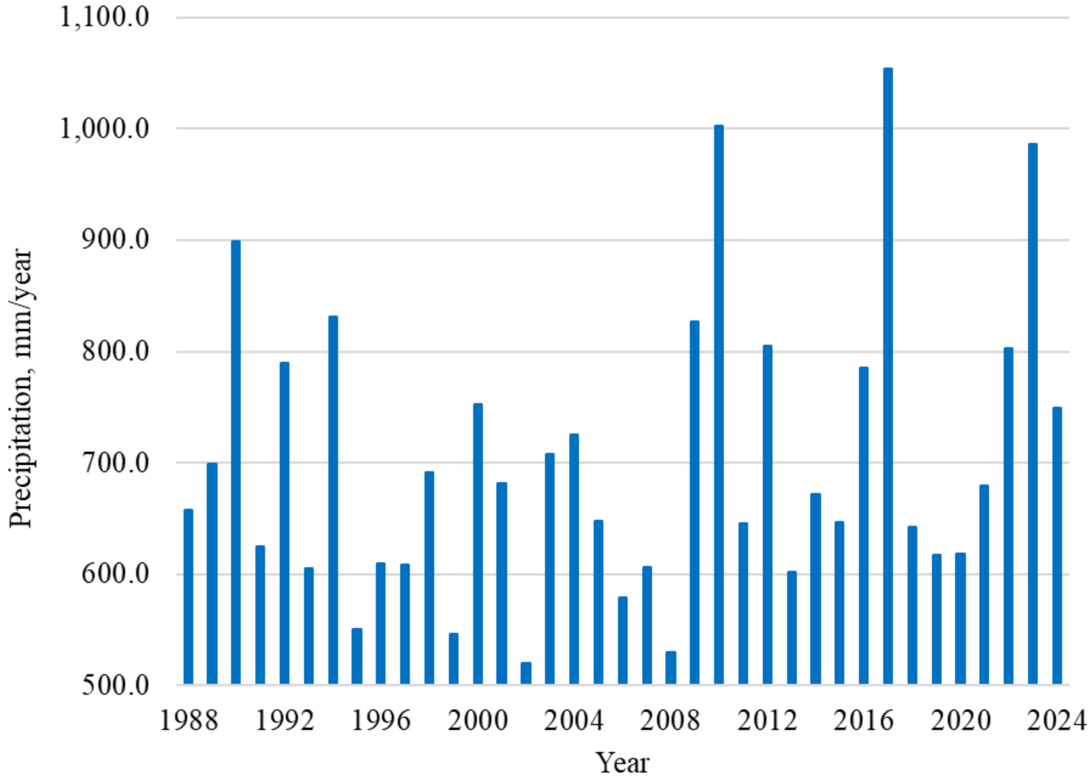

Figure 4.2-3. Annual rainfall in the INPP region in 1988-2024 (measurements of the INPP meteorological station)

The average number of days with snow cover per year in Lithuania ranges from less than 50 at the seaside to 90 in Eastern and Eastern Lithuania. The lowest number of days with snow cover was recorded in the winter of 2019-2020, when in part of Lithuania not a single day with snow cover was registered, while at the Dūkštas meteorological station there were only 10 days with snow cover. The largest number of days with snow cover in Lithuania was recorded in the winter of 1995-1996 in Dūkštas and amounts to 156 days. The average number of days with snow cover at the Dūkštas meteorological station is 91 days [74].

In the period 2012-2024, the average monthly wind speed measured at the INPP monitoring station is 3.4 m/s. More than 80% of the measured average monthly wind speed values vary from 2.9 m/s to 4.1 m/s. The rose of the average monthly wind directions for the period 2102-2022 is shown in Figure 4.2-4. Western, southwesterly and southerly winds prevail.

The maximum values of wind speed (gusts) measured are about 10 times higher and can reach from 23 m/s (August 2012 and 2013) to 36 m/s (October 2012) in individual months.

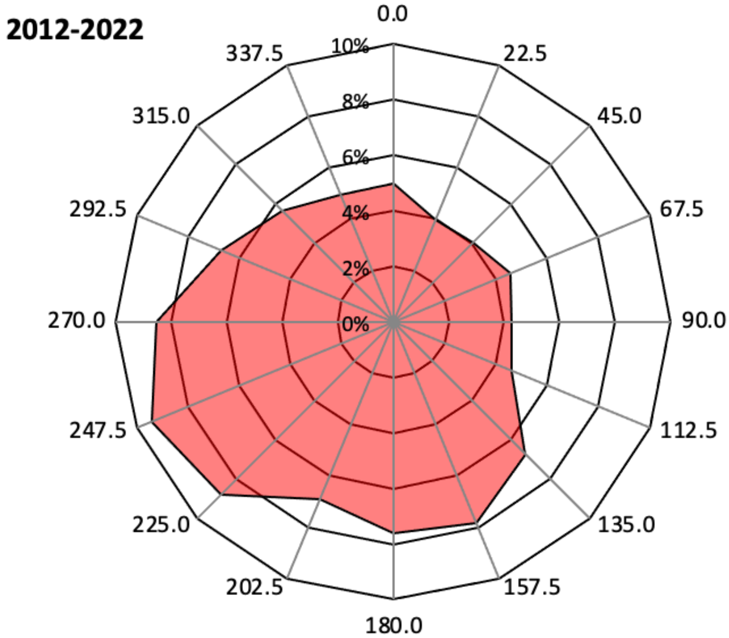

Figure 4.2-4. Wind directions prevailing in the INPP region in 2012-2022 (data of the INPP meteorological station)

4.2.1.2 Air quality

In terms of background pollution, the INPP site and the territory around it are assessed as a relatively clean rural area of the Utena region of Lithuania, for which the characteristic values of the average annual concentrations of the most important air pollutants are provided in Table 4.2-1. The data in the table summarize the average annual values of individual years for the period 2011-2020. The average annual values of ambient air pollutants for individual regions and cities of Lithuania are determined according to continuous measurements carried out by state monitoring at Lithuanian air quality testing stations.

Table 4.2-1. Values of the average annual concentrations of ambient air pollutants in the relatively clean rural areas of the Utena region of Lithuania, μg/m^3

Polluting substance	**Average annual value for the period 2011-2020**
Particulate matter, PM_{10}	10.8
Particulate matter, $PM_{2,5}$	8.0
Nitrogen dioxide, NO_2	4.0
Nitrogen oxides, NO_X	6.0
Sulfur dioxide	1.6

Monitoring of the impact on ambient air quality is not carried out at the INPP site, as the technological processes carried out by the INPP and the pollutant emissions caused by them do not exceed the requirements of the Environmental Monitoring Regulations of Economic Entities [65] requirements set out when such monitoring is to be carried out: during the activity, the hazard indicator of one of the pollutants emitted into ambient air is greater than 104 and the concentration of that pollutant, calculated by modelling without background ambient air pollution, exceeds the limit value for ambient air pollution for the protection of human health for the minimum average period. However, when the hazard indicator for emissions into ambient air is higher than 10, the emissions of such pollutants must be controlled, i.e. the sources of pollution are monitored.

The hazard indicator (TPR) of the pollutant is calculated as follows [65]:

$$TPR = \left(\frac{M_m}{DLK_p}\right)^a$$

Here:

M_m – total emissions from all sources, t/year;

DLK_p – maximum daily permissible concentration of pollutants in the air of residential environments, mg/m^3;

a – the fixed amount depends on the group of pollutants emitted into the ambient air specified in the Resolution of the Government of the Republic of Lithuania [75] Chapter II. The constant value 'a' of group I pollutant is equal to 1.7, II – 1.3, III – 1.0, IV – 0.9, and oxides of nitrogen (as nitrogen dioxide) – 1.3, sulphur dioxide – 1.0, dust (particulates) – 0.9, vanadium pentoxide – 1.7.

Ambient air pollution limit values in accordance with the requirements [76], [77] summarized in Table 4.2-2. Pollution limit values are set for the protection of human health, critical levels of contamination are set for the protection of vegetation.

Table 4.2-2. Ambient air pollution norms, μg/m^3

Pollutant	**Averaging period**	**Limit**	**Critical contamination level**
Sulfur dioxide	1 hour	350 μg/m^3 must not be exceeded more than 24 times in a calendar year	-
	1 day	125 μg/m^3 must not be exceeded more than 3 times in a calendar year	-
	Calendar year and winter (1 October – 31 March)	-	20 μg/m^3
Nitrogen dioxide and oxides of nitrogen	1 hour	200 μg/m^3 may not be exceeded more than 18 times in a calendar year	-
	Calendar year	-	30 μg/m^3
Carbon monoxide	Maximum daily average of 8 hours	10 000 μg/m3	-

Particulate matter PM_{10}	1 day	50 µg/m3 must not be exceeded more than 35 times in a calendar year	-
	Calendar year	40 µg/m^3	-
Particulate matter $PM_{2,5}$	Calendar year	25 µg/m^3	-
Vanadium (V) oxide	1 day	1 µg/m^3	-

According to the INPP environmental air impact assessments [78] pollutants with a TPR > 10 include carbon monoxide, nitrogen oxides, particulate matter and, if fuel oil is burned as a reserve fuel, also produce higher emissions of sulphur dioxide and vanadium pentoxide.

Results of ambient air pollution modelling [78], [79], [80] shows that the estimated (including background pollution) maximum concentrations of carbon monoxide in the period 2010-2020 amount to about 3% of the limit value, concentrations of nitrogen oxides account for about 16% of the average annual and about 30% of the hourly limit value, particulate matter concentrations account for about 30%-40% of the daily and average annual limit values. If alternative fuels were burned, the estimated maximum concentrations of sulphur dioxide would be around 15% of the limit values and that of vanadium pentoxide would be around 7% of the limit value. None of the concentrations of pollutants emitted by the INPP into the ambient air outside the boundaries of the INPP site exceed the established environmental pollution norms. The results of the dispersion modelling are to be assessed as conservative – they usually do not take into account the change in pollution emissions and the calculation assumes that emissions from pollution sources are constant and maximum.

4.2.1.3 Radioactive contamination

The concentration of radionuclides in the ambient air in the observation zone of the INPP site and in the sanitary protection zone of a radius of 3 km is shown in Figure 4.2-5. Small concentrations of Cs-137, Co-60, Sr-90 are measured, which do not differ substantially from those measured in other areas of Lithuania (Utena Meteorological Station) during state radiological monitoring.

Due to air transport from Japan after the accident at the Fukushima nuclear power plant throughout Lithuania in March-May 2011, higher than usual volumetric activities of Cs-137 were measured, as well as other uncharacteristic radionuclides (Cs-134 and I-131) were detected in aerosol samples.

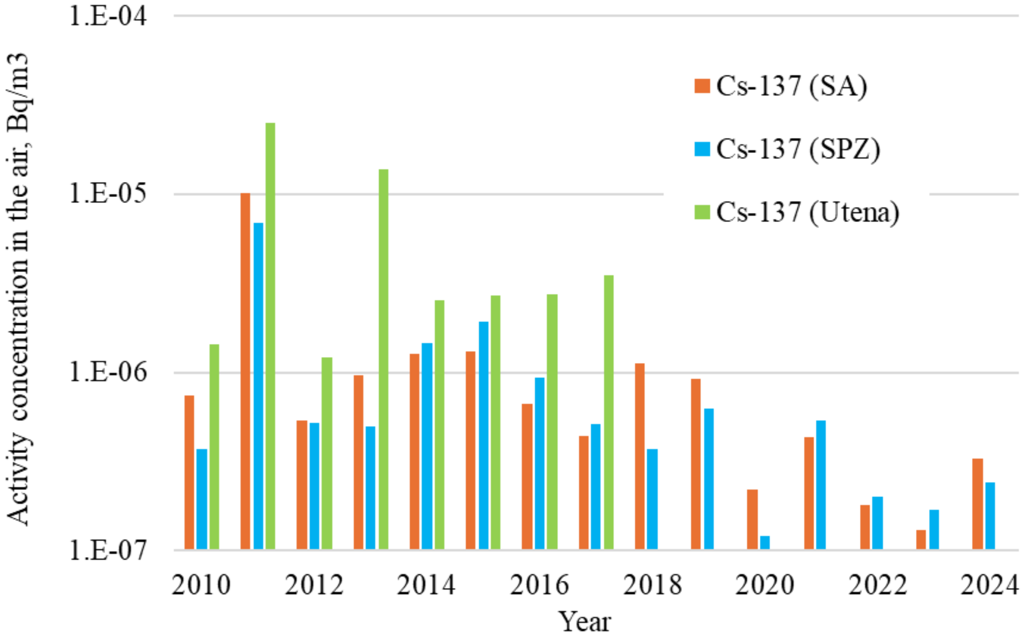

Figure 4.2-5. Volumetric activity of radionuclide Cs-137 in ambient air in the INPP monitoring zone (SA), sanitary protection zone (SPZ) and Utena meteorological station (state environmental monitoring)

The concentration of radionuclides in precipitation in the monitoring zone of the INPP site and in the sanitary protection zone of a radius of 3 km is shown in Figure 4.2-6. In precipitation, small concentrations of Cs-137, Co-60 are usually measured.

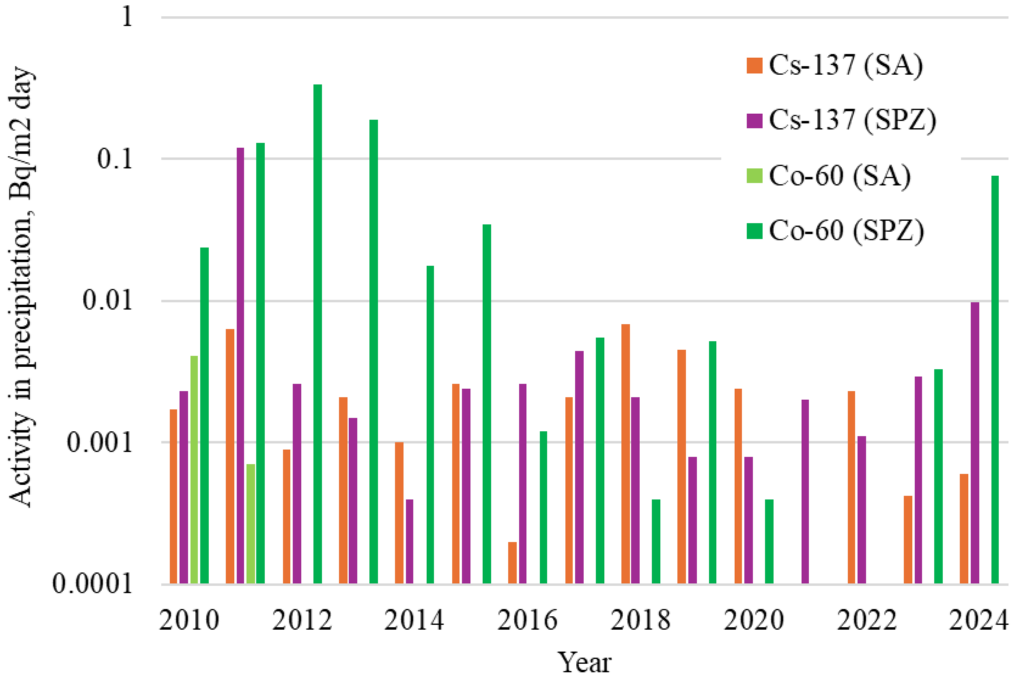

Figure 4.2-6. Radionuclide activity in precipitation of the INPP monitoring zone (SA) and the sanitary protection zone (SPZ)

4.2.2 Planned pollution

4.2.2.1 Sources of pollution

INPP non-radioactive pollutants are emitted into the ambient air from more than 70 different stationary sources of pollution (chimneys, vents, breathers, filters). The number of sources of pollution in the INPP is not constant and changes in the course of decommissioning as the activities carried out change. INPP stationary sources of air pollution can be grouped into the following facilities and activities:

- Steam boiler station. The steam produced in the steam boiler plant is supplied to the LRW treatment facility (building No. 150), where it is used as a heat source for the technological equipment (evaporation, bitumenization). The steam boiler plant is equipped with three 11.2 MW steam boilers produced by the LOOS company in 2004. The total capacity of the steam boiler plant is 33.6 MW. The main fuel of the boiler station is natural gas, the reserve fuel is diesel. Diesel fuel is stored in two 500 m^3 tanks at the INPP site;
- Backup power supply. After the final shutdown of the second reactor, 6 diesel generators with an electrical capacity of 5600 kW were kept in operation at the INPP reserve power station (building No. 111). The generators were periodically tested. Diesel fuel is stored in six 100 m^3 underground tanks at the INPP site (currently, diesel generators are disconnected from the power supply system and dismantled, see Section 4.2.3.1);
- INPP post-operation maintenance. The activity includes such maintenance and repair works of equipment and systems as drilling, milling, sharpening, cutting, grinding, etc. using metalworking tools and machine tools, welding machines, etc., located in various INPP buildings;
- Production of metal structures. Metal drums are used in the handling and final processing of SRW. Drums are made of metal sheets by pressing and welding them. The produced drums are cleaned with metal shots, primed, painted and dried. The equipment for the production of the buildings is located in building No. 130/1, which is located in the observation zone of the INPP site;
- INPP dismantling and initial treatment (shredding, decontamination) works. Dismantling and shredding work is carried out using both mechanical and thermal cutting equipment. For decontamination, water, chemicals, various mechanical devices are used (cleaning with shots, processing with lathes, grinders, etc.);

- SRW incinerator. The plant burns combustable short-lived solid and liquid (oils, lubricants) waste. The incinerator is installed in the SWTF, the industrial operation of the incinerator has been carried out since 2022;
- Other INPP operation and decommissioning activities. These include storage of diesel fuel used in other activities, periodic testing of backup power supply generators located in ISFSF-2 and building No. 185, storage of bitumen (in building No. 161), washing of personnel clothing in a special laundry (in building No. 156) and other activities.

The most important pollutants emitted into the environment by burning natural gas, diesel fuel, flammable radioactive waste, mechanical and thermal treatment of metals are carbon monoxide, nitrogen oxides, particulate matter and sulfur dioxide. A small emission of metal compounds (iron and its oxides, manganese oxides) is possible. Volatile organic compounds are released from diesel fuel and bitumen storage tanks. During the storage and use (in the manufacture of drums, etc.) various chemicals are emitted xylene, toluene, isobutanol, butanol, emulsol, acetone, bulyl acetate, ethanol and other chemical compounds. Sodium hydroxide is emitted into the environment from a special laundry.

The conditions and permissible emissions of pollutants into ambient air are set out in the INPP Integrated Pollution Control and Prevention Permit [57] and in the subsequent emission permit which replaced it [58]. Permissible emissions established by the INPP and according to the inventory of pollution sources and pollution [79], [80] estimated current emissions to ambient air are shown in Figure 4.2-7. Between 2010 and 2024, permissible emissions into ambient air decreased from approximately 200 t/year to 30 t/year.

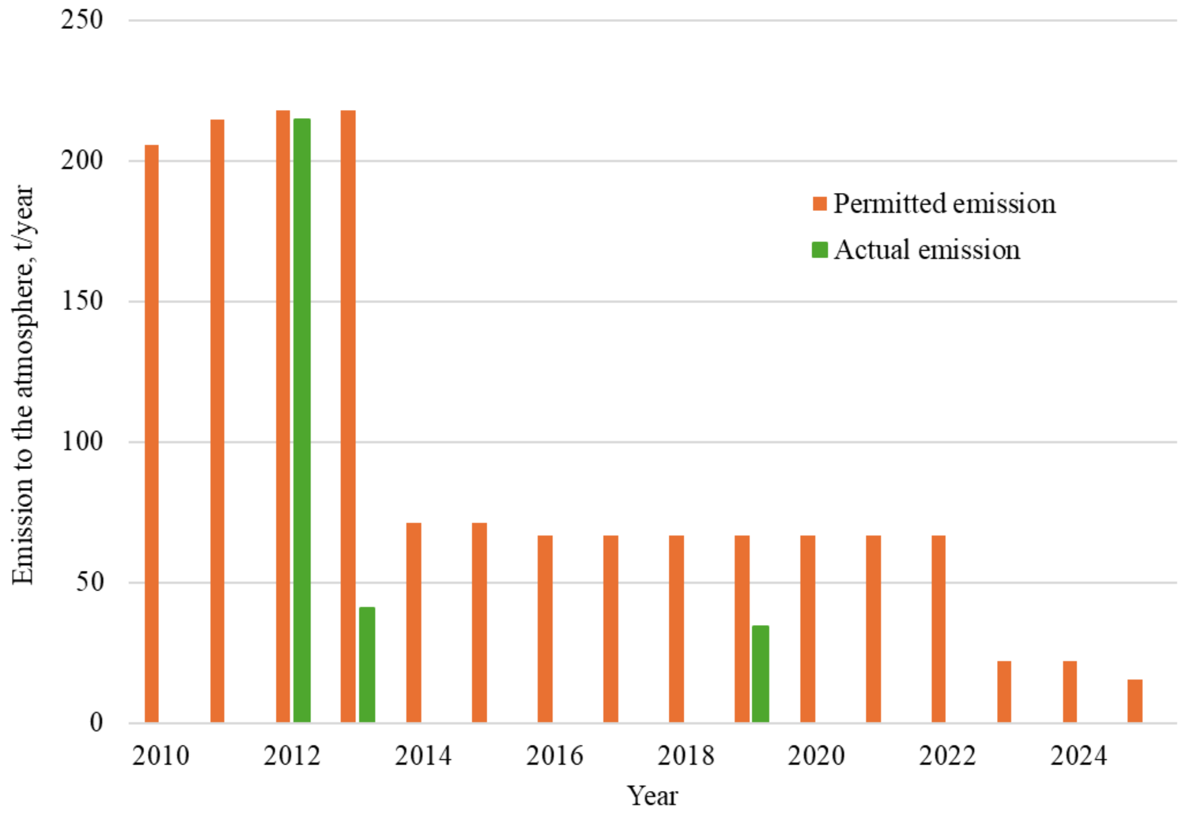

Figure 4.2-7. Permissible emissions to ambient air established by the INPP and current emissions to ambient air assessed in individual years

Ambient air pollution from stationary sources is primarily associated with the steam boiler plant. Steam boiler plant emissions account for approximately 70-90% of all pollutant emissions, Figure 4.2-8. The steam boiler plant is planned to be decommissioned after the installation of new, more energy-efficient LRW evaporation units, see Section 3.2.3. In addition to the steam boiler plant, emissions from other INPP activities have been additionally detailed in Figure 4.2-9. Emissions generated during the dismantling and initial treatment of equipment and systems dominate.

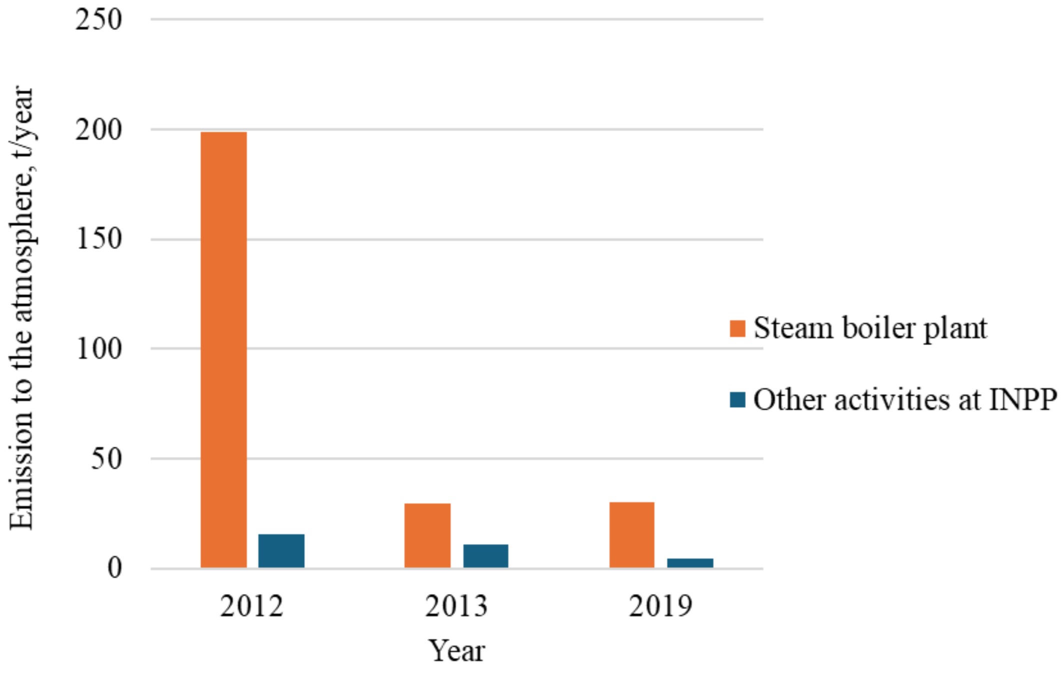

Figure 4.2-8. Pollutant emissions into the ambient air due to steam boiler plant and other activities carried out by the INPP

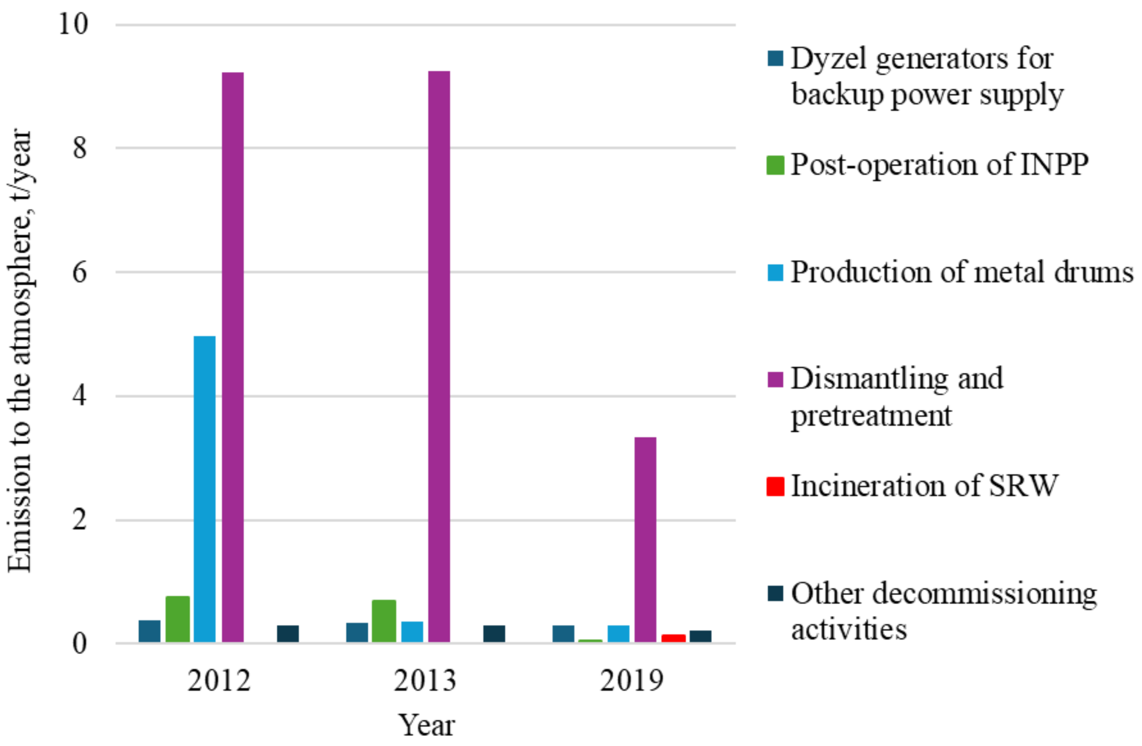

Figure 4.2-9. Emissions of pollutants into the ambient air due to other activities (in addition to steam boiler plant) carried out by the INPP

Emissions of individual pollutants into ambient air are summarized in Figure 4.2-10. Emissions from the combustion of natural gas, diesel fuels, mechanical and thermal treatment of metals predominate: carbon monoxide (CO), nitrogen oxides (NO_x), sulphur dioxide (SO_2), particulate matter (PM). The emission and dispersion of these pollutants determines the air quality at the INPP site and the compliance of the pollution with the established air pollution norms, see Section 4.2.1.2.

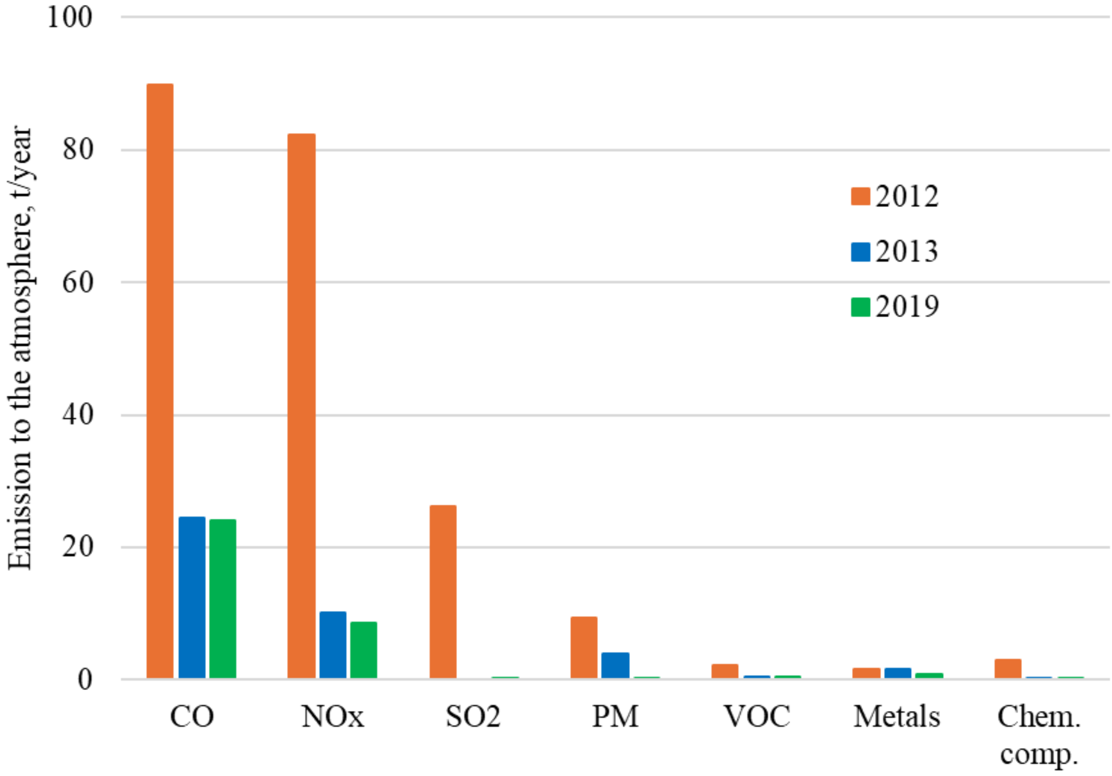

Figure 4.2-10. Pollutant emissions into ambient air from INPP

In addition to stationary sources of pollution, ambient air pollution at the INPP site and adjacent NF sites is also caused by mobile sources of pollution, i.e. vehicles transporting various materials (radioactive waste, building materials, demolition work waste), forklifts, tractors, construction machinery. Most of the mobile pollution sources used by the INPP are powered by diesel fuel. The combustion of diesel fuels releases carbon monoxide, nitrogen oxides, sulfur dioxide, hydrocarbons and particulate matter. In the period 2010-2024, the INPP used from 153 to 75 tons of diesel fuel per year. In the future, it is planned to consume diesel fuel of about 100 t/year, see Section 2.4.

During the demolition and dismantling of buildings and building structures, the recultivation of the site and other construction works, dust (particulate matter) will be generated, the dispersion of which will also affect the air quality at the INPP site.

4.2.2.2 Sources of radioactive contamination

The sources of radioactive pollution of ambient air at the INPP site are special ventilation systems operating in the buildings located in the controlled area. Releases to ambient air are carried out through ventilation chimneys and ventilation ducts. Releases to ambient air occur through:

- ventilation stacks of reactor block buildings No. 101/1 and No. 101/2 (150 m high);
- the ventilation stacks of the LRW treatment facility building No. 150 (75 m high);
- the ventilation stack of the G3 waste sections of the SRW storage building No. 157 (15 m high);
- ventilation ducts of other INPP buildings No. 117/1, 130/2, No. 156, No. 158/2, No. 159 (at a height of 11-20 m);
- the stack of the VLLW sorting module (40 m high) and the ventilation ducts of the RU-2 and RU-3 extraction modules (at a height of 15 m);
- the ventilation duct of the VLLW storage facility (at a height of 9 m).

Next to the INPP site there are two other NF sites - ISFSF-2 and SWTSF. These NF have separate special ventilation systems. After the commissioning of these facilities, radionuclides are emitted into the ambient air during the

ISFSF-2 ventilation chimney (30 m high);

SWTSF ventilation chimney (50 m high).

A new IRWSF will be built on the site of the SWTSF facility, which will have its own separate nuclear ventilation system.

During the decommissioning of the INPP, the number of sources of radioactive air pollution in the environment is not constant and changes depending on the activities carried out. During the D&PT works in building No. 117/1 and subsequently during the initial treatment of Class A waste brought from building No. 117/2, mobile filtering units were used in building No. 117/1 and releases into the ambient air were carried out through ventilation ducts installed on the roof of those buildings. After the completion of the initial treatment activities in buildings No. 117/1 and No. 119, radioactive releases from these buildings no longer take place. Buildings No. 117/1 and No. 117/2 have already been demolished. Discharges from the SRW storage facility building No. 157 took place during the G3 waste disposal in this building, until 2017. After the construction of SWRF and the removal of G3 waste from building No. 157 began in 2018, releases into the environment take place through the RU-3 ventilation duct. SWTSF has been operating and releases into the environment have been carried out since 2018.

Releases of radionuclides into ambient air from the INPP site and adjacent NF is summarized in Figure 4.2-11. Three release groups have been distinguished, the release sizes of which differ significantly: radionuclides H-3, C-14 and other radioactive aerosols (marked as IR group). Annual releases of radioactive aerosols are about 10^7 – 10^8 Bq/year, H-3 about 10^{10} Bq/year and C-14 about 10^9-10^{11} Bq/year. Radionuclide H-3 and C-14 releases from building No. 101/1 are measured only from 2023. For the period from 2010 to 2022, it was assumed that the releases from building No. 101/1 were the same (with the exception of C-14 releases in 2020) as from building No 101/2. Releases of these radionuclides from both buildings in 2023 and 2024 are in a similar order. 2020 The increase in C-14 releases from building No. 101/2 is attributed to the work carried out at that time to unload the EMS rods from the active zone of the Unit 2 reactor, as the rods contain boron carbide and graphite. Such an increase in C-14 releases from building 101/2 was not considered representative of releases from building 101/1. When both reactors are shut down, inert radioactive gas is no longer produced and is no longer released into the environment.

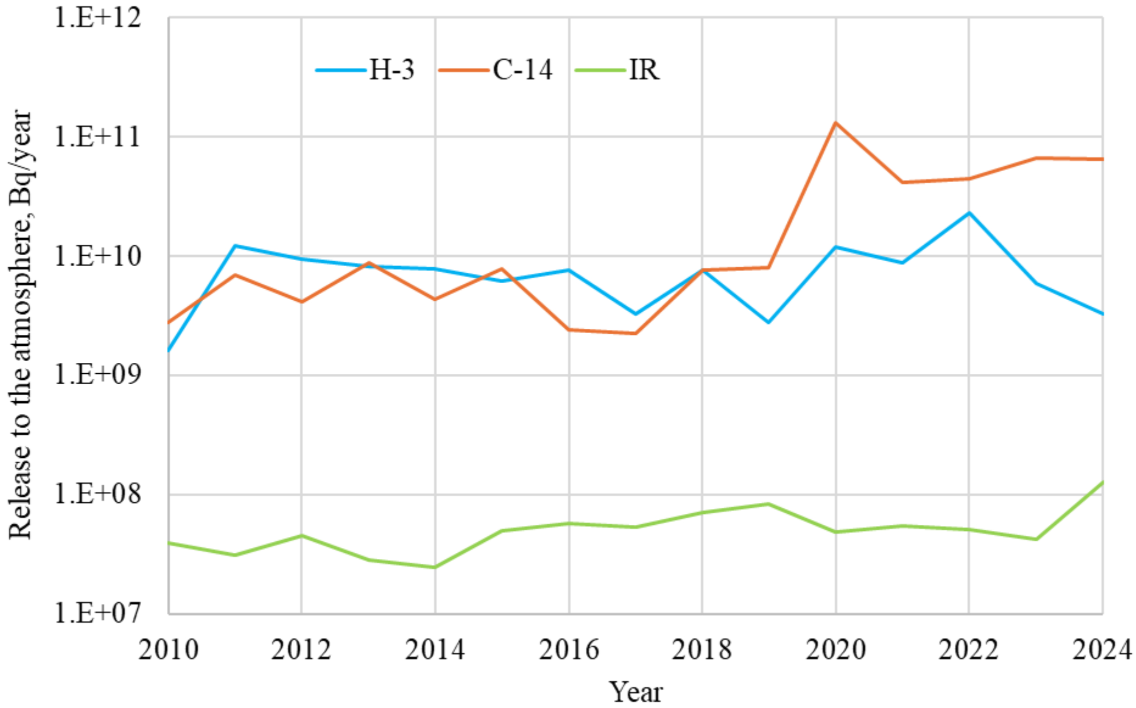

Figure 4.2-11. Radioactive releases into the ambient air from the INPP site and adjacent NF. IR – radioactive aerosols

Radioactive aerosol releases from individual INPP buildings shown in Figure 4.2-12. Releases from reactor unit buildings No. 101/1 and No. 101/2 dominate. Releases from these buildings account for about 75% of the total activity released into ambient air in 2010-2024. Another rather important source of releases is the management of G3 group waste in 157 buildings, i.e. waste disposal until 2017 and removal from 2018. Releases from this building account for about 21% of all releases. Radioactive aerosol releases from all other INPP buildings are less significant and account for about

4% of the total activity released into ambient air in 2010-2024. The radionuclides whose releases predominate in the group of radioactive aerosols are Co-60 and Cs-137.

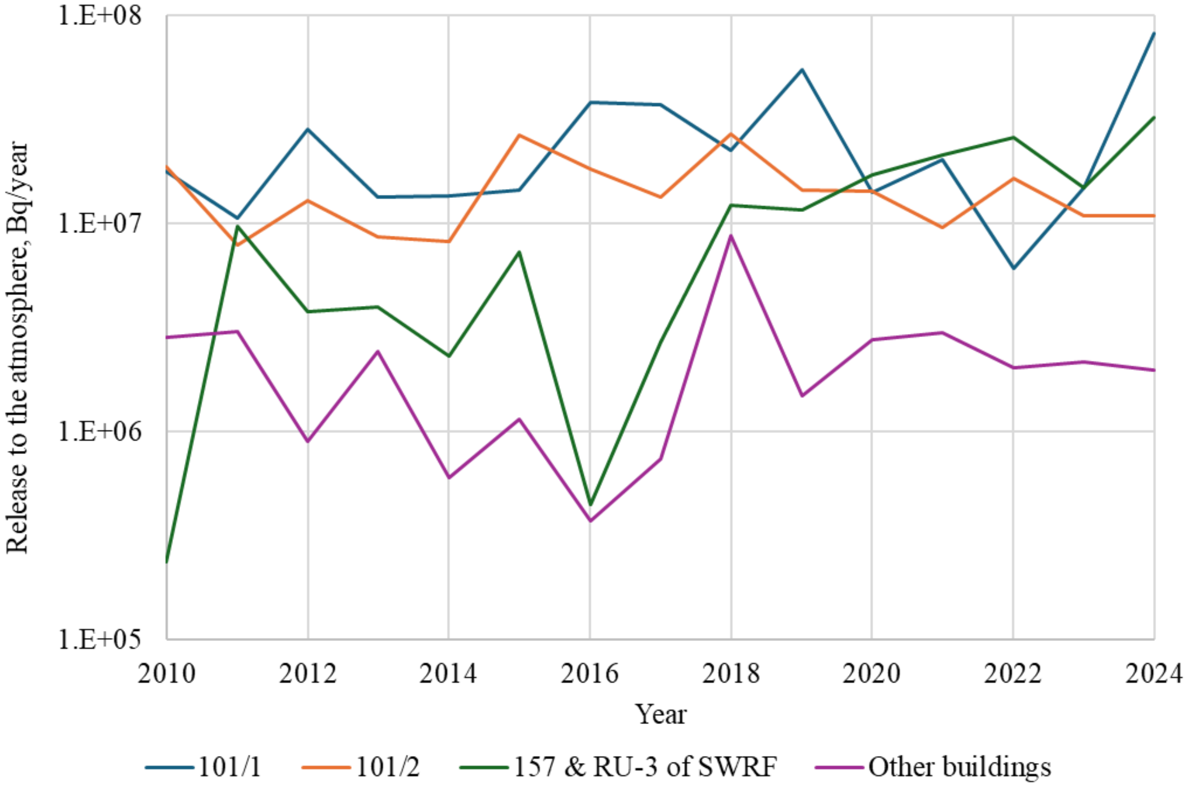

Figure 4.2-12. Releases of radioactive aerosols (IR group) into the ambient air from the INPP site and adjacent NF

Radionuclide H-3 and C-14 releases from the INPP site shown Figure 4.2-13 and Figure 4.2-14. Radionuclides H-3 and C-14 are released from reactor block buildings No. 101/1, No. 101/2, LRW treatment facility No. 150 and ISFSF-2 and SWTSF located next to the INPP. After the start of operation of SWTSF, H-3 and C-14 releases from these facilities reached a value of about $1E^{10}$ Bq/year.

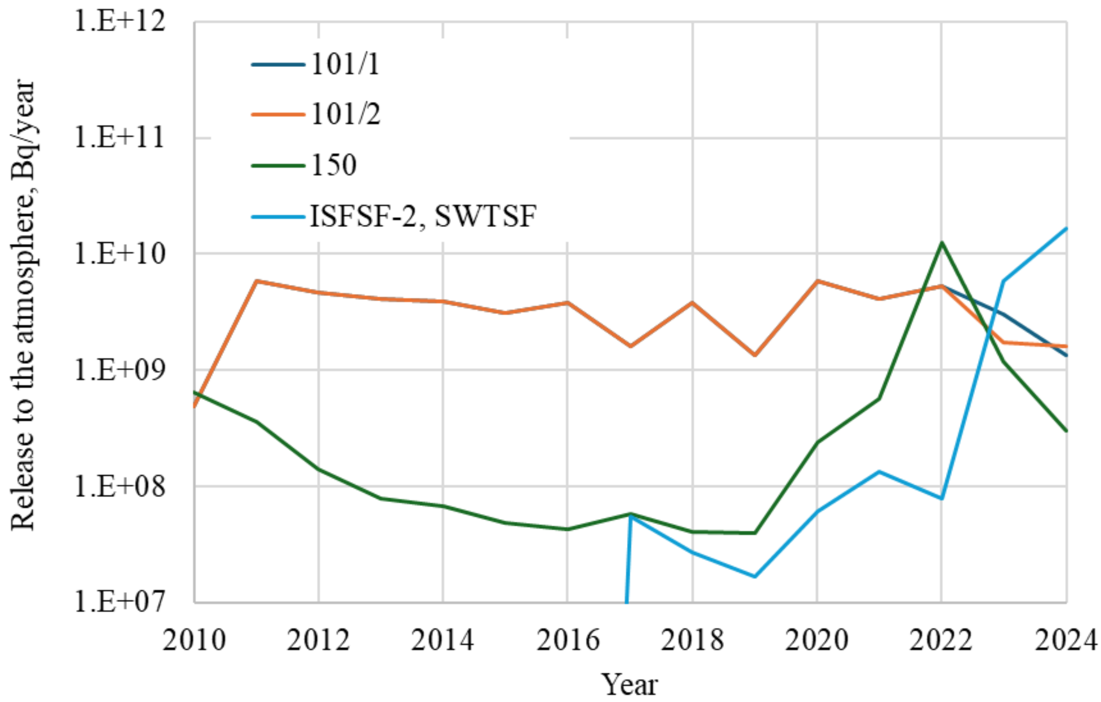

Figure 4.2-13. Radionuclide H-3 releases into the ambient air from the INPP site and adjacent NF

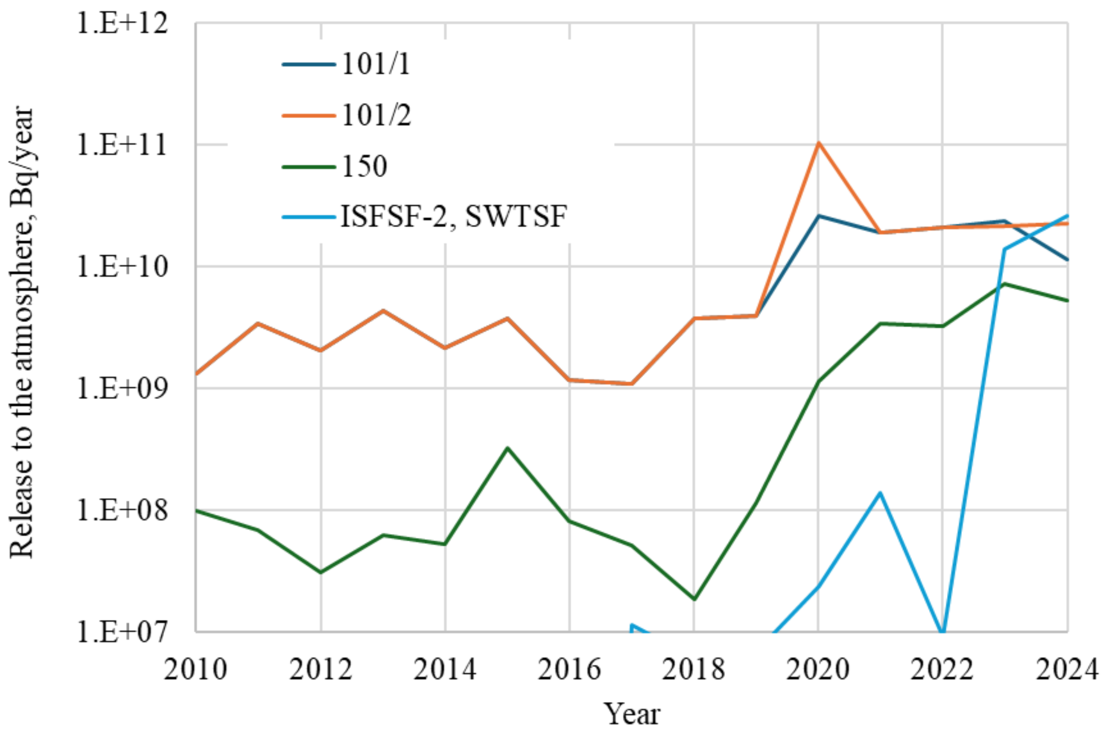

Figure 4.2-14. Radionuclide C-14 releases into ambient air from the INPP site and adjacent NF

Radionuclide releases from the INPP into the ambient air are controlled and limited according to the established limit releases in such a way that the annual effective dose constrain to the resident due to the releases of radionuclides into the ambient air does not exceed 0.1 mSv. Restrictions on uneven increases in pollution shall also apply: intra-monthly radionuclide releases shall not exceed 25% of the annual release limits and intraday radionuclide releases shall not exceed 1% of the annual release limits [66]. In cases where several radionuclides are released into ambient air from several sources, the condition [66]:

$$\sum_i \sum_j \frac{Q_{ij}}{A_j} \le 1$$

Here:

Q_i – j radionuclide released from the i source into the ambient air, Bq/year;

A_j - j radionuclide threshold activity, Bq/year.

The release limit values shall be determined in the permits for the release of radionuclides into the environment [67], [68] and in the plans for the release of radionuclides from the INPP into the environment which subsequently replaced them [69], [70], [71]. Plans shall be prepared and coordinated with the responsible authorities in accordance with nuclear safety requirements [66]. The annual limit releases to ambient air applied during the decommissioning of the INPP are summarized in Table 4.2-3. In order to simplify the control of releases into the environment, the INPP has been grouping radionuclides released into the environment since 2013, distinguishing between radionuclides H-3 and C-14 and two groups of radionuclides: radioactive aerosols (IR radionuclide group) and radioactive inert gas (IRD radionuclide group). Radionuclides evaluated in separate groups are provided in Table 4.2-4 [71]. For radionuclides combined into a group, no individual limit values are determined. For radionuclides in a group, one total limit activity is determined, which is selected taking into account the radionuclides predominant in the group release and applying a conservative (minimum) value of the limit activity of the individual radionuclide predominant in the release. In 2013-2019, the limit activity value of the IR group was applied to the limit activity calculated by Co-60, and since 2020 the limit activity calculated by Cs-137 has been applied.

Since 2020, the minimum release limit values have been set and this is related to the INPP's updated methodology for calculating the radiation doses of the population [71], which is based on simpler and, consequently, much more conservative models of radionuclide dispersion and the parameters used in them [72].

Table 4.2-3. Annual release limits to ambient air apply during INPP decommissioning

Radionuclide	**Limits in individual periods, Bq**			
	2010-2012	**2013-2014**	**2015-2019**	**Since 2020.**
H-3	1.06E+16	1.44E+16	2.22E+14	1.01E+13
C-14	4.56E+13	4.55E+13	3.41E+12	1.42E+11
Co-60	3.68E+11	-	-	-

Sr-90	2.43E+10	-	-	-
Cs-137	1.73E+11	-	-	-
IR grupė	-	9.47E+11	1.72E+12	2.90E+09

Table 4.2-4. Radionuclide groups and radionuclides assessed within them

Radionuclide group	**Radionuclides**
H-3	H-3
C-14	C-14
IR	Mn-54, Co-60, Ni-63, Ni-59, Sr-90, Nb-94, Tc-99, I-129, I-131, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Tb-158, Ho-166m, U-235, U-238, Am-241, Cm-244, Pu-238, Pu-239, Pu-240, Pu-241

A comparison of releases from 2010 to 2024 with release limits is shown in Figure 4.2-15. As can be seen, annual radioactive releases into ambient air in the period 2010-2019 accounted for 0.01% - 0.1% of the established limit for releases. Such releases can be assessed as very small and in line with the ALARA principle. As of 2020, the share of releases activity, with the addition of C-14 and H-3 releases from building No. 101/1, amounts to between 31% and 94% of the established limit for releases. Such an increase in the share of releases is not associated with physically higher releases (see Figure 4.2-11, Figure 4.2-12, Figure 4.2-13, and Figure 4.2-14), but with a change in the methodology for assessing the exposure of the population [71]. This methodology can be refined by replacing conservative dose estimation models with more realistic radionuclide dispersion models that take a broader view of the specificities of individual release sources and atmospheric dispersion [81].

In order to optimize the operation of the ventilation systems of the power units and reduce energy consumption, it may be appropriate to fully or partially dismantle the existing 150 m high ventilation stacks of the power units before preparations are made for the dismantling of the R3 zones of the reactors and to organize releases into the ambient air through lower ventilation stacks. When modifying the stacks, it is important to maintain the same effective filtration of aerosol and other radioactive particle releases, see Section 4.9.4.

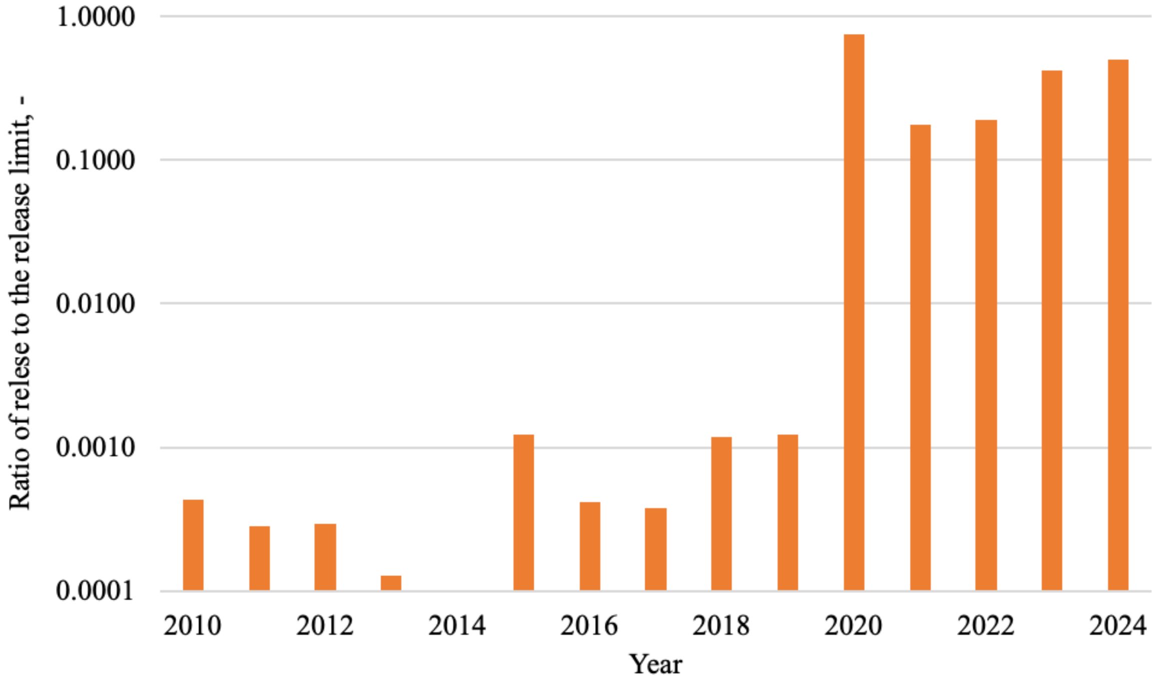

Figure 4.2-15. Comparison of releases to ambient air with marginal releases

4.2.3 Potential impact

4.2.3.1 Exposure to non-radioactive contamination

With the continuation of the decommissioning of the INPP, the number of stationary sources of air pollution currently located in the INPP will decrease. Accordingly, emissions of pollutants into the ambient air will be reduced.

It is planned to complete the operation of the most important source of pollution of the INPP, the steam boiler plant, after the installation of new, more energy-efficient LRW evaporation units, see Section 3.2.3. The new evaporation units will process the LRW under vacuum evaporation conditions, using electricity as an energy source. There will also be no need for reserve boiler fuel – permanent storage of diesel at the INPP site.

The operation of diesel generators formerly located in the INPP reserve power supply station (building No. 111) was completed in 2022. The diesel generators have been dismantled and building No. 111 currently is under demolishing. The reserve power supply diesel generators in the ISFSF-2 building (305 kW) and building No. 185 (75 kW) are periodically tested.

The amount of equipment and system maintenance work is decreasing by gradually isolating, disconnecting and dismantling equipment and systems that are no longer needed for further operation.

The production of metal structures, which started in 2008, was suspended in 2022 and is currently not carried out. If necessary, the production of structures can be resumed.

Pollutant emissions from dismantling and pre-treatment activities are shown in Figure 4.2-16.

The impact of both activities already carried out [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43] and potential emissions from future dismantling and pre-treatment activities. The higher emissions occurred at the beginning of the decommissioning and were caused by the dismantling and shredding of the equipment of the G1 unit. The design solutions of unit G1 provided that HEPA filtration of emissions would be applied to the dismantling of VLLW (Class A) materials. The pollutants generated by mechanical and thermal cutting of out-of-control (Class 0) materials were not specifically cleaned before being released into the environment, resulting in relatively high emissions of aerosols (particulate matter, iron and its compounds) into the ambient air, Figure 4.2-17. Numerical modelling of pollution dispersion showed [33] that the emissions of particulate matter do not exceed the limit concentrations, however, the emission of nitrogen compounds at the INPP site may be problematic. The CO and NOx gases produced during thermal metal cutting are not filtered out by mechanical filters and enter the ambient air directly. Calculations of underground concentrations of pollutants, together with the assessment of background concentrations of pollutants and emissions from other sources of pollution located at the INPP site, showed that the concentration of one of the pollutants, nitrogen oxides, at the INPP site for 1 hour may exceed the limit value (see Table 4.2-2) about 1.2 times. In populated areas (outside the INPP SPZ), the concentration limits will not be exceeded.

When dismantling the analogous G2 unit, mechanical cutting technologies were used more widely. Thermal cutting tools were used only in cases where mechanical cutting methods were impossible or inexpedient. Pollutant CO and NO_x emissions during the dismantling of G2 unit equipment and systems have been reduced by about 3 times, and aerosol emissions have become significantly lower due to their HEPA filtration. The design solutions of all the projects for the dismantling of equipment and systems that were subsequently prepared provided for the filtration of all emissions and this would significantly reduce the possible aerosol emissions of ice.

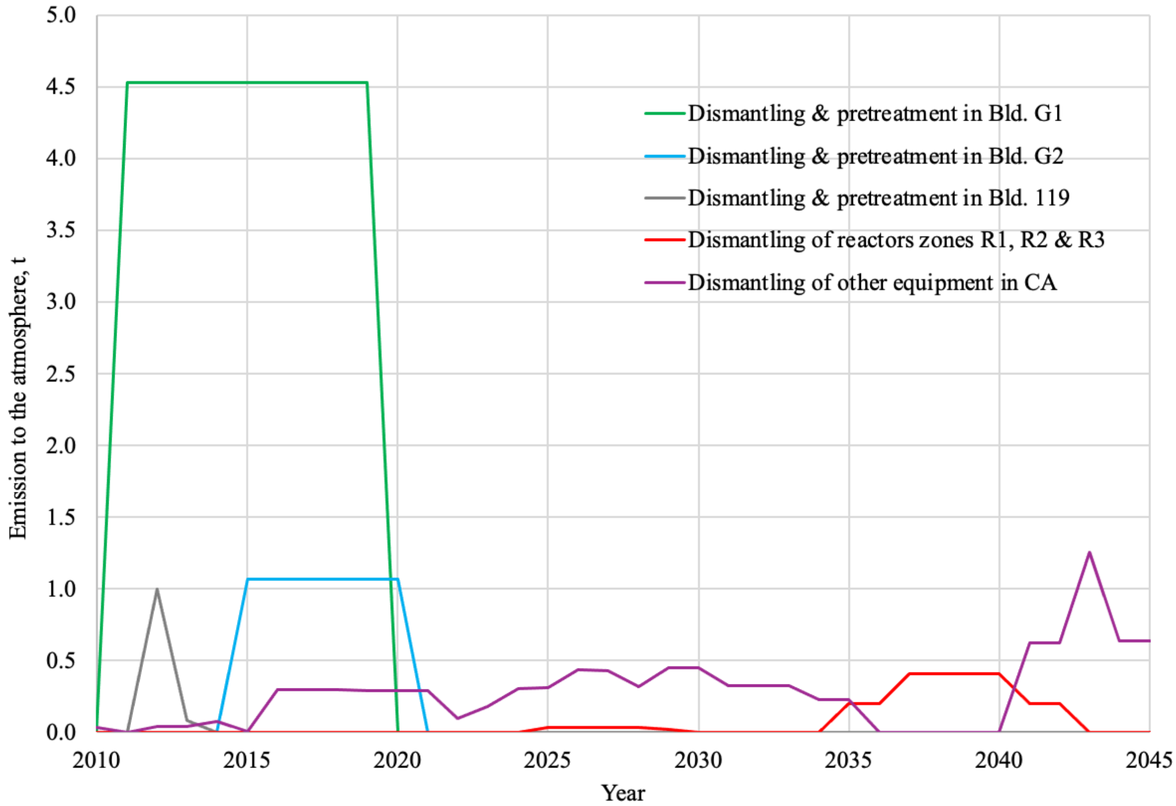

Figure 4.2-16. Individual D&PT projects assess the total emissions of pollutants to ambient air and the projected total emissions to ambient air for further D&PT activities

As the experience of dismantling projects already carried out by the INPP shows, at least a little more significant ambient air pollution can be associated with heat treatment of metals – cutting using a plasma arc or oxygen acetylene gas. The CO and NOx gases produced during these activities are not filtered out by mechanical filters and are emitted directly into the ambient air, Figure 4.2-17. Aerosols (particulate matter of dust, metals or other substances) formed during dismantling and decontamination activities, using both thermal and mechanical measures, are deposited in these filters and are not released into the environment, if they are filtered by HEPA filters of preliminary cleaning and clean cleaning. Decontamination of metals by a stream of shots is carried out in closed protective chambers with HEPA filtration of the exhaust and therefore practically all solid particles are deposited in the filters. Emissions into ambient air are negligible and have no impact on ambient air pollution.

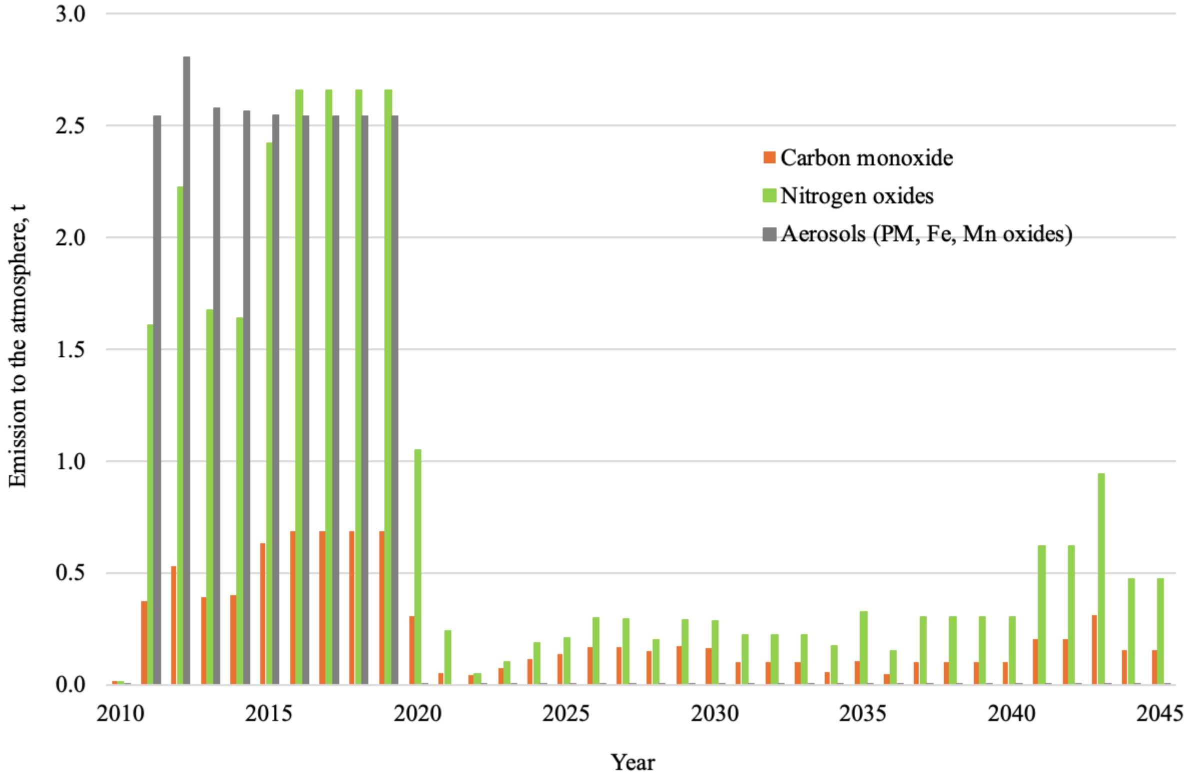

Figure 4.2-17. D&PT projects assess emissions of individual pollutants into ambient air and forecast emissions of individual pollutants into ambient air for further D&PT activities

Forecasts of emissions to ambient air for future D&PT activities, Figure 4.2-16 and Figure 4.2-17, conservatively envisages the use of heat treatment tools of a similar or larger scale as in the D&PT already carried out. It is accepted that, on average, about 70% of the total mass of all metals could be thermally cut, and up to 90% of the total mass of metals when dismantling reactor R3 zones. The emission fractions used to calculate the gaseous emissions are 1E-4 t CO/t heat-cut metal and 3E-4 t NOx/t heat-cut metal. These emission groups summarize the practice of the D&PT projects already carried out by the INPP in a rather conservative manner. The forecasts are also based on the assumption that all aerosols generated by D&PT activities are filtered by HEPA filters, so their emissions will be low, 1E-6 t KD/t of metal. Assessments show that taking into account the masses planned for dismantling in the future, the increasing duration of dismantling works (due to the need to use remotely controlled equipment for the dismantling of rectors and more contaminated components in close proximity to the reactors) and With proper organization of D&PT activities, emissions to ambient air can remain low and do not exceed 1-2 t/year. The increase in pollution emissions seen in the forecast after the end of the dismantling of the R3 zones of the rectors (around 2040 and later) is related to the assumption that the equipment and systems (operating ventilation systems and other residual equipment) that were not dismantled in blocks A1, A2, V1, V2, B1, B2 during the initial stages of dismantling will remain necessary and will be dismantled only at the end of the decommissioning of the INPP.

During the decommissioning of the INPP, dismantling and demolition of building structures will generate dust, demolition equipment and means of transport will emit CO, NO_x, SO_2, particulate matters into the air. The emission of chemicals that cause unpleasant odors into the air is not foreseen. In addition, according to the INPP Pollution Permit [58], it must be ensured that the odours emitted by the activities carried out in the immediate residential environment do not exceed the requirements of the Lithuanian hygiene standard HN 121:2010 [82] odour limit values. Air pollution will be local, covering the territory of the demolished structure and its surroundings within a radius of ~100 m. In addition, demolition works will be carried out in the open air, natural air circulation will allow to avoid the accumulation of significant concentrations of pollutants. According to the data of the chemical and radiological monitoring of the ambient air carried out by the INPP, the decommissioning works of the INPP have not had a significant negative impact on the ambient air so far.

Emissions to ambient air from mobile pollutants burning diesel fuel can be estimated using [83]. Conservatively assuming that the age of self-propelled and other non-self-propelled machines will be more than 13 years, and the diesel engine will comply with at least EURO II standards, the consumption of diesel fuel per 100 t/year will lead to emissions of pollutants into the ambient air by about 10 t/year:

- Carbon monoxide: 6.7 t/year,
- Hydrocarbons: 1.8 t/year
- Oxides of nitrogen: 1.1 t/year;
- Sulphur dioxide: 0.10 t/year;
- Particulate matter: 0.13 t/year.

By renewing the fleet with newer and less polluting cars during the decommissioning, emissions of mobile sources of pollution into the ambient air will decrease. The EURO VI standards for 2012 establish almost 3 times lower emissions.

Compared to emissions into ambient air at the beginning of decommissioning, further decommissioning works will reduce emissions. After the suspension of the operation of the steam boiler plant, the largest source of non-radioactive pollution of the ambient air at the INPP site and the adjacent NF sites will be vehicles transporting various materials (radioactive waste, building materials, demolition work waste), as well as other self-propelled and non-self-propelled machines using diesel fuel.

4.2.3.2 Effects of radioactive contamination

The INPP post-operation maintenance, dismantling and initial treatment of equipment and systems, and radioactive waste management until 2024 did not have a significant negative impact on ambient air quality. Radionuclide releases into ambient air did not exceed the conservatively established release limits, see Section 4.2.2.2.

During the decommissioning of the INPP, the future radioactive releases into the ambient air are presented in Figure 4.2-18. Radionuclide C-14 and H-3 releases predominate, which are about 10^{10} - 10^{11} Bq/year. For other radionuclides combined into the IR group (see Table 4.2-4) annual releases are about 10^{8} Bq/year. The releases of radionuclides of the IR group from individual INPP buildings is shown in Figure 4.2-19. Releases from reactor unit buildings No. 101/1 and No. 101/2 dominate. Also a significant source of releases is the removal of the G-3 group SRW from building No. 157 with the RU-3 module. Releases from all other INPP and adjacent NF buildings are lower, about 10^{7} Bq/year.

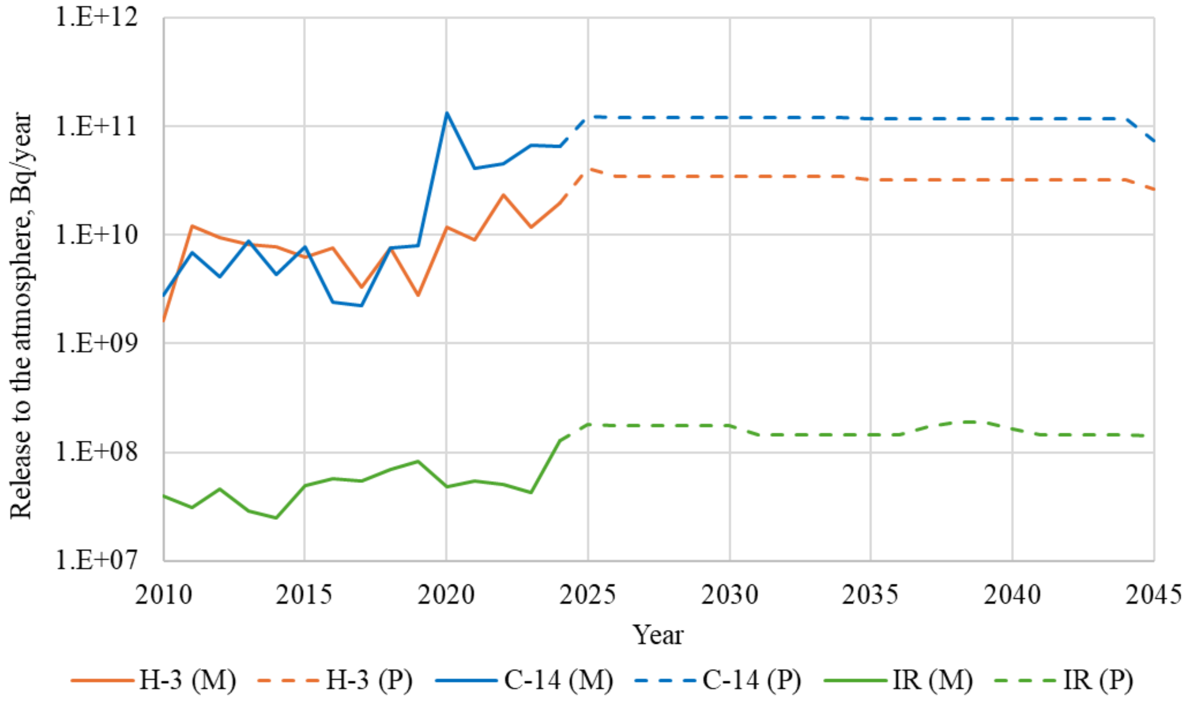

Figure 4.2-18. Radionuclide releases of groups H-3, C-14 and IR into ambient air from INPP, (M) – monitoring data, (P) – projected releases

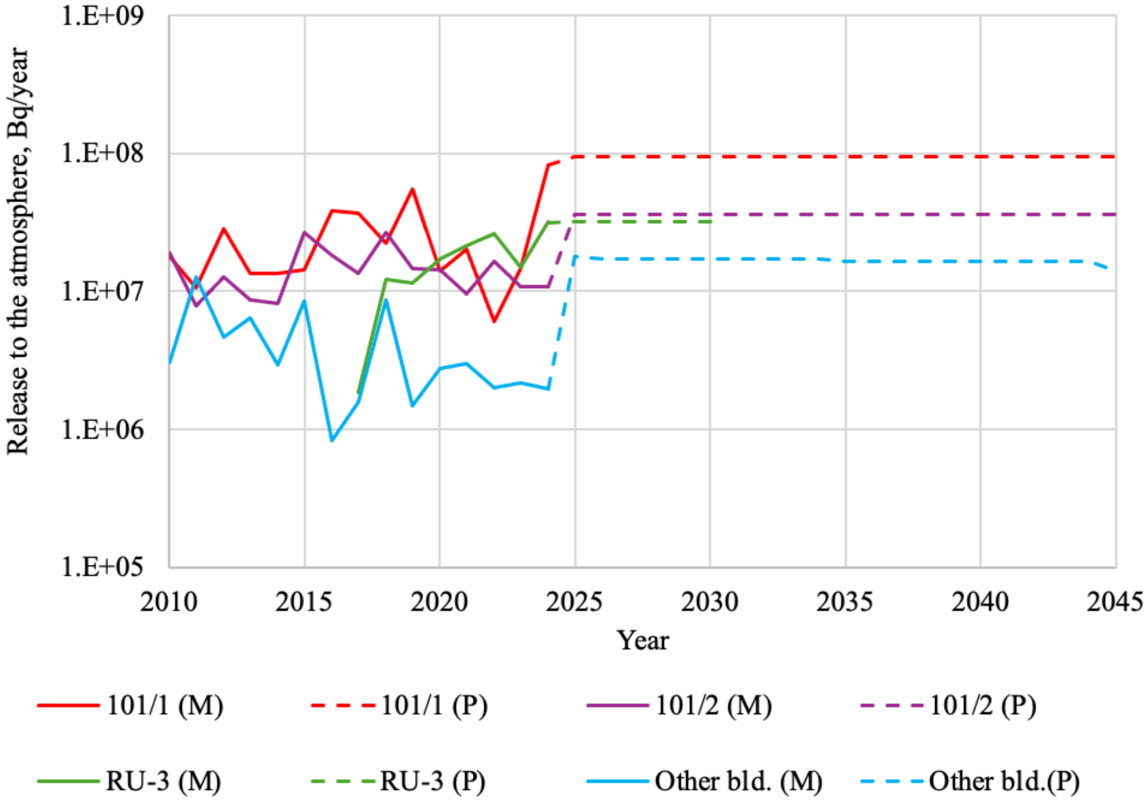

Figure 4.2-19. Releases of radionuclides of group IR from individual INPP buildings, (M) – monitoring data, (P) – projected releases

The releases of the IR group are dominated by radionuclides Co-60 and Cs-137. The activities of the radionuclides Sr-90 and Nb-94 are also measured. Figure 4.2-20, Figure 4.2-21, Figure 4.2-22, and Figure 4.2-23 show radionuclides that are measured and predicted in various EIA studies [27], [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43] evaluated releases from reactor unit buildings No. 101/1 and No. 101/2. When forecasting releases after 2035, possible releases to ambient air during the dismantling of reactor R3 zones were assessed.

The forecast of dismantling releases to ambient air from Zone R3 is based on the following basic assumptions:

- The concept and sequence of dismantling correspond to the planned most important design solutions for the dismantling of the R3 zone, described in Section 3.2.4.1;
- Radionuclide activity is for 2035-01-01;
- When cutting metals, 10% of their mass is damaged, and 10% of the damaged mass consists of small airborne particles that enter ventilation units and exhaust air systems. These groups, together with the assessment of the filtration of releases into the environment, quite conservatively summarize the practice of the already completed INPP D&PT projects, see also Section 4.2.3.1;

- For the removal of bulk materials, a fraction of 0.2% of airborne particles is applied. This figure conservatively summarizes the formation of small bulk matter falls from airflow pollution up to 3 m high under conditions of forced ventilation in enclosed rooms [84];
- When removing graphite blocks, 1% of their mass is damaged. The planned design solutions provide for the removal of graphite blocks without damaging them or with minimal damage. 10% of the damaged mass consists of small particles transported by air flow;
- Radionuclide releases into the environment are filtered using HEPA filters, filtration efficiency 99.99%.

The results of radiological monitoring show that the dismantling of low-level radioactive (Class 0, A) equipment and systems and the treatment of the generated waste in reactor block buildings (and other INPP buildings) do not lead to significant radioactive releases into the environment. Releases into the environment are determined not only by the decommissioning activities carried out, but also, often to a greater extent, by the remaining undismantled reactors and operating systems. It is predicted that the current releases from the reactor units will remain similar to the existing ones until the R3 zones of the reactors are dismantled. During the dismantling of R3 zones, higher releases of radionuclides Co-60 and Nb-94 are expected, see Figure 4.2-20 and Figure 4.2-23. Higher releases of radionuclide Cs-137 in 2017-2022, see Figure 4.2-21, related to the management of SNF in reactor units and export to ISFSF-2. Actual releases into the environment were lower than projected [27] when handling leaking and damaged SNF assemblies. The forecast of releases presented in Figure 4.2-20, Figure 4.2-21, Figure 4.2-22, and Figure 4.2-23 conservatively rounds and covers the change in release irregularities of at least 10%. A more accurate assessment of releases will be carried out when preparing technological projects and safety analysis reports for the planned D&PT activities.

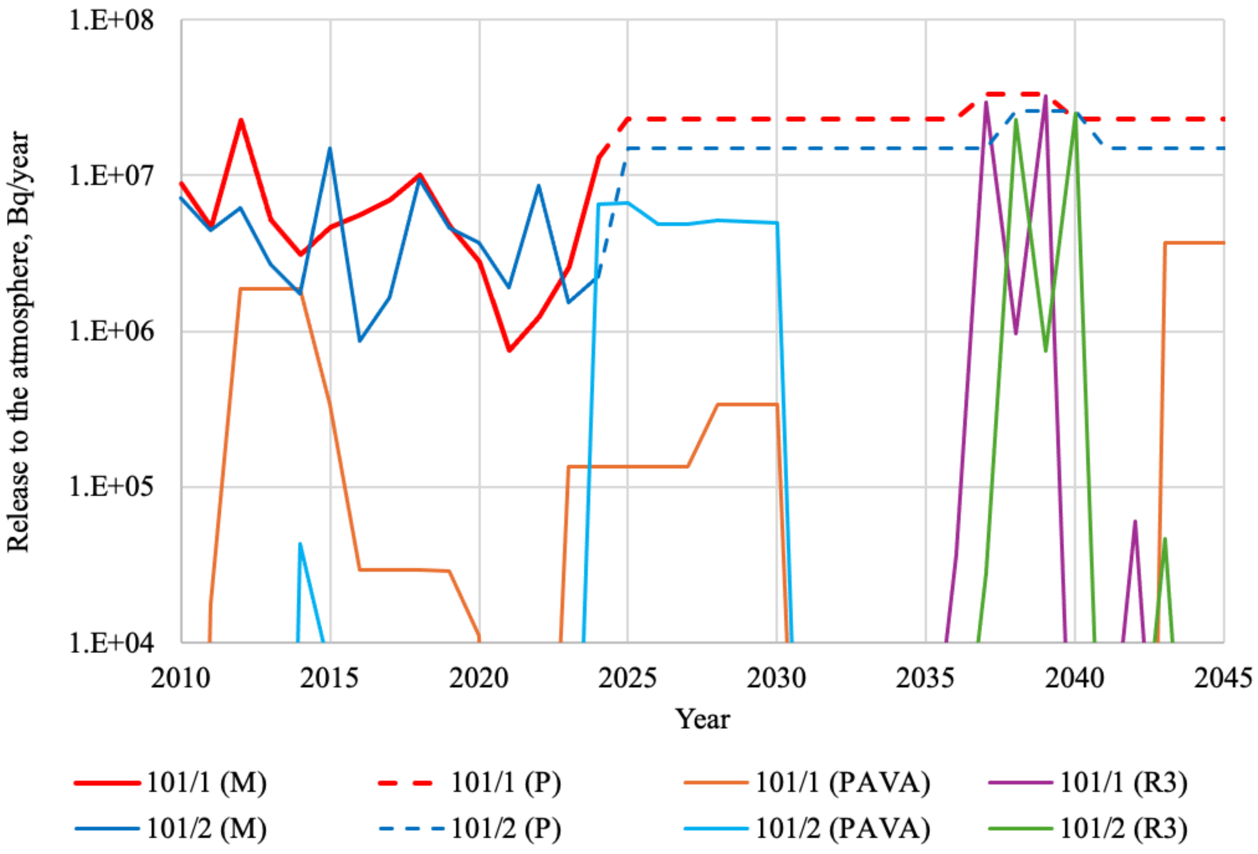

Figure 4.2-20. Radionuclide Co-60 releases into ambient air from reactor unit buildings No. 101/1 and No. 101/2, (M) – monitoring data, (P) – projected releases, (PAVA) – releases estimated in EIA studies of individual D&PT projects, (R3) – projected dismantling releases of R3 zone

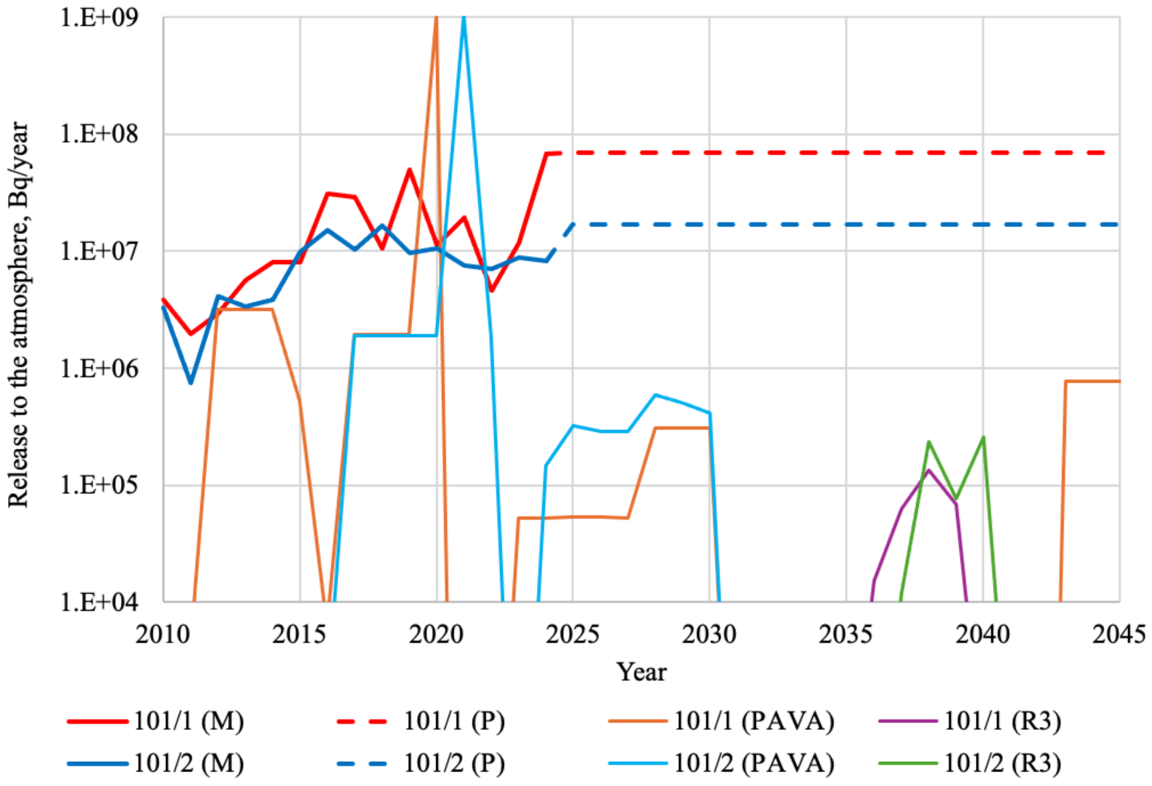

Figure 4.2-21. Releases of radionuclide Cs-137 into ambient air from reactor unit buildings No. 101/1 and No. 101/2, (M) – monitoring data, (P) – projected releases, (PAVA) – releases assessed in EIA studies of individual D&PT projects, (R3) – projected dismantling releases of R3 zone

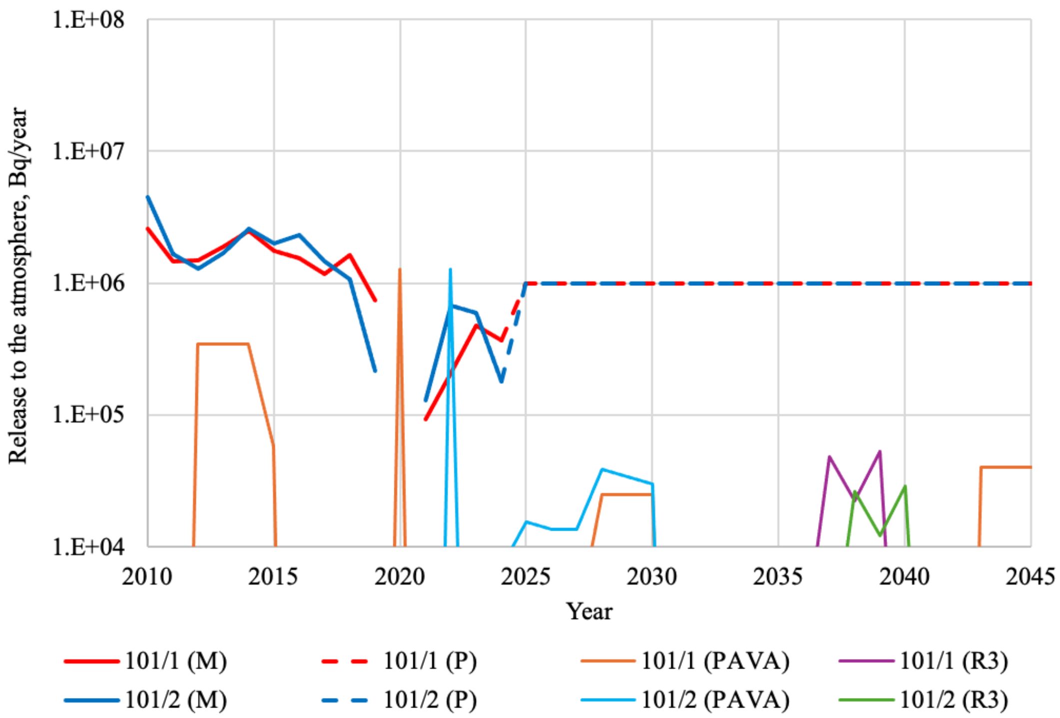

Figure 4.2-22. Releases of radionuclide Sr-90 into ambient air from reactor unit buildings No. 101/1 and No. 101/2, (M) – monitoring data, (P) – projected releases, (PAVA) – releases assessed in EIA studies of individual D&PT projects, (R3) – projected dismantling releases of R3 zone

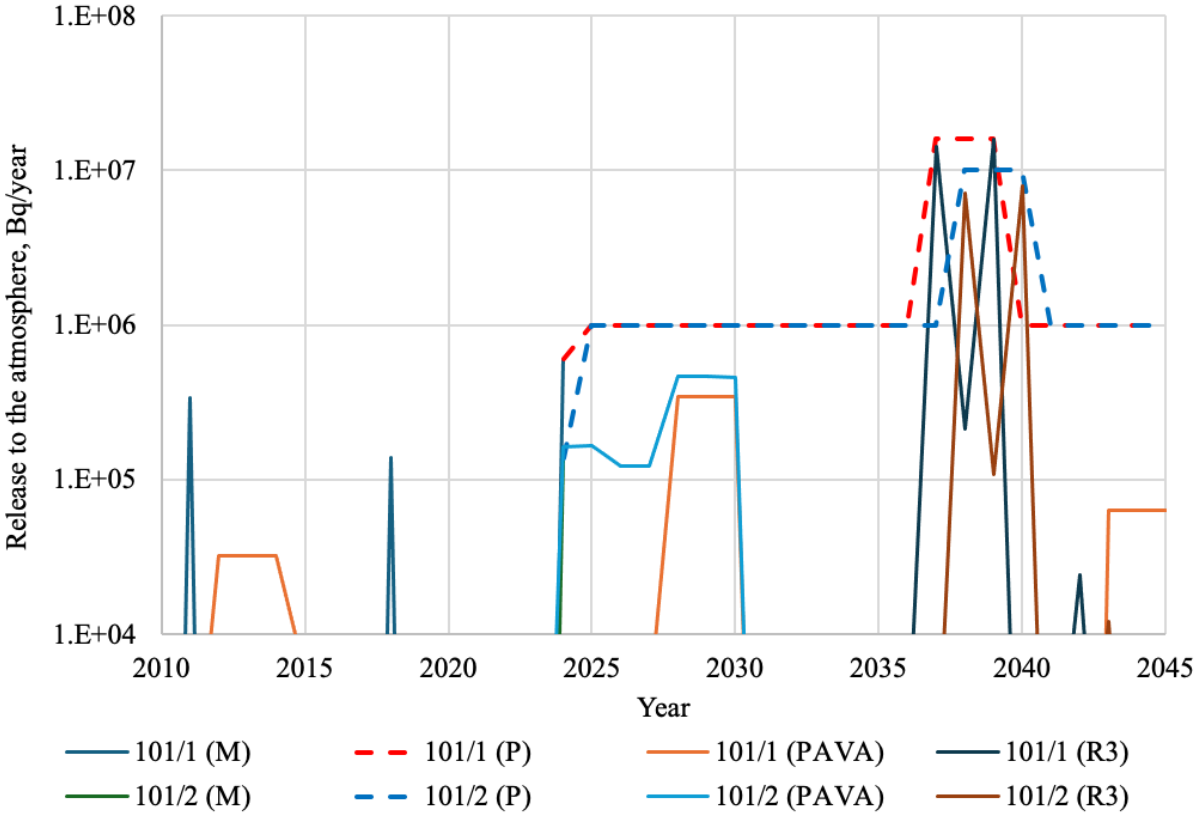

Figure 4.2-23. Releases of radionuclide Nb-94 into ambient air from reactor unit buildings No. 101/1 and No. 101/2, (M) – monitoring data, (P) – projected releases, (PAVA) – releases assessed in EIA studies of individual D&PT projects, (R3) – projected dismantling releases of R3 zone

The results of radiological monitoring also show that significant radioactive releases into the environment are not caused by the storage of treated and moderately radioactive waste (classes A, B, C, D, E) in storage facilities (VLLW storage facility, building No. 158/2).

After 2024, the most important sources of radionuclide releases into ambient air remain the following, see Figure 4.2-19:

- Reactor unit buildings No. 101/1 and No. 101/2, where post-operation maintenance of energy unit equipment and systems and dismantling and pre-treatment of disused equipment and systems is carried out, storage of dismantled materials;
- Withdrawal of operational accumulated SRW of groups G2 and G3 from existing storage buildings No. 157 and 157/1 using the retrieval units RU-2 and RU-3;

Operation, decommissioning and RW management activities carried out in other controlled areas of the INPP and adjacent NF sites and in the buildings located there will also lead to releases into the ambient air, but the total releases of these activities will be lower compared to the releases from reactor block buildings.

Comparison of the predicted releases into ambient air with the limit for releases established in 2020 is shown in Figure 4.2-24. The released activity of the radionuclide C-14 constitutes about 83% of the limit releases established for this radionuclide, the released activity of the IR group radionuclides constitutes about 6% of the limit releases established for this group, and the released activity of the radionuclide H-3 constitutes about 0.3% of the limit releases established for this radionuclide. The annual effective dose of the population determined by the limit releases of C-14 is 0.001 mSv/year, i.e. constitutes 1% of the limited dose part applicable to radionuclide releases into ambient air, 0.1 mSv/year, see Section 4.2.2.2. Therefore, the limit releases of C-14 can be increased while optimizing the limit releases of other radionuclide groups.

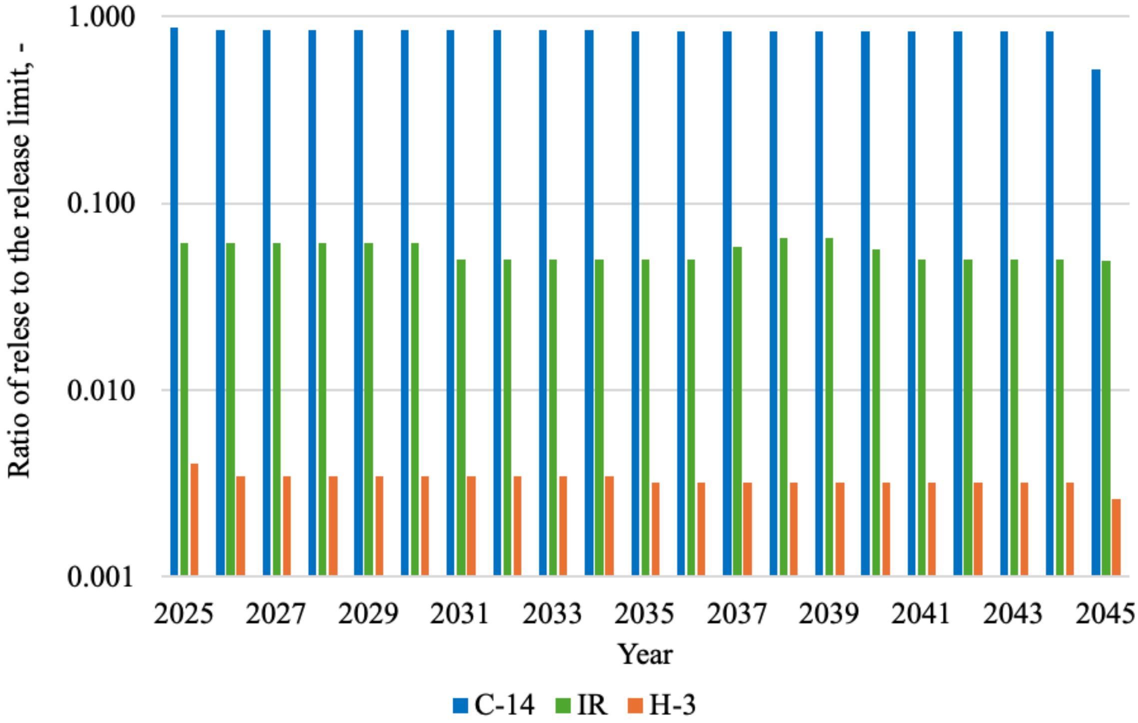

Figure 4.2-24. Comparison of releases from INPP into ambient air with the releases limits set for 2020

4.2.4 Mitigation measures

For the dismantling and pre-treatment of equipment and systems, which may potentially lead to the formation of airborne particulates and aerosols, HEPA filtration of releases into ambient air must be provided for and applied. As the experience of the INPP decommissioning projects that have already been implemented shows, this allows to significantly reduce the releases of both radioactive and non-radioactive materials into the ambient air.

The release limit for radionuclide C-14 into the ambient air may be revised. The release limit applicable to this radionuclide from 2020 is determined based on the data from the decommissioning projects prepared in 2020 and earlier. The existing release limits for ambient air may be reviewed and optimized by applying the ALARA principle and maintaining a low environmental impact that meets radiation safety requirements.

In order to reduce the negative impact of demolition works on the ambient air, the structures of the buildings being demolished and the construction scrap being managed can be irrigated (watered with water) so that it does not cause dust. It is recommended to transport dusty construction waste in covered vehicles or use other means to protect against dust dispersion and environmental pollution during transportation.

4.3 Soil

4.3.1 Current state

The territory of the Ignalina NPP is affected by the construction and operation of the Ignalina NPP and is almost entirely covered with man-maid ground. Thus, there is practically no natural soil layer. The man-maid ground contains the mixture of the clayey loam, gravel, pebble, sand and the organic residues in certain places.

As part of environmental monitoring, Ignalina NPP has been carrying out radiological measurements of soil samples in the Ignalina NPP region since 1986 and presents the measurement results of the soil samples in the annual radiological monitoring reports. Soil samples are also taken and analysed at the individual sites of nuclear facilities (buffer storage (B19-1), SWRF (B2), ISFSF (B1), SWTSF (B34), “Landfill” near-surface disposal facility (B19-2)) at Ignalina NPP. As can be seen from the results of radiological monitoring of the Ignalina NPP region (see Table 4.3-1, and Figure 4.3-1), the variation of the radionuclides concentrations in the soil samples during the monitoring period is insignificant. The results of naturally occurring radionuclides K-40, Ra-226 and Th-228 are presented for comparison. These radionuclides are not released into the environment from the Ignalina NPP.

Table 4.3-1. Radionuclides concentrations in the soil samples in the Ignalina NPP region [85]

Year	Concentration, Bq/kg									Total, except Ra, Th, K	
	Cs-137	Cs-134	Mn-54	Co-58	Co-60	Sr-90	Ra-226	Th-232	K-40	Bq/kg	Bq/m^2
2010	2.88	0	0.34	0	0	0	22.3	24.5	573	3.22	153
2011	1.48	0	0.35	0	0	6.15	37.9	25.1	596	7.98	327
2012	1.81	0	0.19	0	0	1.88	3.91	19.8	442	3.88	80.3
2013	4.84	0	0	0	0	0.49	2.12	29.8	525	5.33	126
2014	2.98	0	0	0	0	3.99	1.38	25.4	541	6.97	324
2015	3.03	0	0	0	0	1.94	0.63	22.3	460	4.97	194
2016	3.17	0	0	0	0	1.54	2.14	29.1	629	4.70	158
2017	3.60	0	0	0	0	1.45	18.9	23.0	744	5.05	153
2018	1.13	0	0	0	0	0.88	16.1	21.9	806	2.01	78.4
2019	2.20	0	0	0	0	0	0	16.3	632	2.20	77.4
2020	0.53	0	0	0	0	0	8.23	9.58	461	0.53	17.3
2021	1.26	0	0	0	0	2.56	583	16.3	14.7	3.82	157
2022	4.73	0	0	0	0	1.92	571	14.8	15.3	6.65	132
2023	2.30	0	0	0	0	1.85	13.5	8.25	604	4.14	335
2024	1.32	0	0	0	0	0	9.8	10.98	488	1.32	154

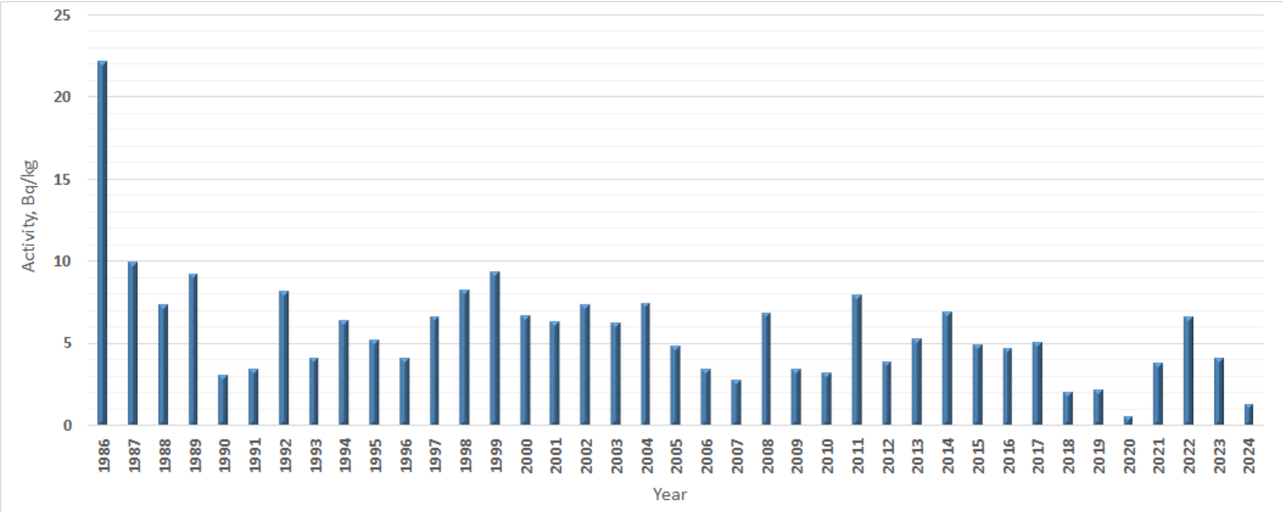

Figure 4.3-1. Total concentration of the radionuclides in the soil samples in the Ignalina NPP region in 1986-2024 [85]

4.3.2 Potential impact

Taking into account the chemical and radiological monitoring data of the Ignalina NPP, the already completed decommissioning activities of the INPP did not have a significant negative impact on the soil. The planned economic activities will be carried out in such a way that the soil will not be polluted under normal operating conditions. The mechanisms, equipment and vehicles used for the dismantling, demolition of structures and the management of the resulting demolition waste will be controlled so that the soil is not contaminated with fuel and lubricants. In addition, after the demolition of buildings and structures, recultivation of the INPP site will be carried out, preparing the necessary soil and planting the territory with greenery. In this way, the surface soil layer will be brought closer to natural conditions.

As indicated in the EIA program [6], during the planned economic activity, additional impacts increasing the erosion of the existing top layer of soil and its contamination are not expected, therefore, an assessment of the impact on soil is not performed in the EIA report.

Emergency situations and the related potential soil contamination causing possible radiological impact on the population are analysed in the Section 5 “Risk Analysis”.

4.3.3 Impact mitigation measures

As the planned economic activity will not cause a negative impact on the soil, no impact mitigation measures are foreseen.

4.4 Underground

4.4.1 Current state

The geological cross-section of the Ignalina NPP region (Figure 4.4-1 and Figure 4.4-2) comprises rocks of a crystalline basement and a sedimentary cover. The crystalline basement is 703–756.7 m beneath the ground surface. It consists of lower proterozoic rocks: usually gneiss, granite, migmatite, etc., which consist of biotite and amphibole [29].

The sedimentary succession consists of Pre-Quaternary and Quaternary rocks. Its thickness is 703–756.7 m. Upper Proterozoic, Vendian complex, and Paleozoic rocks spread in the Pre-Quaternary succession. The Vendian compex is composed of gravelite, feldspathic quartz sandstone of various coarseness, aleurolite and argillite. The geologic cross-section of the Paleozoic erathema consists of Lower, Middle Cambrian, Ordovician, Lower Silurian, and Middle and Upper Devonian rocks. The Lower Cambrian consists of usually fine-grained and very fine-grained quartz sandstone (with small amounts of glauconite), siltstone and clay which are of various coarseness; the Lower-Middle Cambrian of fine-grained and very fine-grained quartz sandstone; the Ordovician of limestone and marlstone layers; the Lower Silurian of domerite and dolomite; the Middle Devonian of gypsum breccia, domerite, dolimite, also fine-grained and very fine-grained sandstone, siltstone and clay layers; the Upper Devonian of fine-grained and very fine-grained sand, sandstone, siltstone and clay layers. The thickness of Vendian complex is 139–159 m, the overall thickness of the Lower and Middle Cambrian rocks is 93–114 m; 144–153 m thickness of the Ordovician rocks; 28–75 m thickness of the Lower Silurian; and the thickness of the Devonian rocks is less than 250 m [29].

The possible existence of natural resources is determined by local geological structure, which in turn is determined by geological processes have formed the sedimentary subsoil of the INPP region. As the region was mainly formed during last glacial epoch the sand and gravel resources for industrial use are a typical feature of the region [86]. At the 5 km distance to the east direction with respect to Ignalina NPP there is the so-called Sauliakalnis gravel-sandpit. Ignalina NPP industrial site and its surrounding area according to the available information and recent investigations do not possess valuable underground resources [29], [47].

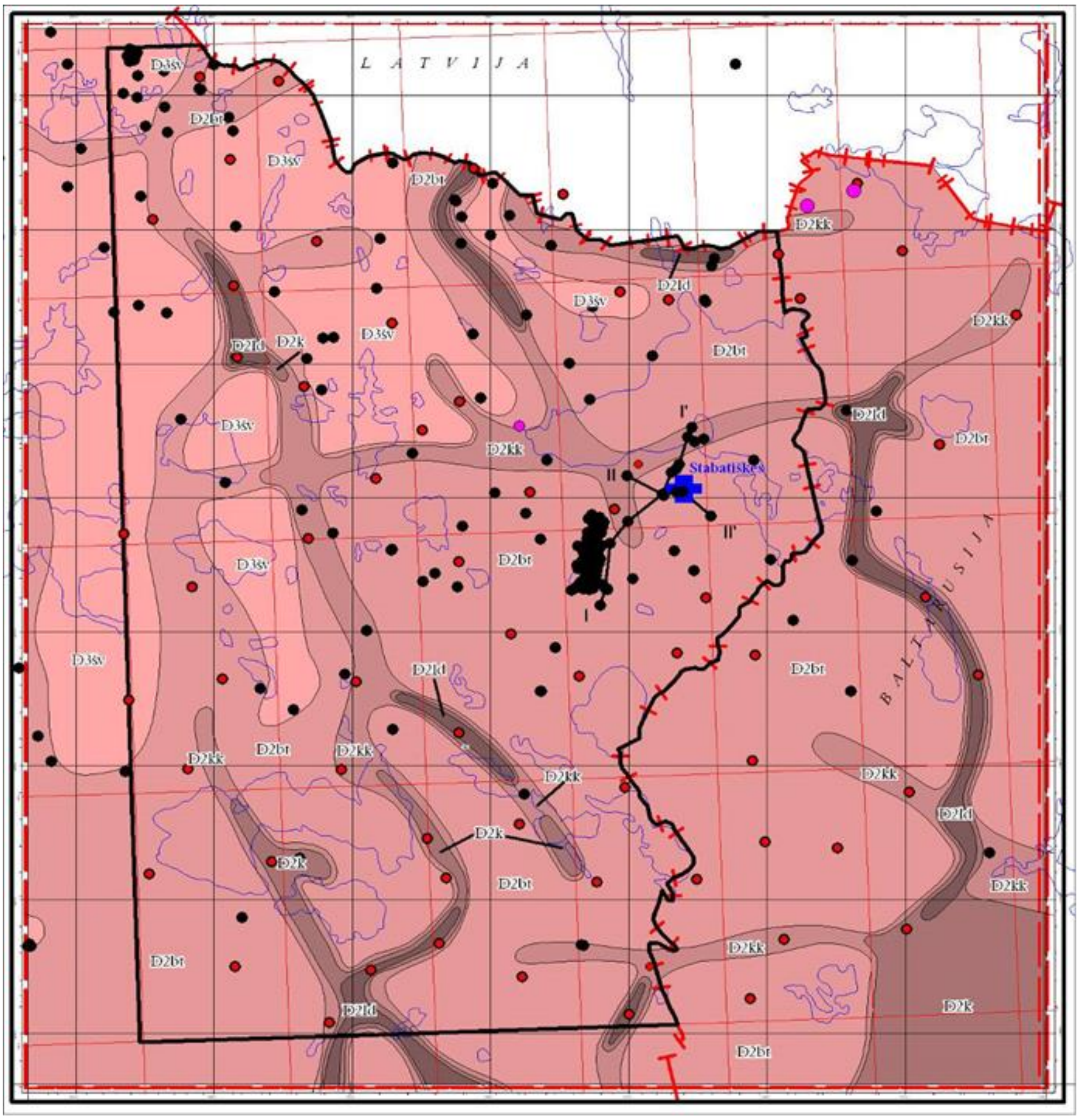

Figure 4.4-1. Revised pre-Quaternary geological map of Ignalina NPP region [87].

Red short lines indicate boundary between Lithuania, Latvia and Belarus, red lines – coordinate scale of the local Lithuanian coordinate system LKS-94

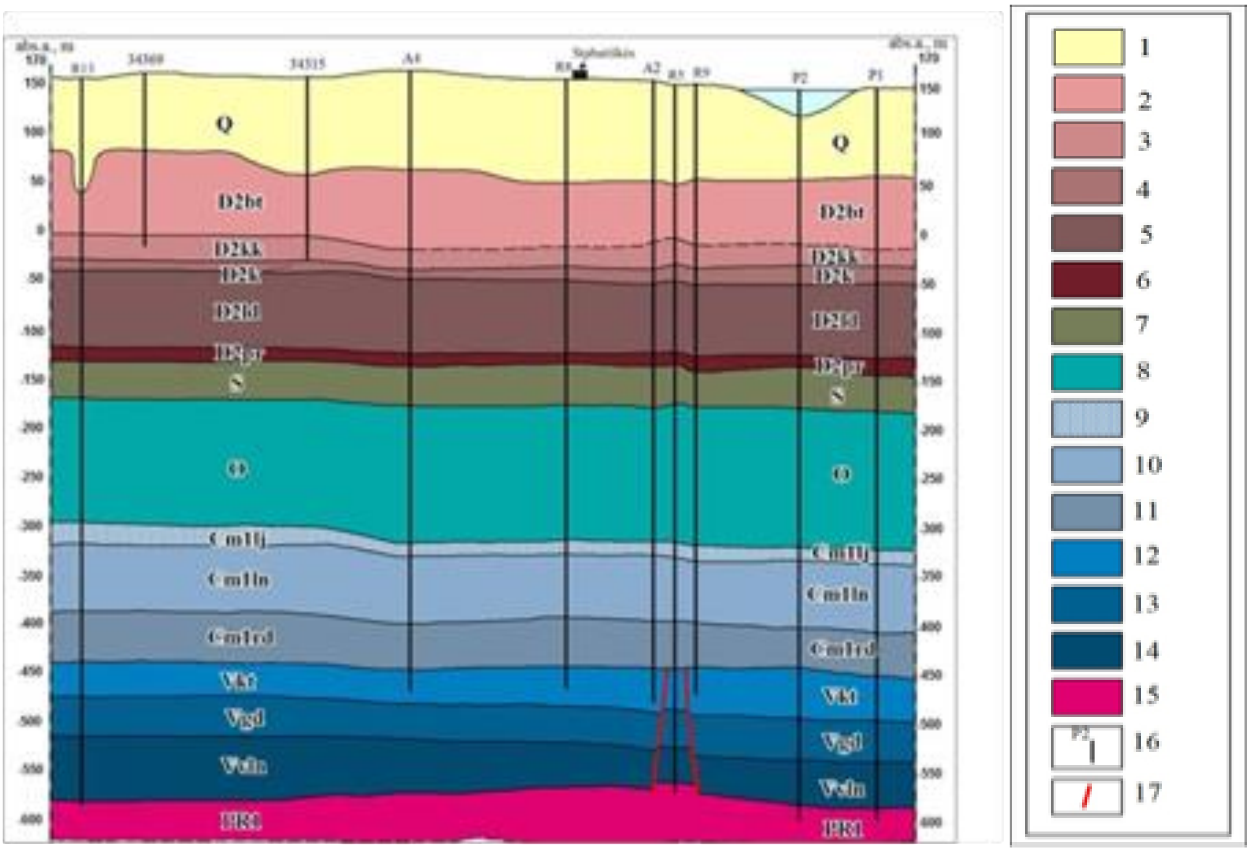

Figure 4.4-2. Geological cross-section I-I’ of the INPP region (for cross-section location see Figure 4.4-1)

Legend:

1 – Quaternary: till, sand, silt, clay.

2-6 – Middle Devonian:

- 2 – Butkūnai Formation:sand, sandstone with shale and siltstone interlayers;
- 3 – Kukliai Formation: sand, sandstone, siltstone, shale;
- 4 – Kernavė Formation: dolomitic marlstone, clay interlayers;
- 5 – Ledai Formation: dolomitic marlstone, dolomite;
- 6 – Piarnu Formation: sand, sandstone, dolomite.
- 7 – Lower Silurian: dolomitic marlstone, dolomite, limestone.
- 8 – Ordovician: limestone, sandstone and marlstone.

9-11 – Lower Cambrian:

- 9 – Aisčiai Group Lakaja Formation: sandstone with shale interlayers;
- 10 – Baltija Group Lontova Formation: shale with sandstone interlayers;
- 11 - Baltija Group Rudamina Formation: shale with siltstone and sandstone interlayers.

12-14 – Lower-Upper Vendian:

- 12 –Kotlin Regional Stage: clayey sandstone, siltstone, gravelite, shale;
- 13 – Gdov Regional Stage: sandstone, gravelite, siltstone;
- 14 – Volynian Group: sandstone, gravelite, breccia.

15 – Lower Proterozoic: granite, gneiss, amphibolite, milonite.

16 – Borehole.

17 – Fault.

4.4.2 Potential impact

The impact of the planned economic activity on the underground (geological) components is not expected.

As indicated in the EIA program [6], an assessment of the impact on underground components is not performed in the EIA report.

4.4.3 Impact mitigation measures

Since the planned economic activity will not cause a negative impact on the underground, no impact mitigation measures are foreseen.

4.5 Landscape

4.5.1 Current state

The current landscape around the INPP with power generation units, radioactive waste management and storage facilities, spent fuel storage facilities, repositories, a facility of wastewater treatment facilities and pipelines of the Visaginas city heating system is characterised as industrial. The currently the most prominent part of INPP is the ventilation stacks of the power units, see Figure 2.2-2.

The landscape around the nuclear power plant consists mainly of forests and wetlands. Lake Drūkšiai is the main element of the natural landscape. The landscape of Lake Drūkšiai basin is characterised by the relief that formed during the glacial period, it is characterised by picturesque hills, valleys, lakes, and plains, as well as pine forests and ample watery meadows.

The most valuable landscape areas, such as Gražutė Regional Park, Smalva Hydrographic Reserve, Smalva Landscape Reserve, Pušnis Protected Area and Tilžė Protected Area, which is a geomorphological reserve, are located at a distance of 10 km or more from the territory of the INPP.

4.5.2 Potential impact

After the completion of the decommissioning of the Ignalina NPP, the industrial component will be removed from the landscape, i.e. the majority of the INPP buildings, structures, ventilation stacks will be demolished, and the landscape will become closer to the natural one. After the decommissioning of the Ignalina NPP is completed, the following facilities will remain in operation on the Ignalina NPP site and adjacent to it (see Section 3.2.10):

- Bituminised radioactive waste repository;
- Buffer storage facility of the VLLW repository;
- Industrial waste repository;
- Interim spent nuclear fuel dry storage facility ISFSF-1;
- Interim spent nuclear fuel dry storage facility ISFSF-2;
- Solid radioactive waste treatment and storage facility SWTSF;
- Very low-level radioactive waste (VLLW) repository;
- Near surface repository for low- and intermediate-level radioactive short-lived waste (LILW-SL).

The expected state of the INPP site after the completion of the INPP decommissioning is shown in Figure 3.2-36 and Figure 3.2-37, see Section 3.2.10.

4.5.3 Impact mitigation measures

Since the impact of the planned economic activity on the landscape will be positive, no impact mitigation measures are foreseen.

4.6 Biodiversity

4.6.1 Current state

The Ignalina NPP region is located in the Aukštaitija Upland and belongs to the physical-geographical region of the Baltic Upland. The highest and driest areas of the the region are covered with forests. The relief is hilly and there are many lakes. The Ignalina NPP region belongs to the mixed forest region of the taiga biome.

From the point of view of biodiversity, there are several ecological complexes in the Ignalina NPP region: Lake Drūkšiai, Lakes Smalva and Smalvykštis with surrounding land, Antalieptė Lagoon (the Antalieptė hydroelectric power plant water reservoir has been installed on the Šventoji River), Pušnies Swamp, etc. However, no species of flora and fauna protected under Lithuanian and European legislation have been identified in the territory of the Ignalina NPP industrial site.

According to the Ignalina NPP radiological monitoring program, the specific activity of radionuclides is measured in samples of vegetation and fauna within a 30 km radius of the INPP monitoring zone, as well as in samples of vegetation and fish of Lake Drūkšiai. The average annual values of the specific activity of radionuclides in individual components of the biological environment are summarized in Table 4.6-1.

Small concentrations of globally distributed Cs-137 and Sr-90 (most of which were released into the environment after the Chernobyl NPP accident and spread throughout the territory of Lithuania) and the activity of the naturally occurring radionuclide K-40 are measured. Technogenic radionuclides Mn-54 and Co-60 are not measured in the environmental components at the INPP. The variation of radionuclide Cs-137 in the period 2010-2024 in individual samples of the biological environment collected in the INPP monitoring zone is shown in Figure 4.6-1 and Figure 4.6-2.

Table 4.6-1. Average annual specific activity of individual radionuclides in the biological environment components of the INPP monitoring zone in 2010-2024.

Biological environment component	**Specific activity, Bq/kg**				
	Cs-137	**Mn-54**	**Co-60**	**Sr-90**	**K-40**
Grass	0,03	0	0	0,6	787
Moos	18	0	0	4,4	173
Mushrooms	29	0	0	0,12	89
Elk	3,4	< 0.3	< 0.3	-	98
Deer	1,7	< 0.3	< 0.3	-	99
Wild Boar	2,4	< 0.3	< 0.3	-	88
Fish	1,2	0	0	0,06	121

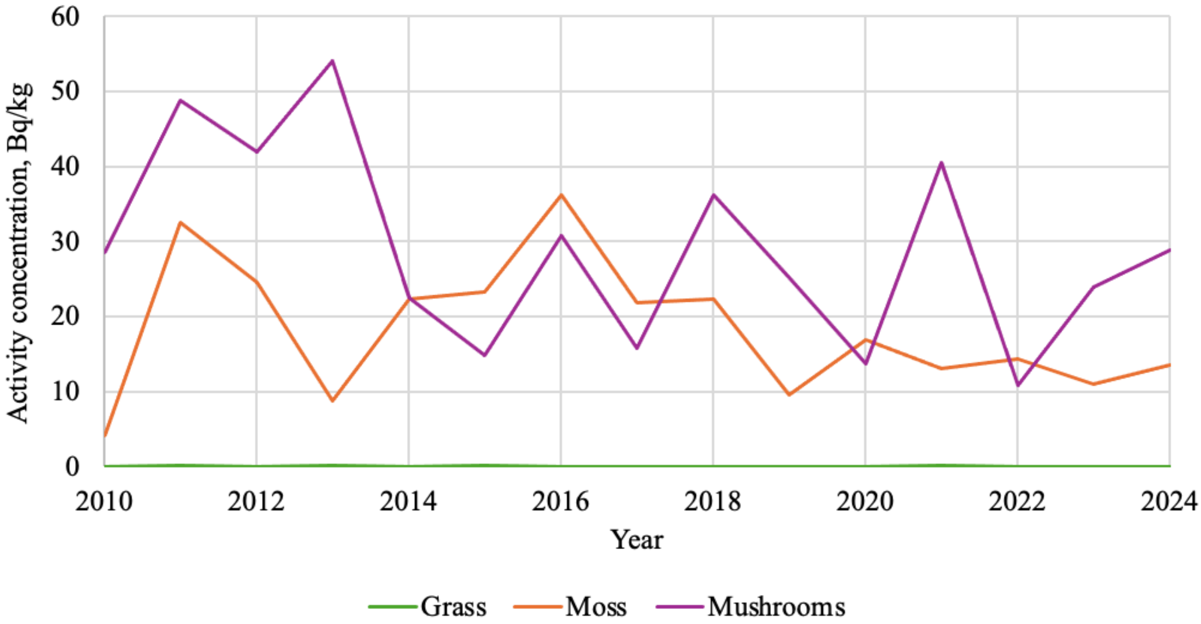

Figure 4.6-1. Specific activity of radionuclide Cs-137 in vegetation samples collected in the INPP region

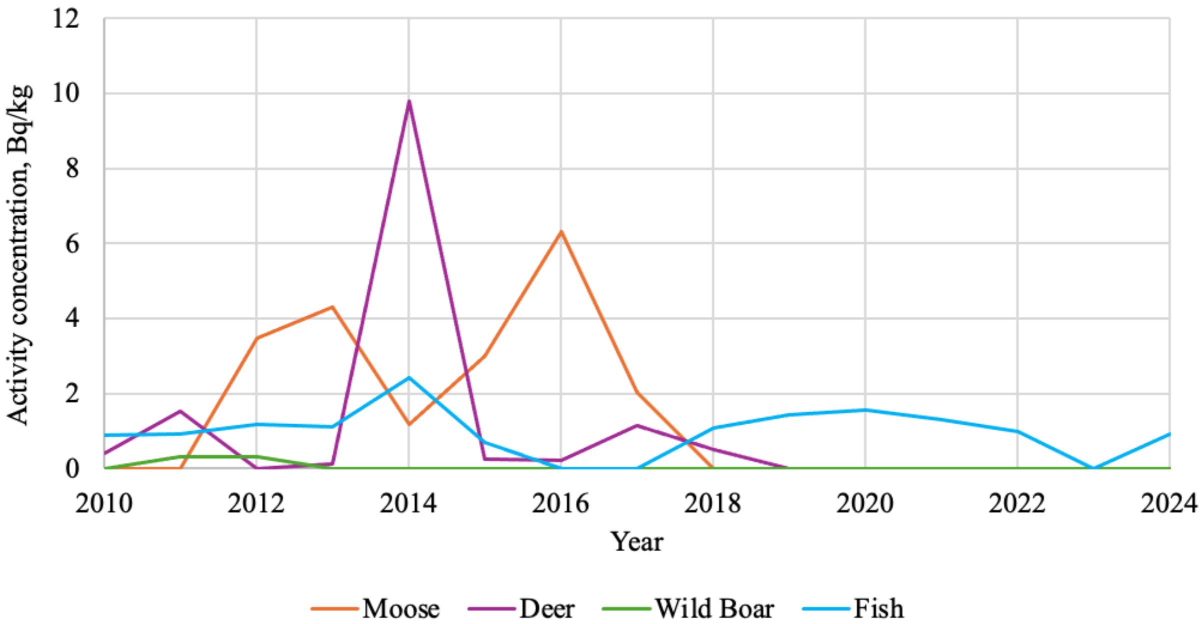

Figure 4.6-2. Specific activity of radionuclide Cs-137 in living nature samples collected in the INPP region

The contamination of food raw materials in Lithuania is measured by implementing the state radiological environmental monitoring programme [88], [103], and etc. Compared to other regions of Lithuania, the specific activities of radionuclides in the biological environment components of the INPP observation zone are not distinctive. The concentrations of radionuclide Cs-137 in fish samples, measured during the INPP environmental radiological monitoring and state monitoring in Lithuania, are shown in Figure 4.6-3. Higher specific activity of radionuclide Cs-137 is found in mushroom samples collected in the forests of southwestern Lithuania, as this part of Lithuania was affected by the passing radioactive cloud of the Chernobyl NPP accident.

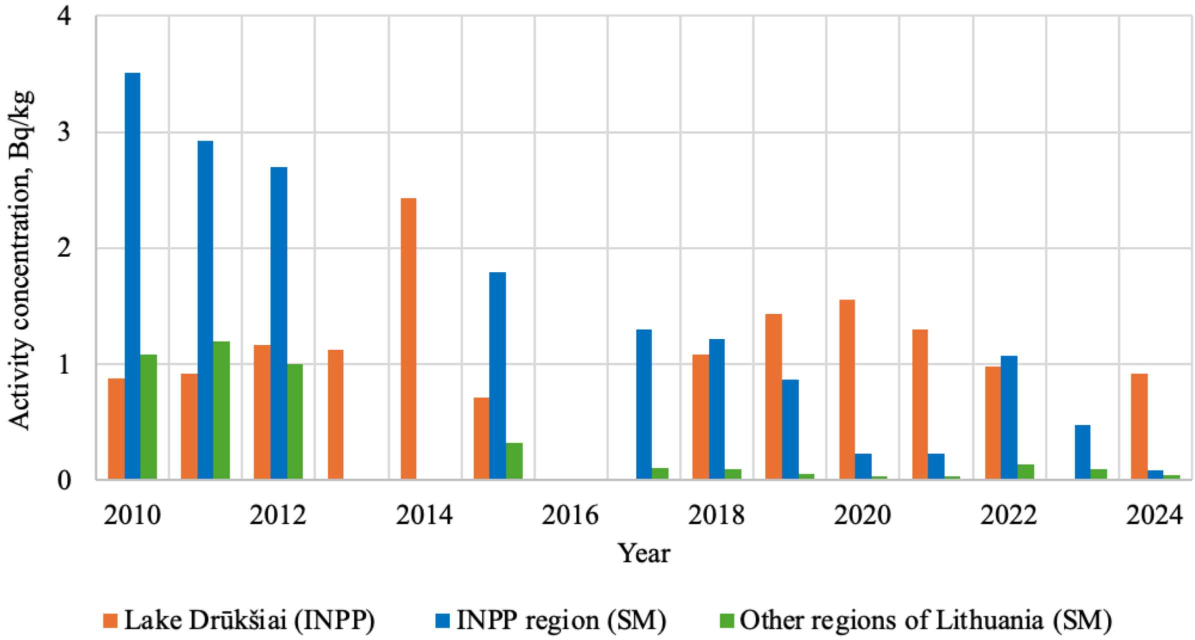

Figure 4.6-3. Average specific activity of radionuclide Cs-137 in fish samples taken in separate regions of Lithuania during the INPP radiological monitoring programme (INPP) and the state radiological monitoring programme (SM)

Water quality and radioactive contamination of Lake Drūkšiai are summarized in Sections 4.1.1.3 and 4.1.1.4. According to physico-chemical indicators Lake Drūkšiai is classified as having a very good or good ecological status. The values of BOD_7, ammonium nitrogen, nitrite nitrogen, phosphate phosphorus meet the requirements of the quality indicators applicable to water bodies for carps. The volumetric activity of radionuclides in the water of Lake Drūkšiai is low, the measured activities of individual radionuclides are often lower than the minimum detectable activity. Compared to other Lithuanian water bodies that are not in the INPP impact zone and where state radiological monitoring is carried out (Kaunas Reservoir, Lake Plateliai), the volumetric activities of radionuclides Cs-137 and Sr-90 in the water of Lake Drūkšiai are not exceptional and correspond to the values measured in other places.

The background levels of ionizing radiation near the INPP site and in more distant areas are summarized in Section 4.9.3.2. An increase in the background ionising radiation is measured in the western part of the INPP site and is associated with the radioactive waste accumulated during the operation of the INPP storage facilities. Once the SRW (especially the G3 group) is removed from the existing storage facilities, see Section 3.2.2, this source of ionizing radiation will be eliminated. The gamma radiation dose rate outside the 3 km SPZ boundary of the INPP does not differ from the gamma radiation dose rate in more distant areas.

4.6.2 Protected areas

The Ecological network "NATURA 2000" is a network of protected areas of the European Community, designated when implementing the Directives of the Council of the European Communities 79/409/EEC [89] and 92/43/EEC [90]. According to the Council Directive 79/409/EEC of 2 April 1979 on the Conservation of Wild Birds (further – Birds Directive) the Special Protection Areas (SPAs) are to be established and when implementing the Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora (further – Habitat Directive) the Special Areas for Conservation (SACs) are to be established.

Potential NATURA 2000 territories are areas corresponding the established criteria for selection of Special Areas for Conservation (SACs) and indicated in the list, approved by Minister of the Environment [91], and areas where according to the requirements stated in the Law on Protected Territories of the Republic of Lithuania [92] Article 24, protected areas are established with a purpose to grant them the status of the Special Protection Areas (SPAs).

Prior to establishment of SAC, based on scientific research, potential SAC are selected, and the list is presented to the European Commission (EC). After the potential SAC is approved by EC, the Member States commence their establishment. When establishing SPA, first of all based on scientific criteria and research data the most suitable areas are selected. Based on these selected territories the national protected areas are established and later they are granted the status of European SPA.

The NATURA 2000 network areas closest to the Ignalina NPP are shown in Figure 4.6-4. The following protected areas are located closest to the Ignalina NPP:

- 4.5 km to the northwest – Smalva hydrographic reserve;
- 9.5 km to the west – Smalva landscape reserve;
- 12.5 km to the southwest – Pusnis telmological reserve;
- 12.5 km to the west – Grazute regional park.

Figure 4.6-4. NATURA 2000 network area near the Ignalina NPP

(1 – Lake Drūkšiai; 2 – Smalva hydrographic reserve; 3 – Smalva landscape reserve; 4 – Gražute regional park; 5 – Lakes Dysnai and Dysnykstis; 6 – Pušnis telmological reserve. A – INPP industrial site)

In the territory of the Republic of Latvia, the following protected areas are fully or partially located in the radius of 30 km around the Ignalina NPP (see Figure 4.6-5): protected landscape area "Augsdaugava", which includes the nature park "Daugavas loki", protected landscape area "Augszeme", which includes the nature park "Meduma ezeraine" and the nature park "Svente", as well as nature reserves "Bardinska ezers" (lake), "Skujines ezers" (lake), and the nature park "Silene", which includes the nature reserves "Ilgas" and "Glusonkas purvs" (swamp). All of the above-mentioned areas are important at the European level, as they are included in the NATURA 2000 network of protected areas.

All area in the 30 km zone around the Ignalina NPP in the territory of Belarus belongs to Braslau administrative district. In the territory some protected areas are located. The nearest and probably best known one is the Braslau Lakes National Park (see Figure 4.6-6). The Braslau Lakes National Park was established for the purpose of protecting the natural complex of Braslau lakes group, its unique ice age landscape, biodiversity (especially plant and animal) typical for the so-called Belarusian Lake; organization of environmental education of the population; conservation of cultural heritage; as well as to organise recreation and tourist activities. The Braslau Lakes National Park was established in 1995.

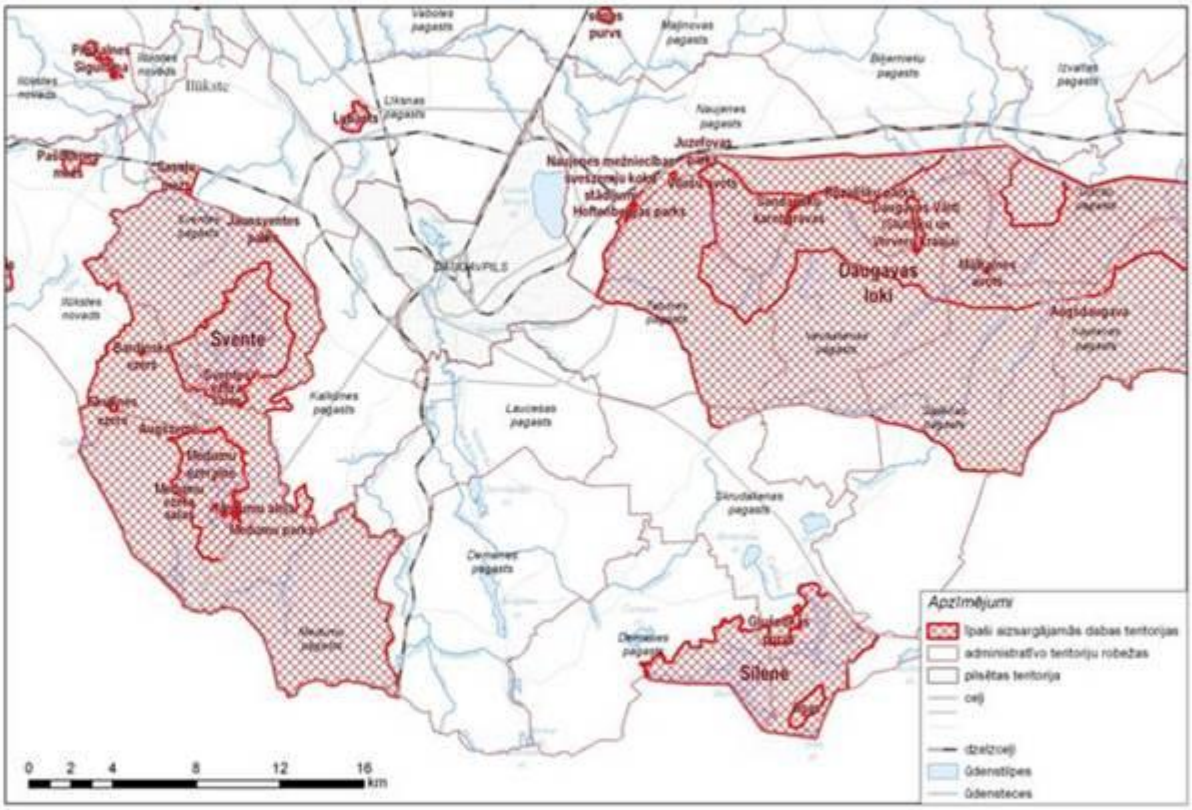

Figure 4.6-5. Protected areas in the Republic of Latvia located in the radius of 30 km zone around the Ignalina NPP

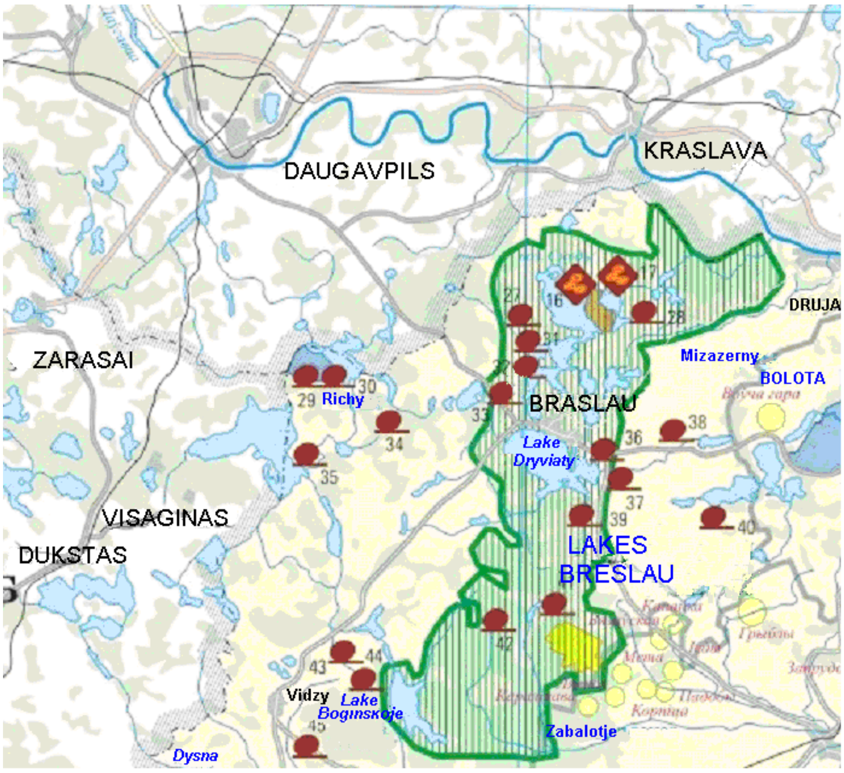

Figure 4.6-6. National Park "Braslau Lakes" (Belarus)

4.6.3 Potential impact

The decommissioning of the INPP is being carried out in the territory of the INPP industrial site, where no flora and fauna species protected under Lithuanian and European Union legislation have been identified.

Based on the results of environmental water monitoring, the decommissioning activities carried out at INPP did not have a significant negative impact on Lake Drūkšiai, see Section 4.1.1. The discharge of wastewater into Lake Drūkšiai is decreasing. The release of radionuclides into ambient waters is significantly lower than the established limits for release into environmental waters. The increased activity of radionuclides Cs-137, Co-60 and Sr-90 accumulated in the bottom sediments is a consequence of both the operation of the INPP and the global dispersion of these radionuclides (released into the environment after the accident at the Chernobyl INPP).

The increased activity of bottom sediments does not have a significant impact on the biota of Lake Druksiai. The publication [93] provides an assessment of the external, internal and total exposure of the fauna and flora of Lake Druksiai from technogenic radionuclides Cs-137, Sr-90, Mn-54 and Co-60 and as well as natural K-40 using the ERICA program and applying 2007–2011 data of the State Environmental Monitoring and radiological monitoring carried out by the Ignalina NPP.

The calculations were performed using the maximum specific and volumetric activity values of radionuclides determined during the assessment period. The findings show that:

- Algae are exposed to the highest exposure from all assessed natural and technogenic radionuclides, up to 0.17 μGy/h. Bottom-dwelling fish are exposed to lower radiation, about 0.1 μGy/h, and other fish, about 0.04 μGy/h;
- The highest exposure of biota is caused by natural K-40. The contribution of radionuclides Sr-90, Mn-54, Co-60 to total exposure is very small;
- Biota exposure due to Cs-137 which spread globally as a result of the Chernobyl NPP accident, compared to other technogenic radionuclides, is the highest. The exposure of algae and bottom-dwelling fish to the radionuclide Cs-137 is approximately 0.03 μGy/h and 0.02 μGy/h, respectively.

The maximum dose rate due to technogenic radionuclides is about 0.03 μGy/h or 0.72 μGy/day. This dose rate is lower than the reference dose rate levels for aquatic organisms (1-10 μGy/day) set out in the ICRP publication [94], when the effects of ionizing radiation on individual biota organisms are likely to occur, and which are recommended for use as a reference level when optimising environmental protection from ionizing radiation exposure. Therefore, it can be stated that the effects of ionizing radiation on the biota of Lake Drūkšiai are not significant and mitigation measures to reduce the impact are not necessary.

In terms of background pollution, the INPP site and the surrounding area are considered to be a relatively clean rural area of the Utena region of Lithuania, see Section 4.2.1. Emissions of pollutants CO, NO_x, SO_2, etc. from stationary pollution sources of INPP are constantly decreasing. Small concentrations of Cs-137, Co-60, Sr-90 are measured in the ambient air of INPP, which are essentially the same as those measured in other areas of Lithuania during state radiological monitoring. No significant increase in pollution is expected as the INPP decommissioning continues, see Section 4.2.3. During the demolition of buildings, an increase in noise, vibrations and dust in the environment is possible. However, this impact will be limited in terms of time and location and therefore will have no significant impact on biodiversity.

The INPP decommissioning works will not affect protected areas in the Republics of Lithuania, Latvia and Belarus, as well as the protected plant and animal species in these areas. These areas are sufficiently far away from potential impact factors (noise, transport, vibrations, dispersion of pollution released into the air and water).

The impact of INPP decommissioning works and radioactive waste management activities is local, limited to the territory of the INPP industrial site and the territories of the adjacent NF sites and the closed transportation roads connecting them. INPP decommissioning activities do not have a significant impact on biodiversity and will not have a significant impact on biodiversity in the future, continuing the decommissioning activities of the INPP.

4.6.4 Impact mitigation measures

Since the planned activity will not have a significant impact on biodiversity, no specific measures to mitigate the impact on biodiversity are foreseen. Measures to mitigate the impact on ambient water and air are described in Sections 4.1.4 and 4.2.4. The application of these measures also reduces the potential negative impact on components of the biological environment.

4.7 Social and Economic Environment

4.7.1 Current state

4.7.1.1 Population and demographic indicators

Based on 2024 data, the total number of permanent residents in the Ignalina NPP region, which consists of Visaginas municipality (58 km^2), Ignalina district (1447 km^2) and Zarasai district (1334 km^2), reached 47 461 (in Visaginas – 19 493, in Ignalina and Zarasai districts – 13 746 and 14 222, respectively). Although the INPP region comprises 4.3% of the country's territory, however its population is about 1.6% of the country's population. Thus, the INPP region is referred as one of the regions with a small population and one of the lowest population densities in all of Lithuania, except for the Visaginas town, where the population density reaches 337.7 people/km^2 and significantly exceeds the national average value of 44.2 people/km^2. Since 2008 until 2024 the total population of the Ignalina NPP region decreased by ~31.0% - from 68.8 to ~47.5 thousand residents (see Figure 4.7-1).

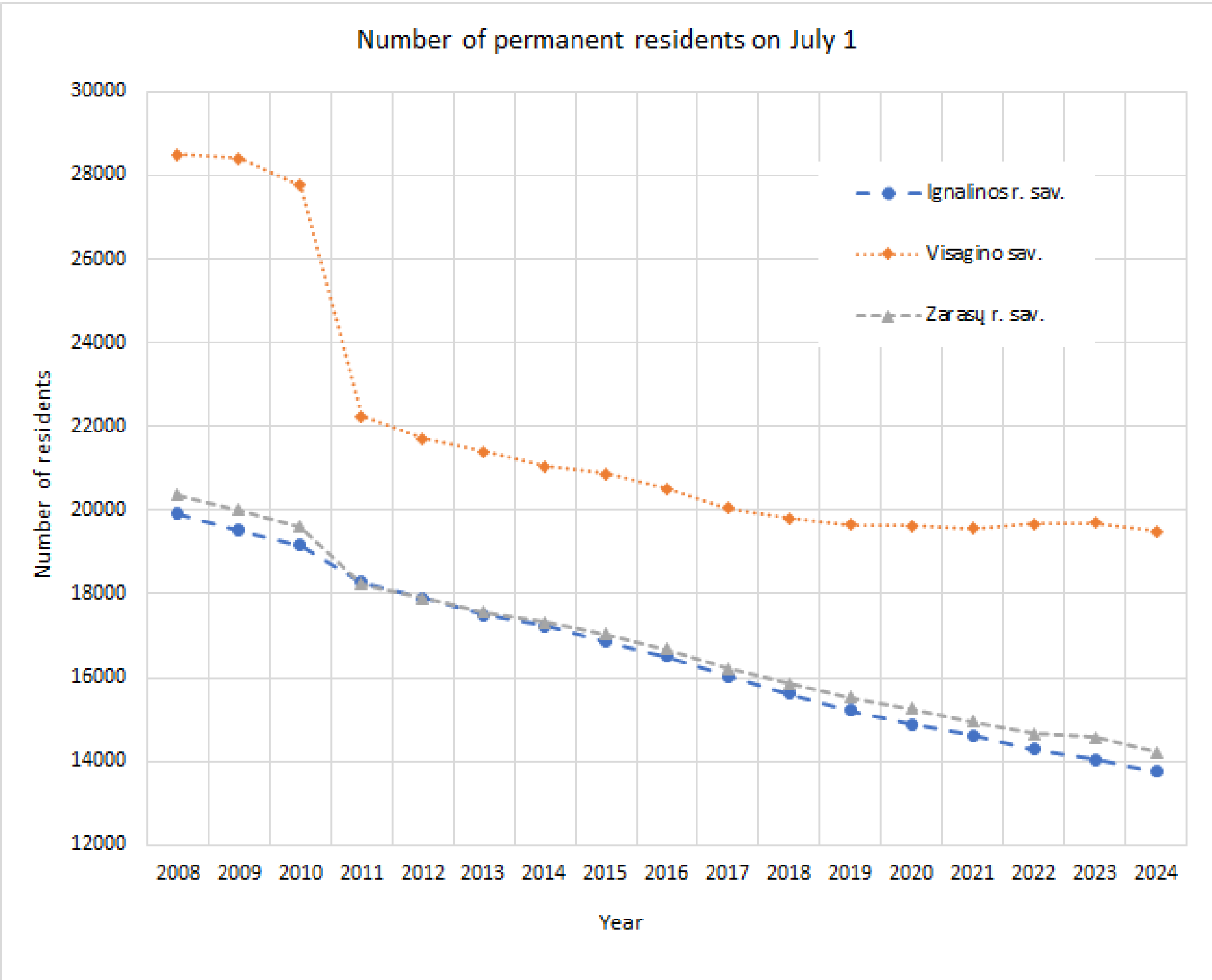

Figure 4.7-1. Population variation in the INPP region in 2008-2024 (https://osp.stat.gov.lt/)

The demographic situation describes the number, composition, territorial distribution of the population, their changes, and analyses demographic processes (birth rate, death rate, migration). Demographic indicators of the Ignalina NPP region and Lithuania in 2022 are presented in Table 4.7-1.

Table 4.7-1. Demographic indicators in 2024 (https://osp.stat.gov.lt/)

Indicator	Visaginas town	Ignalina district	Zarasai district	Utena county	Lithuania
Permanent residents, people	19 493	13 746	14 222	125 008	2 891 232
Population density, people/km^2	337.7	9.6	10.8	17.5	44.2
Population under 14, %	12.4	9.6	10.8	10.8	14.5
Population aged 15-64, %	60.7	63.2	64.2	64.4	65.1
Population aged 65 and over, %	26.9	27.2	25.0	24.7	20.3
Share of men, %	45.8	47.5	47.4	48.0	47.3
Share of women, %	54.2	52.5	52.6	52.0	52.7
Number of births, people	80	66	71	568	18 673
Birth rate per 1000 inhabitants	4.1	4.8	5.0	4.6	6.5
Number of dead, people	305	314	293	2 298	37 444
Death rate per 1000 inhabitants	15.6	22.9	20.6	18.5	13.0
Natural population change, people	-225	-248	-222	-1 730	-18 771
General rate of natural population change per 1000 inhabitants	-11.5	-18.1	-15.6	-13.9	-6.5
Demographic aging factor	217	283	231	228	140
Net migration, people	37	27	-112	-1 746	23 099

As can be seen from the data for 2024 presented in the Table 4.7-1, the largest share of the population by age structure is made up of residents aged 15–64 in Visaginas town – 60.7%, in the Republic of Lithuania – 65.1%. According to the birth rate per 1000 inhabitants, in 2024 Visaginas town had the lowest rate in the Ignalina NPP region and was 37% lower than the Lithuanian average. The death rate per 1000 inhabitants in Visaginas town was the lowest in the Ignalina NPP region, but 20% higher than the Lithuanian average. The higher death rate of the Ignalina NPP region is explained by the fact that people aged 65 and older living in the region make up more than 25% of the population, while in Lithuania the share of this age group is 20.3%. The highest demographic aging factor in the Ignalina NPP region is in the Ignalina district, which is 102% higher than the Lithuanian average, the lowest – in Visaginas town, but even there the coefficient value is 55% higher than the Lithuanian average.

4.7.1.2 Economic activity

From an economic point of view, the Ignalina NPP region is a poorly developed region of Lithuania (except for Visaginas). Agriculture of low intensity and forestry dominate in the region. Ignalina and Zarasai district municipalities are classified as areas where farming conditions are less favourable [95]. The main reasons for this classification are: a large proportion of infertile lands in the region, low grain crop productivity, and low rural population density. No valuable mineral resources (except for quartz sand) have been discovered in the Ignalina NPP region.

The main features of the economic activity of the Ignalina NPP region:

- The predominant activities of the population are wholesale and retail trade, vehicle repair and construction, information and communications, artistic, entertainment and recreation activities and other service activities;
- Land use – extensive agriculture, forestry, rural tourism and organic farming;
- Several years ago, economic activity in Visaginas became more diverse, especially diversification in the service and industrial spheres increased;
- Recreational and resort activities have been developed in the Ignalina NPP region and nearby.

The number of economic entities operating in the Ignalina NPP region in 2022 was 1103, in 2023 – 1191, in 2024 – 1305, in 2022 – 735, in 2023 – 800, in 2024 – 951. The region is dominated by small companies (about 75% of all companies), with 4 or fewer employees. In 2023, the annual turnover of companies operating in Visaginas city was about 261 million euros, Ignalina district companies – about 163 million euros, Zarasai district – about 156 million euros. Among the major employers in addition to Ignalina NPP (about 1600 employees), CJSC "Visagino linija" operates in Visaginas, which employs about 600 people, and "Intersurgical", which employs about 420 people.

Foreign direct investment at the end of 2023 was 17.79 million euros in Visaginas municipality, 8.07 million euros in Zarasai district, and 14.42 million euros in Ignalina district. Foreign direct investment per capita in the municipalities of the Ignalina NPP region is more than 10 times lower (Visaginas – 908 euros, Ignalina district – 1,044 euros, Zarasai district – 562 euros) than the Lithuanian average of 12 320 euros per capita.

In 2024, the number of employed people in the Ignalina NPP region (i.e. the number of people aged 15 and over who work in any job and receive wages in cash or in kind or have income or profit) amounted to about 19.6 thousand people. Compared to the total employment rate of the Lithuanian population (73.6%), the employment rates of the population in the municipalities comprising the Ignalina NPP region were lower in 2024 - the employment rate in Visaginas municipality reached

62.8%, in Ignalina district - 51.7%, in Zarasai district - 55.6%. Based on 2024 data, the ratio of registered unemployed people to working-age residents in the Ignalina NPP region is higher than in Lithuania (8.7%) - in Visaginas, Ignalina district and Zarasai district municipalities - 9.8%, 12.6% and 10.7%, respectively.

4.7.2 Potential impact

The planned economic activity will be carried out at the industrial site of the Ignalina NPP. A sanitary protection zone (SPZ) has been established around the Ignalina NPP within a radius of 3 km, where economic activity not related to the operation and decommissioning of the Ignalina NPP is restricted. There are no permanent residents in the established SPZ. The decommissioning works will be carried out by qualified Ignalina NPP personnel, the dismantling and demolition works of the structures will be carried out by employees of Ignalina NPP or other regional companies. The planned economic activity will have a positive impact on the social and economic environment, ensuring employment for the population of the Ignalina NPP region.

The decommissioning of the Ignalina NPP and the management of radioactive waste are financed by the European Union through the Ignalina Programme (86%) and the budget of the Republic of Lithuania (14%) [96]. According to FDP, the planned cost of decommissioning the INPP in the is 3.3 billion euros (including risks and inflation, but excluding physical and fire protection costs). For the period 2000–2027, the European Commission has committed to allocate 2.1 billion euros for decommissioning, and the Republic of Lithuania has allocated 218.3 million until 2021 inclusive. The share of Lithuania's contribution to decommissioning will not be increased and will remain at 14%. In order to continue the decommissioning of INPP using the immediate dismantling strategy, it is important to ensure the financing of this activity until the completion of the decommissioning works at INPP. According to the first package of proposals for the 2028–2034 multiannual financial framework published by the European Commission, 678 million euros is planned as seven years financial support for the Ignalina NPP decommissioning programme.

A very important factor is the age of the employees of the Ignalina NPP. At the end of 2022 ~1605 employees worked at the INPP, of which ~180 had already reached retirement age. In 2024, almost 350 employees reached retirement age, and in 2027 – almost 600 will reach that age. It is likely that some of the employees of retirement age will continue to work at the INPP, but it is predicted that due to ageing, the INPP will lose a third of its current employees. With the departure of these employees, a large part of whom have been working since the beginning of the operation of the Ignalina NPP, part of the historical memory and knowledge will inevitably be lost. The design of the dismantling of the equipment, structures and systems of the Ignalina NPP is an activity where historical knowledge is very valuable. In order to compensate for the number of retiring personnel, a whole series of measures are being implemented to promote the attraction of young specialists and new competencies, as well as retraining and upskilling of existing personnel, preservation of critical knowledge, formation of a strong and desirable employer image, and promotion of employee loyalty.

As indicated in the EIA program [6], no studies of the impact on the socio-economic environment are planned in the EIA report for the planned economic activity.

4.7.3 Impact mitigation measures

No exceptional and specific mitigation measures for the socio-economic environment related to this planned economic activity are foreseen. The implementation of the Ignalina NPP decommissioning using immediate dismantling strategy, making maximum use of the existing workforce and competencies of the INPP, is one of the important factors reducing the impact on the socio-economic environment of the Ignalina NPP region. Moreover, after the completion of the decommissioning works, the INPP site will continue to operate the NF intended for the storage and disposal of radioactive waste, therefore the personnel operating these NF will continue to be employed in this area. Since many nuclear power plants in the world have already been built quite a long time ago and many of them will be decommissioned over time, the Ignalina NPP has already accumulated and will continue to gain unique experience in the future, through reactor dismantling, which can be applied to other NF operation or decommissioning projects and in the field of radioactive waste management.

4.8 Immovable cultural heritage

4.8.1 Current state

The planned economic activity will be carried out at the Ignalina NPP industrial site in a restricted area. The following cultural heritage objects are located outside the Ignalina NPP industrial site, at a distance of 0.6-2.5 km from the site of the planned economic activity (see Figure 4.8-1):

- Petriškės ancient settlement (area of the territory – 8000 m^2, the nature of the valuable characteristics - archaeological).
- Petriškės ancient settlement II (area of the territory – 3100 m^2, the nature of the valuable characteristics - archaeological).
- Petriškės ancient settlement III (area of the territory – 16750 m^2, the nature of the valuable characteristics - archaeological).
- Petriškės mound (area of the territory – 4800 m^2, the nature of the valuable characteristics - archaeological).
- Grikiniškės ancient settlement (area of the territory – 30800 m^2, the nature of the valuable characteristics - archaeological).
- Grikiniškės ancient settlement II (area of the territory – 49500 m^2, the nature of the valuable characteristics - archaeological).
- Grikiniškės ancient settlement III (area of the territory – 18200 m^2, the nature of the valuable characteristics - archaeological).

Other objects important for cultural heritage (e.g. Čeberakų, Pasamanės mound, Lapusiškės Hill, and etc.) are at the significant distance from the industrial site of the Ignalina NPP.

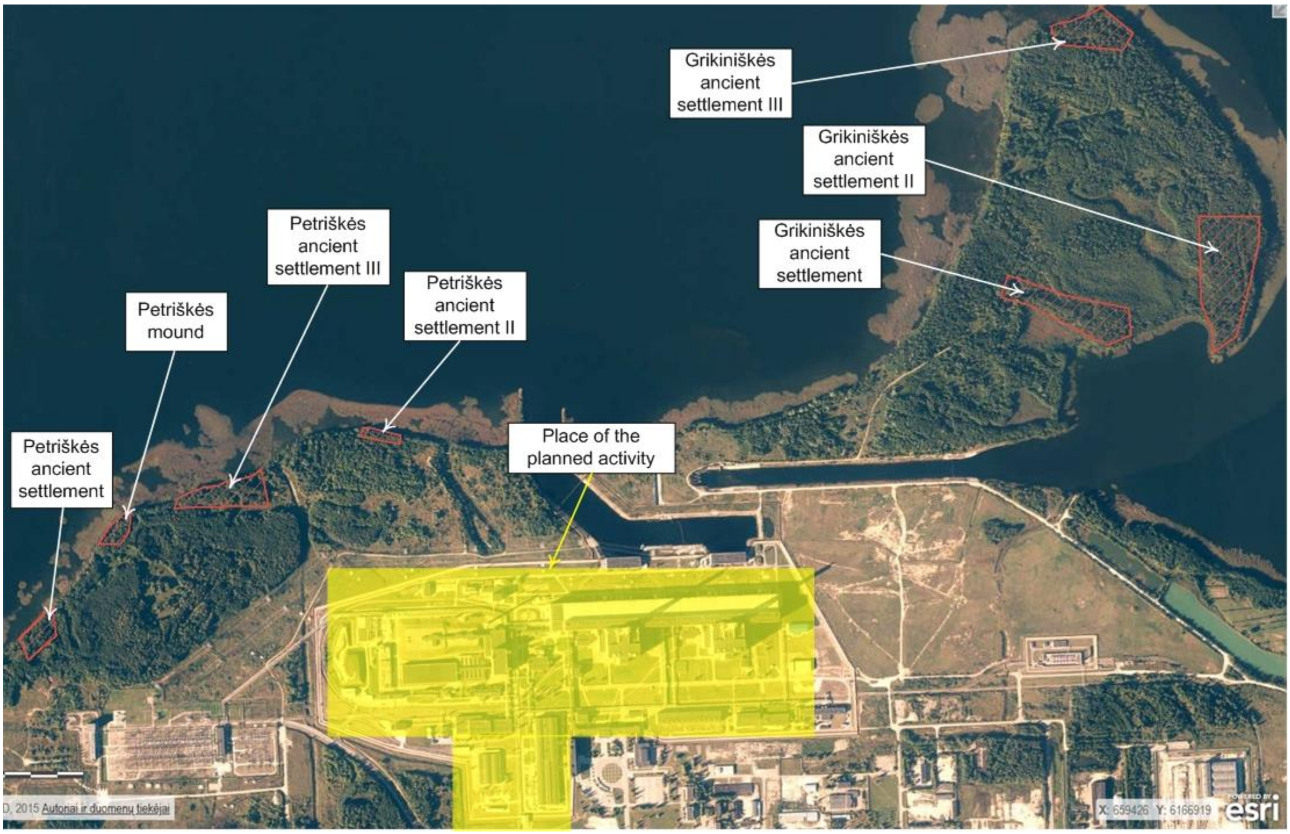

Figure 4.8-1. Cultural heritage objects located near the Ignalina NPP industrial site (information from the website https://kvr.kpd.lt)

4.8.2 Potential impact

The planned economic activity will be carried within the boundaries of the Ignalina NPP industrial site and will not affect the identified cultural heritage objects and zones.

As indicated in the EIA program [6], no studies of the impact on the cultural heritage values are planned in the EIA report.

4.8.3 Impact mitigation measures

Since the planned economic activity will not have an impact on the cultural heritage of the region, no mitigation measures are foreseen.

4.9 Public health

4.9.1 Current state

The current state of public health is described by presenting and comparing certain statistical indicators of morbidity and morbidity of the population of the Ignalina NPP region (Visaginas city, Ignalina and Zarasai districts), Utena county and the whole of Lithuania (see Table 4.9-1). Morbidity and morbidity are the main indicators of health statistics, respectively showing the number of new cases of the disease (acute and chronic diseases detected for the first time in life) detected during the year and the total ratio of the number of all known cases of the disease to the number of population at a given point in time. These indicators are publicly available in the Public Health Monitoring Information System (https://sveikstat.hi.lt) and the Official Statistics Portal of Statistics Lithuania (https://osp.stat.gov.lt/sveikata).

Table 4.9-1. Population health indicators in 2024 (https://sveikstat.hi.lt)

Indicator	Visaginas m.	Ignalina district.	Zarasai district.	Utena district.	Lithuania
220001 Morbidity (A00-T98, U04-Y98) per 10 000 inhabitants	9 292.6	8 412.3	8 209.5	8 254.8	8 873.0
220601 Morbidity of nervous system diseases (G00-G99) per 10 000 inhabitants	1 453.2	2 345.9	1 695.4	1 056.0	1 653.7
220501 Morbidity of mental illness (F00-F99) per 10 000 inhabitants	578.6	1 687.7	1 370.7	1 271.5	1 199.8
221001 Morbidity of respiratory diseases (J00-J99) per 10 000 inhabitants	4 084.6	2 838.4	2 886.5	2 347.8	3 452.8
220301 Morbidity of blood diseases (D50-D89) per 10 000 inhabitants	410.9	574.2	474.7	422.7	521.7
220201 Incidence of tumours (C00-D48) per 10 000 inhabitants	1 478.3	1 064.6	993.9	965.0	1 123.6

The overall morbidity rate of the residents of Visaginas city is higher than that of Lithuania and Ignalina NPP region and Utena county. However, morbidity rates for individual diseases, e.g. mental and blood diseases, are lower than the Lithuanian average and the overall indicators of the Ignalina NPP region and Utena county.

According to the General Regulations on Public Health Monitoring of Municipalities, approved by the Order of the Minister of Health of the Republic of Lithuania No. V-488 "On the

Approval of the General Regulations on Public Health Monitoring of Municipalities" of 11 August 2003, the Municipality of Visaginas Municipality. carries out public health monitoring in Visaginas municipality and publishes the results publicly in the annual reports. According to 2023 data, Visaginas municipality. Compared to the Lithuanian average, the values of public health monitoring indicators are distributed as follows: 48.9 per cent are better than the Lithuanian average, 24.5 per cent of indicators fall into the group corresponding to the Lithuanian average, and 26.6 per cent fall into the group of the lowest values. The main causes of death of residents of Visaginas municipality in 2023: from diseases of the circulatory system (I00-I99) – 138 people (72 men and 66 women), in second place malignant tumours (C00-C96) – 58 people (36 men and 22 women), in third place in diseases of the digestive system (K00-K93) – 15 people (15 men and 5 women).

4.9.2 Potential impact on staff

4.9.2.1 Non-radiological effects

The impact of the planned economic activity on the personnel carrying out the demolition works of buildings is related to the fact that dangerous works will be carried out, which are characterised by a higher occupational risk, in the event of which the probability of injury or other harm to the health of the employee due to the exposure of the harmful and/or dangerous factor(s) of the working environment is higher. During the planned economic activity, the following dangerous works will be carried out:

- Work that puts workers at risk of falling or falling, the risk of which is increased by the nature of the demolition, the working methods or the environmental conditions at the workplace or on the construction site;
- Work that poses a risk to the safety and health of workers due to the chemicals used;
- Installation and dismantling of prefabricated heavy elements;
- Lifting of loads by hand, mechanical loaders, excavators, cranes and other means;
- Work using potentially hazardous equipment;
- Work in the vicinity of moving machinery or parts thereof;
- Works close to high-voltage networks (wires);
- Works in wells, excavations, tunnels, collectors and other underground installations and structures;
- Earthworks in pathogenically contaminated soil, in the protective zones of underground power grids, gas pipeline and other underground communications;
- Soil mining and fortification;

- Works near the roadway.

Due to the above-mentioned hazardous works, a negative impact on the health of the employees carrying out demolition works is possible for the following reasons:

- Falling objects and hitting objects can cause injuries to employees;
- Dangers that arise from being in an environment that can impair vision;
- Acoustic noise, vibrations;
- Risk of hand injuries due to contact with materials and equipment;
- Falling from a height or danger of falling into a basement/pit;
- Inhalation of particulate matter, harmful gases or substances;
- Poisoning with chemicals.

The territory of the demolished structure and the workplaces, where potential risks to the health and safety of workers will be marked with signs established by occupational safety and health regulatory acts, collective and personal protective equipment of employees will be used, which are described in more detail in the Section 4.9.4 “Impact mitigation measures”.

4.9.2.2 Radiological exposure

The main requirements to ensure the long-term protection of personnel health from the dangers posed by ionizing radiation are set by the Lithuanian hygiene standard HN 73:2018 [97]. The hygiene standard is to be implemented in accordance with the provisions of the Law on Radiation Protection of the Republic of Lithuania [98] and Directive 2013/59/Euratom [99] of the Council of Europe. The hygiene standard [97] lays down the following limit doses for exposure of workers:

- the annual effective dose is 20 mSv. In exceptional circumstances, in agreement with the regulatory authority, a higher effective dose of up to 50 mSv per year shall be authorised, provided that the average annual dose does not exceed 20 mSv for any five consecutive years, including the year in which the limit dose has been exceeded.
- the annual equivalent dose for the lens of the eye is 20 mSv. The limit annual equivalent dose may be 50 mSv, provided that it does not exceed 100 mSv in any 5 consecutive years;
- annual equivalent dose for skin, limbs (hands and feet) – 500 mSv. The cut-off dose for skin is applied to the average annual dose of any area of 1 cm2, regardless of the area exposed to irradiation.

Radiation protection optimisation activities [100] are carried out at the Ignalina NPP in order to keep the exposure doses of the company's employees at a reasonably achievable minimum level. Additional radiation control requirements apply to INPP employees [101]: the annual dose limit to the employee is 18 mSv, the daily dose limit is 0.2 mSv. Planned exposure of workers in excess of the daily dose limit but not exceeding the annual dose limit may only be justified in pursuit of the following objectives:

- save lives or avoid serious injuries;
- avoid large doses of collective human exposure;
- to avoid the spread of an accident and its serious consequences.

Occupational exposure limits, up to 50 mSv per year, may only be permitted in exceptional cases and only in agreement with the regulatory authority.

The INPP implements a programme for monitoring the exposure of employees and workplaces [102], the purpose of which is to assess the effectiveness of the measures necessary for the creation of safe working conditions from the point of view of radiation protection, based on the analysis of the results of systematic measurements of the power of the respective exposure dose, radioactive air and surface pollution and effective dose of exposure of employees. The INPP ALARA programme and the INPP employee exposure and workplace monitoring programme are regularly reviewed and updated.

The dismantling of the equipment and structures of the Ignalina NPP and the maintenance of the INPP are carried out by the INPP personnel. During the period of decommissioning of the INPP, the number of INPP personnel monitored and controlled from the point of view of radiation protection decreased from approximately 2100 (2010) to 1340 (2024) employees. Personnel of other (external) organisations, performing works under contracts, are used to carry out specific activities in the decommissioning activities of the INPP. From the point of view of radiation protection, the number of personnel of other organizations monitored and controlled in individual years amounted to about 600 - 1000 employees.

The collective exposure of INPP personnel and other organisations is summarised in Figure 4.9-1. The collective dose of INPP personnel performing INPP post-operational maintenance, dismantling of disused equipment and structures, and management of RAs amounted to an average of about 700 man-mSv/year. The collective exposure of the staff of other organizations is significantly lower and amounts to an average of about 20 man-mSv/year.

The average exposure of INPP personnel and employees of other organisations is summarised in Figure 4.9-2. The average exposure of INPP employees is less than 0.8 mSv/year and accounts for an average of about 2% - 4% of the limit annual effective dose. The exposure of INPP personnel during decommissioning is managed and complies with the ALARA principle. The average exposure of employees of other organizations is on average about 0.03 mSv/year.

The maximum annual exposure of individual employees did not exceed the radiation protection [97] and INPP [101] requirements, see Figure 4.9-3. In the period 2010-2024, the annual effective dose of no employee exceeded 18 mSv. The number of employees with exposure to more than 10 mSv/year is not large and only in separate years (2018 and 2024) amounted to 17 employees per year, respectively 1%-1.3% of the total number of INPP personnel. Employee exposure is reduced by applying various technical (biological protections, extended tools, automatic cutting tools, remote-controlled mechanisms, MFIs, decontamination of premises, etc.) and organisational (permission to carry out activities according to instructions and orders, training of employees, marking of premises, control of access to certain premises, etc.).

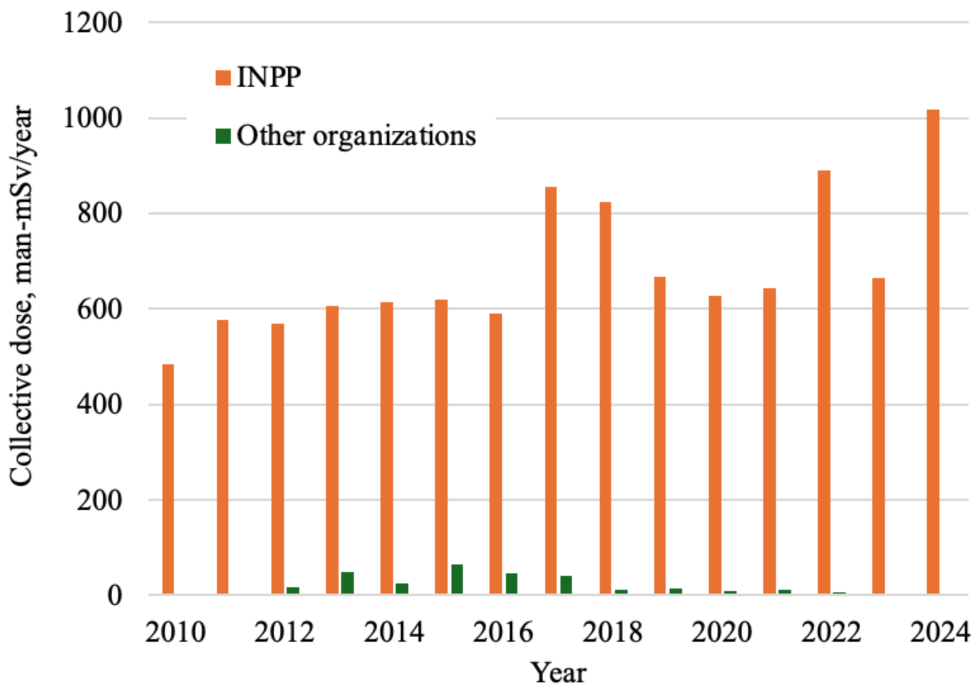

Figure 4.9-1. Collective annual effective dose of employees of the INPP and other organizations

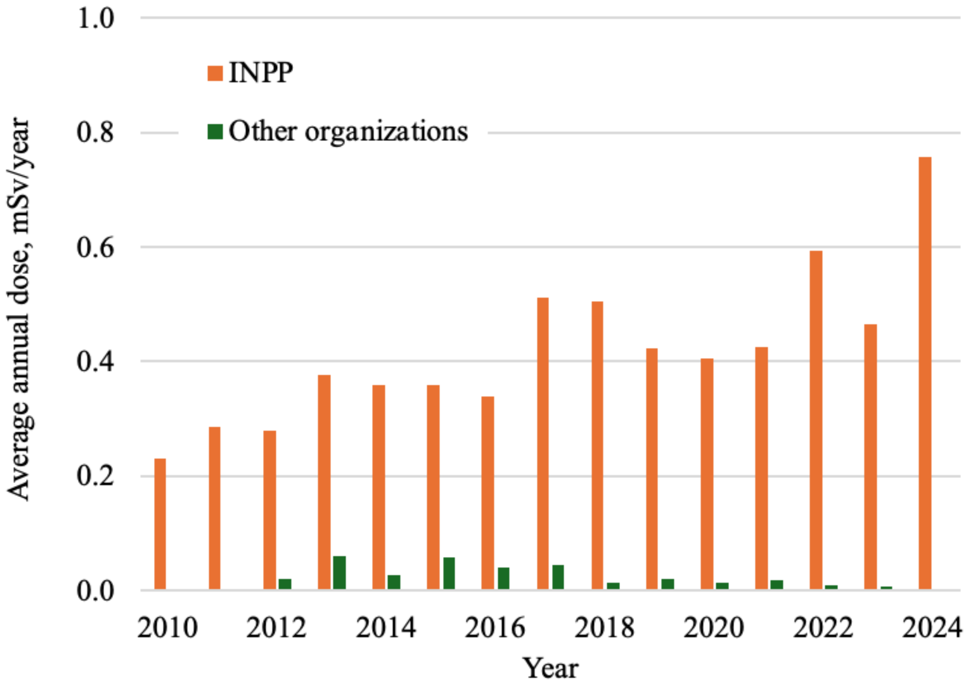

Figure 4.9-2. Average annual effective dose of employees of INPP and other organizations

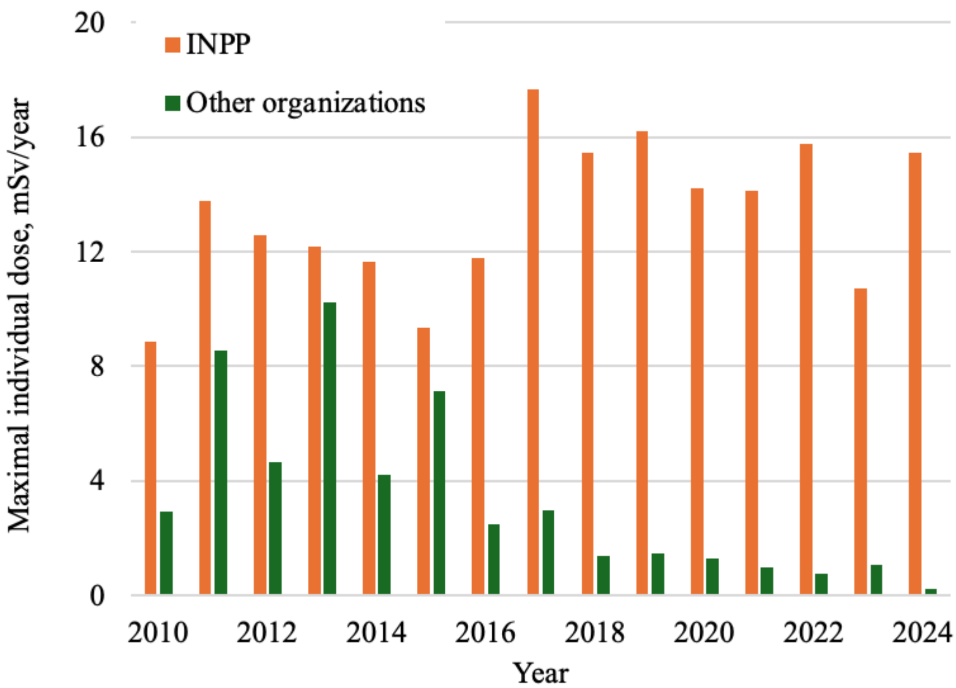

Figure 4.9-3. Maximum annual effective dose for employees of INPP and other organizations

The collective dose may increase in the future as the INPP staff decreases and the dismantling of equipment increasingly contaminated with radionuclides is carried out. Limiting and optimizing the exposure of both the collective staff and the individual employee will require the wider use of remote-controlled equipment, e.g. dismantling of reactor R3 zones, some adjacent elements of the main circulation circuits, and pre-treatment (shredding, containerization) of Class C, E SRW. Selection of dismantling tools and technologies, determination of the sequence of works, control and optimization of personnel exposure is carried out in the preparation of technical projects for the dismantling and initial treatment (D&PT) of individual equipment and structures. The safety of technical solutions, including the radiation protection of personnel, is evaluated and justified in the preparation of safety analysis reports for D&PT technological projects. The compliance of personnel safety solutions with the established radiation protection requirements and the ALARA principle is assessed by the responsible authorities. The permit to carry out D&PT works is issued by VATESI [10].

4.9.3 Potential impacts on population

4.9.3.1 Non-radiological effects

During the demolition of structures, potential impacts on public health are related to air pollution and noise.

During the dismantling and demolition of building structures, dust will be generated, demolition techniques and means of transport will emit CO, NO_x, SO_2 and particulate matter into the air. Air pollution will be local, covering the territory of the demolished structure and its surroundings within a radius of ~100 m. In addition, demolition works will be carried out in the open air, natural air circulation will allow to avoid the accumulation of significant concentrations of pollutants. According to the data of the chemical and radiological monitoring of ambient air since the beginning of the operation of the Ignalina NPP, the decommissioning works of the Ignalina NPP have not had a significant negative impact on the ambient air so far.

The machinery used for the demolition of the structures will make noise, which will be controlled. Periodically, a noise assessment will be carried out in the area. If the limits are exceeded, the sounds of the devices and equipment used will be reduced by the use of aperture suppressors, sound-absorbing enclosures or panels, acoustic barriers and screens. As in the case of air pollution, noise exposure is possible only in the very territory of the structure to be demolished and its surroundings (at a distance of 300-500 m), where there are no permanent residents, and the personnel carrying out the work will be most affected (see Section 4.9.2.1).

4.9.3.2 Radiological exposure

The main requirements to ensure the long-term health protection of the population from the dangers posed by ionising radiation are set by the Lithuanian hygiene standard HN 73:2018 [97]. The hygiene standard is to be implemented in accordance with the provisions of the Law on Radiation Protection of the Republic of Lithuania [98] and Directive 2013/59/Euratom [99] of the Council of Europe. The hygiene standard [97] sets the following limit doses for exposure of the population:

- annual effective dose of 1 mSv;
- an annual equivalent dose for the lens of the eye – 15 mSv;
- annual dose equivalent to skin – 50 mSv. The limit dose applies to the average annual dose of any area of 1 cm^2, regardless of the area exposed to irradiation.

In order to optimize radiation protection, limited doses are set in the planned exposure situation. For populations exposed to exposure from radioactive releases from NF and exposure directly from NF annual effective dose constrain is 0.2 mSv [97]. This dose constrain is applied to residents who live and carry out economic activity outside the NF sanitary protection zone, but who may enter it (taking into account statistical data on the peculiarities of the lifestyle and nutrition of local residents) or who work in the NF sanitary protection zone while carrying out permissible economic activities not related to the construction, operation, decommissioning or maintenance of closed radioactive waste repositories of NF.

The annual effective dose E of the population's exposure to the environment due to radioactive material releases from the INPP site buildings and adjacent NF is calculated by applying the so-called dose multiplication factors:

$$E = \sum_i Q_i \times g_i$$

Here:

E – is the annual effective dose of a resident due to the releases of radionuclides into the environment, Sv. Annual effective doses are calculated separately for releases into ambient air and into ambient water, Sv;

Q_i – is the annual releases of the i radionuclide into ambient air or into ambient water, Bq;

g_i – is a dose multiplication factor for the i radionuclide, Sv/Bq. Dose multipliers are determined separately for releases into ambient air and into ambient water.

The assessment of population exposure using dose multiplication factors was introduced during the operation of the INPP. The dose multiplication factors established in 2000 were also applied at the beginning of the decommissioning of the INPP. In 2020, when updating the plan for the release of radionuclides from the Ignalina NPP into the environment [71], new dose multiplication factors were established and approved. The new dose multiplication factors were determined by applying simpler and significantly more conservative models of radionuclide dispersion in the environment and using more conservative general parameter values in the models [72]. The new dose multiplication factors for the most important radionuclides released into the environment are presented in Table 4.9-2. Dose multiplication factors [71] were calculated by assessing a representative population – a resident permanently residing immediately outside the existing 3 km radius SPZ of the INPP, growing and consuming food products of plant and animal origin in the garden and pasture located there, as well as catching and consuming fish caught in Lake Druksiai and using the water of Lake Druksiai.

Table 4.9-2. Dose multiplication factors for the most important radionuclides released into ambient air and water (Lake Drūkšiai) [71]

Radionuclide	Annual effective dose multiplication factor, Sv/Bq	
	For releases into ambient air	For releases into ambient waters
H-3	9.81E-20	8.12E-19
C-14	7.05E-18	-
Mn-54	2.10E-16	8.70E-17
Co-60	9.81E-15	6.46E-15
Sr-90	9.01E-15	2.89E-15
Nb-94	2.00E-14	1.34E-14
Cs-134	1.08E-14	8.25E-15
Cs-137	3.38E-14	2.82E-14
Eu-152	2.89E-15	7.59E-16
Eu-154	2.21E-15	6.13E-16
U-235	5.09E-15	2.39E-15
U-238	1.08E-14	2.47E-15
Am-241	1.94E-14	1.02E-14
Pu-238	2.05E-14	1.05E-14
Pu-239	2.35E-14	1.25E-14
Cm-244	9.53E-15	3.95E-15

Current and planned releases of radioactive materials from the INPP into the ambient water are presented in Sections 4.1.2.2 and 4.1.3. The current and planned exposure of the resident during the decommissioning of the INPP caused by radioactive releases into the ambient water (Lake Drūkšiai) is summarized in Figure 4.9-4. During 2010 – 2024 period, the annual effective dose of the resident changed from 5.0E-5 mSv/year to 1.4E-3 mSv/year, making an average of about 5.3E-4 mSv/year. From a conservative point of view, it is predicted that the radiation of the population after 2024 should not change substantially until the dismantling of the R3 zones of the reactors and would on average to be about 1E-3 mSv/year.

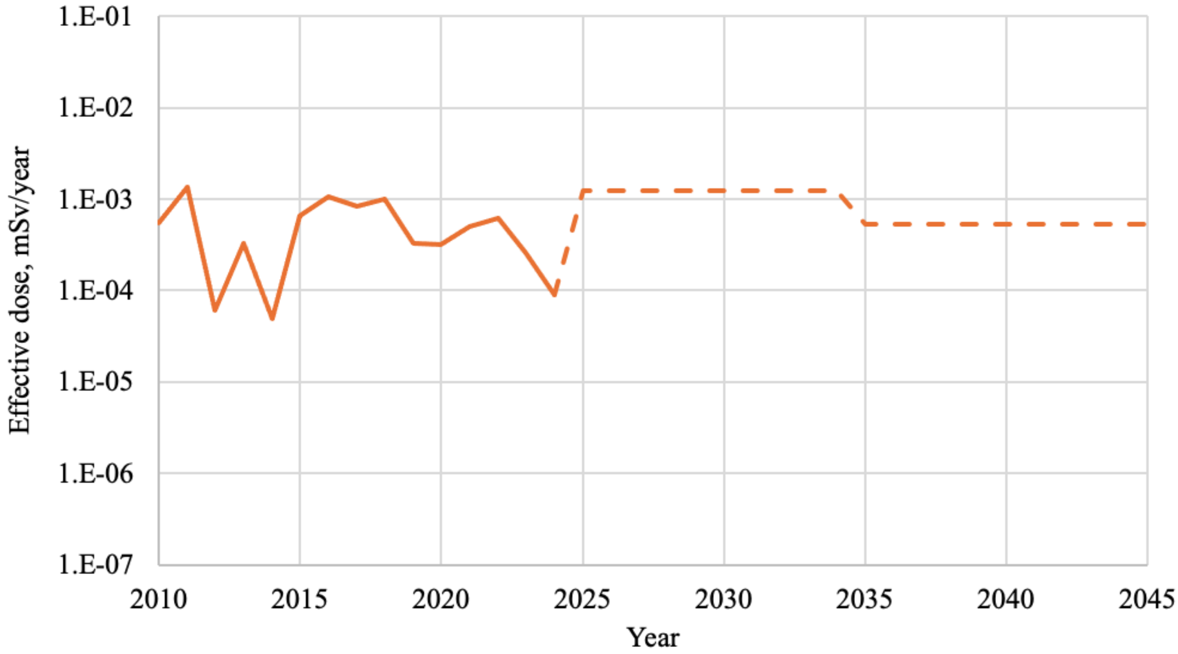

Figure 4.9-4. Annual effective dose to a resident due to radioactive releases into ambient water

The annual effective dose of the resident caused by radioactive releases into the ambient water through separate wastewater discharge channels is shown in Figure 4.9-5. The removal of SNF from power units and the removal of water from most SNF storage pools has reduced radionuclide releases from both reactor block buildings since 2022. An increase in radioactive releases is not foreseen in the future, but it is predicted that radionuclide releases will persist until the dismantling and initial treatment of radionuclide-contaminated equipment and systems in reactor units is completed. Therefore, about 1E-4 mSv/year of population exposure due to radioactive releases through the discharge channel and GPNN-3 is predicted. Radionuclide releases via GPNN-1,2 and the exposure of the population during decommissioning depended on the treatment of the LRW. The treatment of the LRW in building No. 150 will continue to be carried out, therefore, it is predicted that radionuclide releases via GPNN-1,2 will remain the main source of radiation of the population due to radioactive releases into the ambient water and may lead to about 1E-3 mSv/year of population exposure. The projected reduction of exposure after 2035, when all the LRW accumulated during the INPP operation will be treated and the quantities treated by the LRW will decrease, see Sections 3.1.1.2.3 and 3.2.3. The exposure of the population caused by GPNN-PBKS releases is not significant. This source of releases and the radiation of the population caused by it will not change in the future.

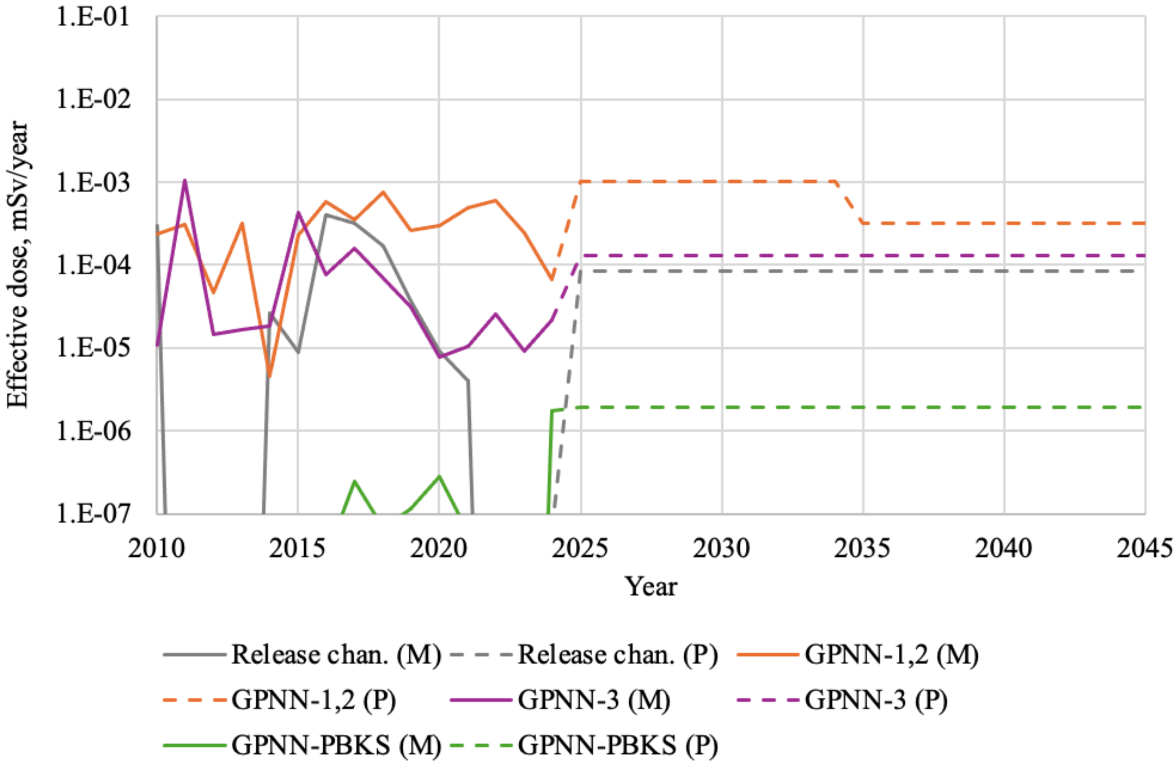

Figure 4.9-5. Annual effective dose to a resident caused by radioactive releases to ambient water through individual wastewater discharge channels. (M) – monitoring data, (P) – predicted releases

The annual effective dose of the population caused by the releases of individual radionuclides into the ambient water is shown in Figure 4.9-6. During 2010 – 2024, on average, about 78% of the annual effective dose of the population is caused by the releases of the radionuclide Cs-137. Radionuclides Co-60 and H-3 releases each account for 11% of annual exposure. It is predicted that this trend will continue in the future. Releases of radionuclide Cs-137 will result in approximately 79% of the population's annual effective dose, while releases of radionuclides Co-60 and H-3 will result in 14% and 6% of the population's annual effective dose, respectively.

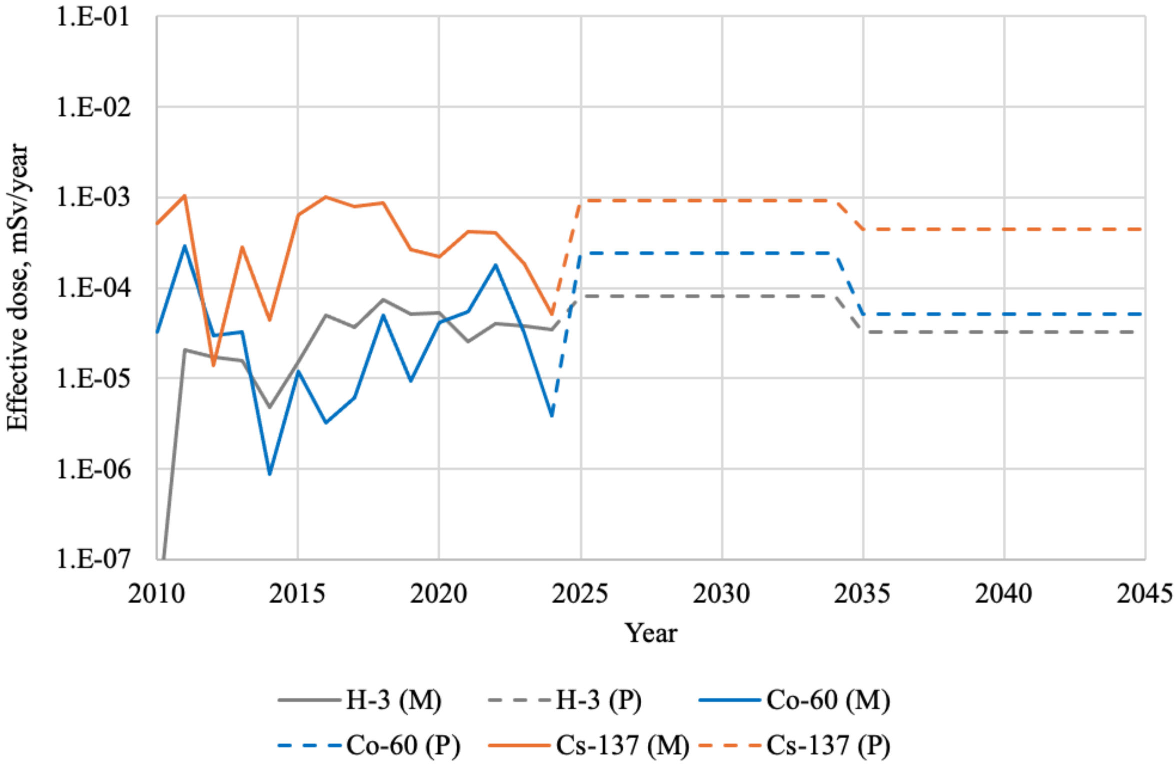

Figure 4.9-6. Annual effective dose to a resident due to releases of individual radionuclides into ambient water. (M) – monitoring data, (P) – predicted releases

Current and planned releases of radioactive materials from the INPP and adjacent NF into the ambient air have been evaluated in Sections 4.2.2.2 and 4.2.3.2. The exposure of the population caused by the releases of radionuclides of groups H-3, C-14 and IR into the ambient air is summarised in Figure 4.9-7. On average, the release of radionuclides of the IR group determines about 84% of the annual exposure of the population. On average, the release of radionuclide C-14 leads to about 16% of the annual exposure of the population. The exposure caused by the release of radionuclide H-3 is not significant. In the period 2010-2024, the annual exposure of a resident due to radioactive releases into ambient air averaged about 1.3E-3 mSv/year, varying from the start of decommissioning works of 5E-4 mSv/year in 2010 to 3.6E-3 mSv/year in 2024. It is predicted that the radiation of a resident due to radioactive releases into the ambient air should not exceed 4E-3 – 5E-3 mSv/year.

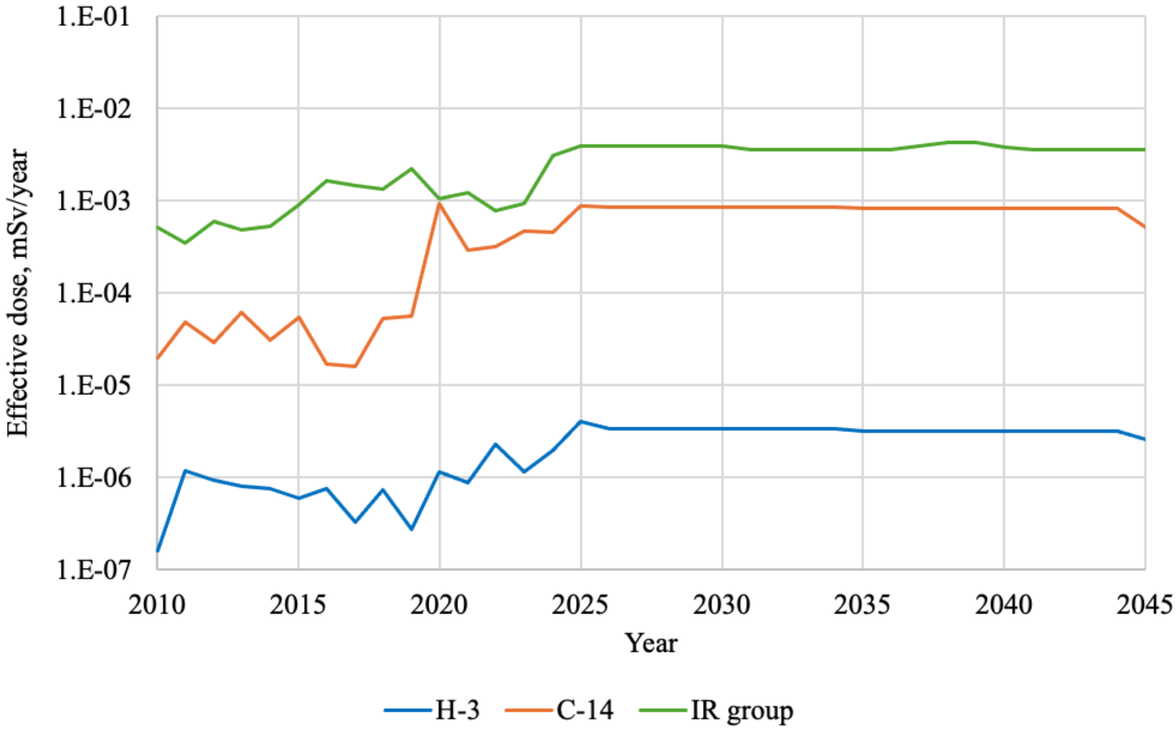

Figure 4.9-7. Annual effective dose to a resident due to releases of radionuclides of the H-3, C-14 and IR groups into ambient air

The radiation of the resident caused by the releases of radionuclides of the IR group into the ambient air is additionally detailed in Figure 4.9-8. Releases of radionuclides Co-60 and Cs-137 account for about 96% of the annual exposure of the population. The releases of the radionuclides Sr-90 and Nb-94 leads to about 4% of the annual exposure. The proportion of the remaining IR radionuclides in the annual effective dose is less than 1%.

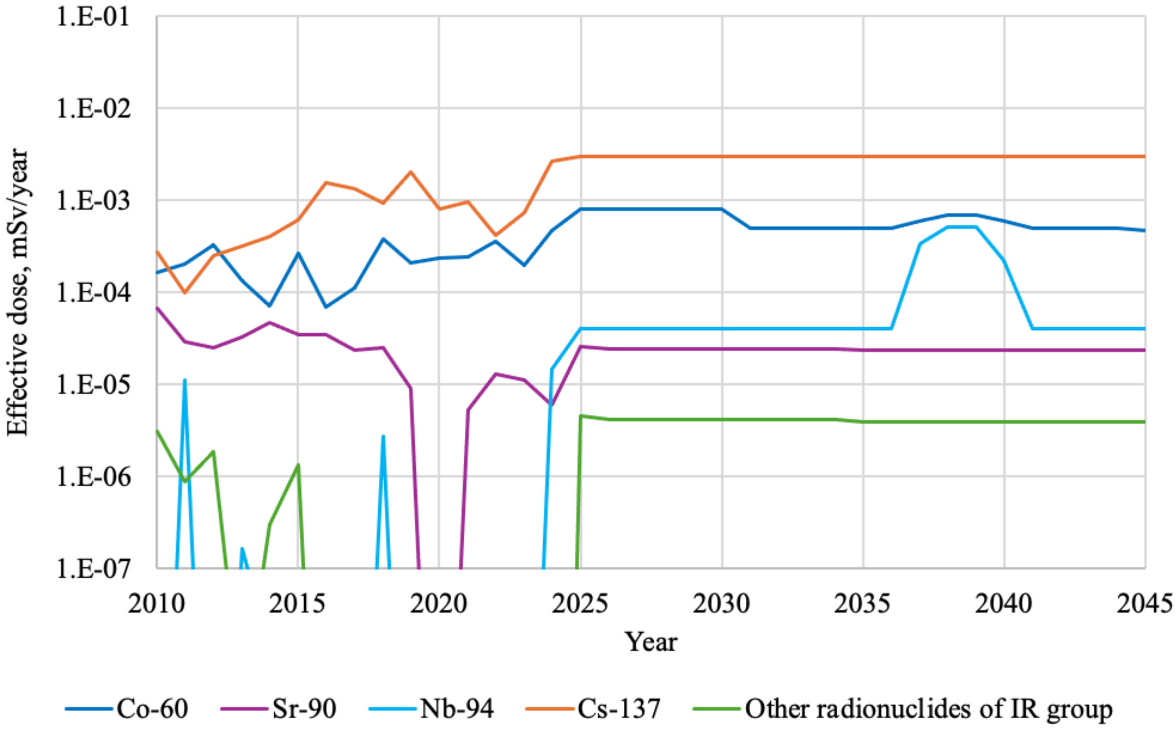

Figure 4.9-8. Annual effective dose to a resident due to releases of IR group radionuclides into ambient air

The ionising radiation fields in the western part of the INPP site have increased due to the SRW accumulated during the operation of the INPP and stored in buildings No. 157 and No. 157/1 and the activities carried out for the removal of these SRW, see Section 3.2.2. The increase in the background of ionizing radiation is measured in the western part of the INPP site. The increase in ionizing radiation is local and decreases rapidly with a distance. The retrieval of the SRW (in particular group G3) from the existing buildings Nos 157 and 157/1 will remove this source of ionising radiation. Gamma radiation dose rate measurements with stationary sensors of the INPP SkyLink system [85] installed at various distances from the INPP site are summarized in Figure 4.9-9. The increase in the background of ionizing radiation in a permanent living environment is not measured. The gamma radiation dose rate outside the INPP SAZ does not differ from the gamma radiation dose rate in more remote areas.

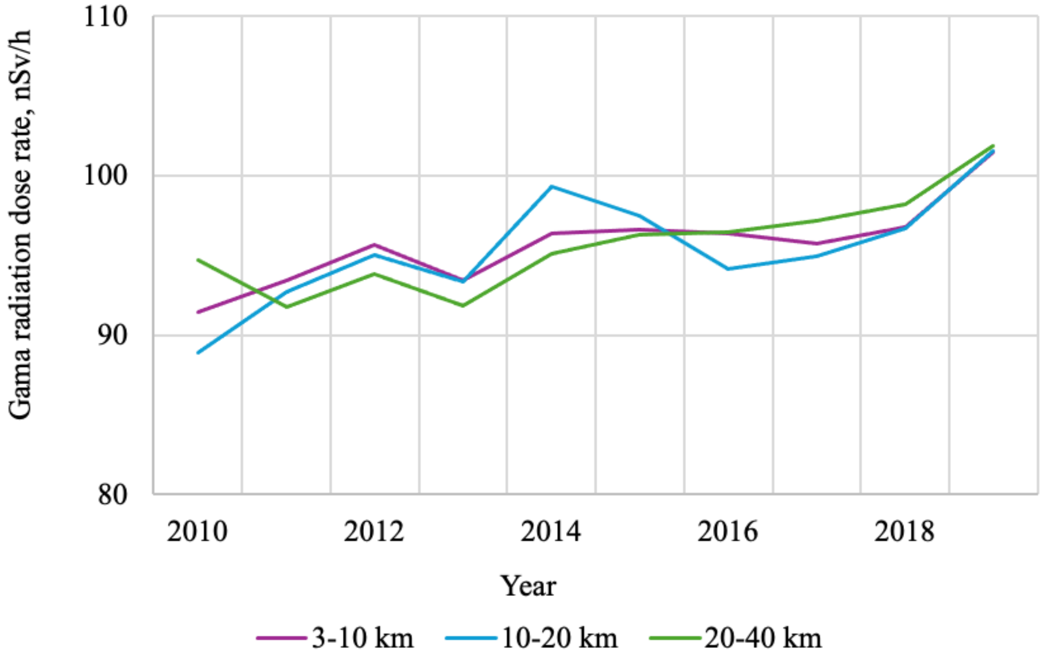

Figure 4.9-9. Variation of the average annual dose rate of gamma radiation near the INPP SPZ and moving away from INPP

Figure 4.9-10 summarizes the measurements of the annual ambient ionizing radiation dose equivalent with stationary TLD dosimeters [85] installed at various distances from the INPP site. Ionizing radiation exposure near the INPP SPZ does not differ from exposure in more distant areas. Measurements of the environmental dose equivalent show that the decommissioning and RW management activities carried out at the INPP site and the adjacent NF do not lead to direct exposure of the resident.

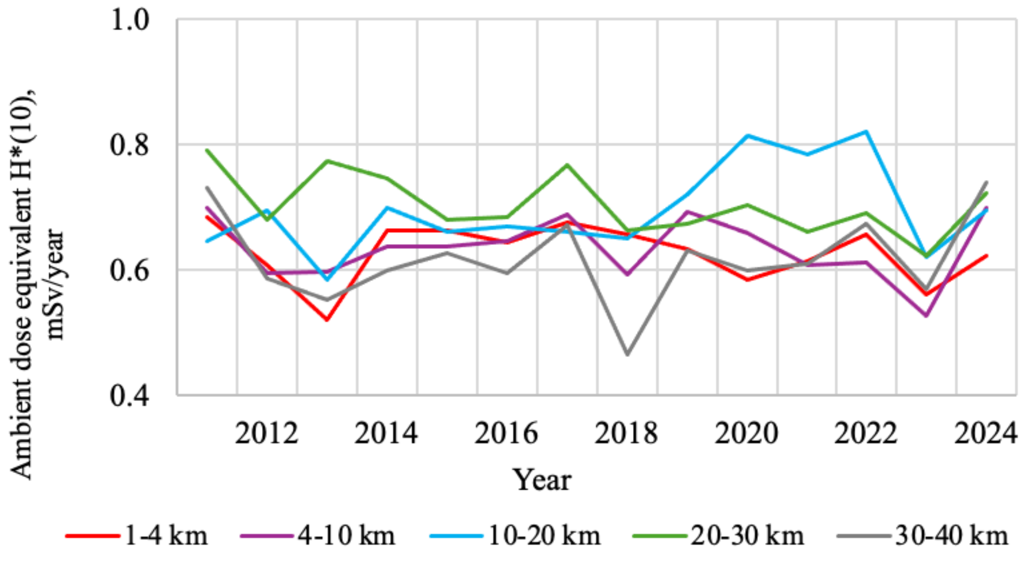

Figure 4.9-10. Measurements of the average annual environmental dose equivalent using TLD dosimeters near the INPP site and away from INPP

Similar results are presented in the reports of the state radiological monitoring carried out in Lithuania, where dose equivalent measurements in the INPP region are compared with those of other regions of Lithuania (Kupiškis district, Vilnius district) and the main cities of Lithuania (Vilnius, Kaunas, Panevėžys, Šiauliai and Klaipėda), see Figure 4.9-11. Based on the results of the measurements for 2010 – 2024 in the reports of the State Radiological Monitoring [88], [103] and others, it is concluded that the works carried out by the INPP do not lead to additional exposure to the residents of Lithuania.

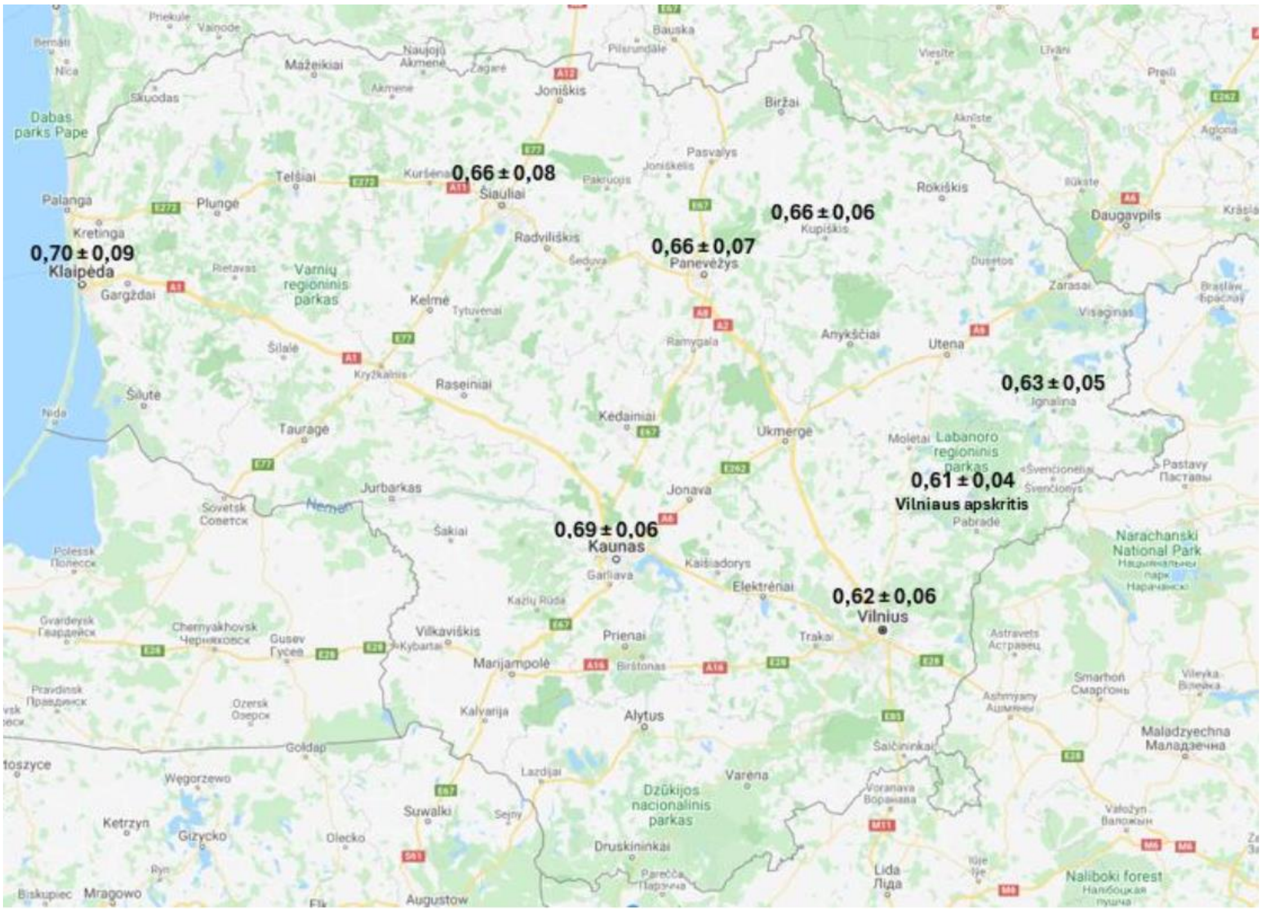

Figure 4.9-11. Average annual environmental dose equivalent (mSv) in the largest cities of Lithuania, Vilnius county, Ignalina and Kupiškis districts in 2024. [103]

The resident's exposure due to the ongoing and planned decommissioning of the INPP is summarized in Figure 4.9-12. The annual effective dose of the population in the period 2010 – 2024 averaged about 2E-3 mSv/year, increasing to 4E-3 mSv/year in individual years. It is predicted that with the continuation of decommissioning activities, the annual effective dose of the population may be about 6E-3 mSv/year. The planned exposure of the population will not exceed the established dose constrain, which is 0.2 mSv/year. The planned exposure of the population can be about 3% of the dose constrain.

After 2045, after the completion of the dismantling of the reactors and the repair of intermediate-level radioactive (class C and E) RW, as well as the repair of most of the low-level radioactive (class B and E) RW, the dismantling of residual equipment and systems will be carried out. The activities will include the management of short-lived low-level radioactive (class B) and very low-level radioactive (class A) RW. During this period, the impact on the population will be similar and smaller (due to radioactive decay) than at the beginning of the decommissioning of the INPP, when most of the similarly contaminated equipment and systems were dismantled.

The annual effective dose of the resident caused by the decommissioning of the INPP will not exceed 10 μSv and may be considered to be insignificat from the point of view of radiological effects.

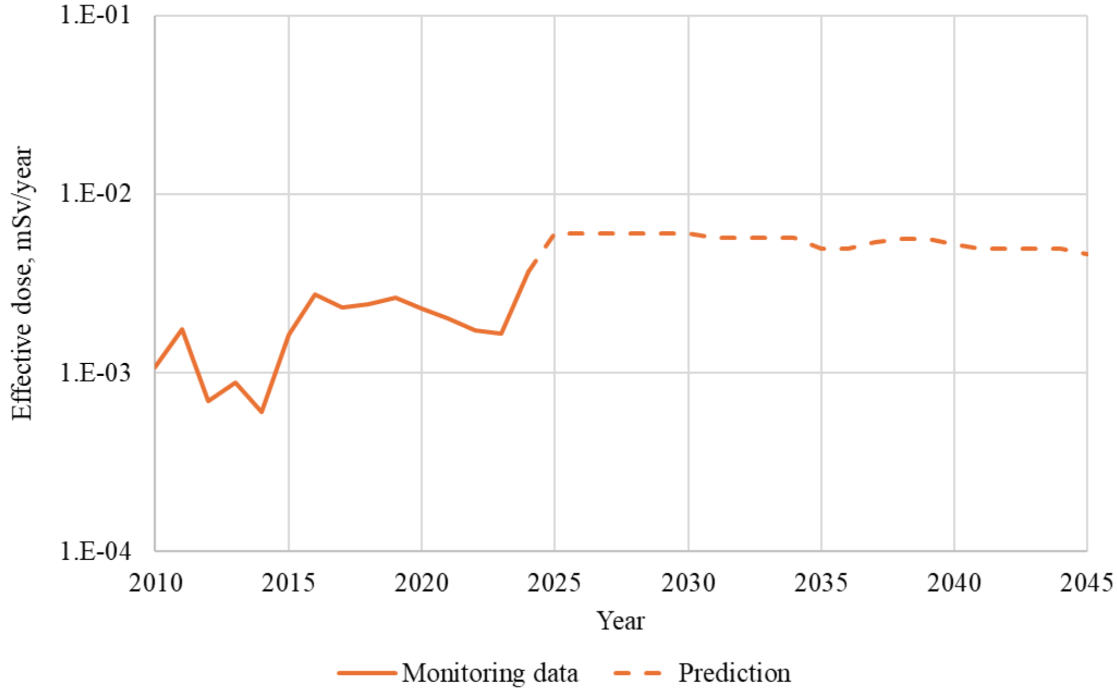

Figure 4.9-12. Annual effective dose to the population due to the decommissioning of INPP

4.9.4 Impact mitigation measures

The measures to reduce the negative impact of air pollution and noise caused by the demolition works carried out during the decommissioning of the INPP are the irrigation of the demolished structures of the building and the construction scrap that is being managed with water so that it does not cause dust, and the impact of noise sources on residents can be suppressed by acoustic barriers, screens and other sound-absorbing means.

Collective and personal measures to reduce the negative impact can be applied to workers carrying out demolition works. Collective protection measures include warning signs, fencing of work areas, installation of crossing bridges with fencing over trenches, use of inventory ladders and stickers, collective regulatory measures to improve work organisation and workplace planning (reducing noise, vibration). Workers' personal protective equipment (PPEs) is very diverse and depends on the nature of the work performed and the risks and impacts it poses. Employees' APP consists of protective helmets, safety glasses, face shields, protective headphones, respirators, gas masks with an air supply hose, gloves against mechanical impact, work clothes, gloves and shoes, a bright vest, and those working at height must have harnesses.

Radiation protection of personnel and specific radiation protection measures adequate to the planned activities must be foreseen in the preparation of the D&PT technological designs and evaluated in the safety analysis reports of these projects. The planning of new D&PT projects must use the experience gained during the implementation of previous D&PT projects, proven work tools and ways of organising work. Only trained personnel who are instructed for a specific activity should work. Activities in which personnel are exposed to increased exposure must be continuously evaluated and, if necessary, adjusted by applying additional technical and organisational measures for radiation protection.

The radiation doses of the population due to radioactive releases into the environment are not high and are predicted to be about 6% of the dose constrain. Decommissioning activities must be planned and carried out while maintaining low releases of radioactive materials into the environment. Measures to limit exposure to the population must be foreseen in the preparation of the D&PT technological designs and evaluated in the safety analysis reports of these projects.

In order to optimize the operation of the ventilation systems of the power units and reduce energy consumption, it may be appropriate to fully or partially dismantle the existing 150 m high ventilation stacks of the power units before preparations are made for the dismantling of the R3 zones of the reactors and to organize releases into the ambient air through lower ventilation stacks. The assessments of radioactive releases into the ambient air performed in this EIA report (see Section 4.2.3.2) and the assessments of the impact of radioactive releases into the ambient air on the population (see Section 4.9.3.2) include the situation if the main ventilation stacks of the INPP were partially dismantled or replaced with smaller ones. Doses to the population are calculated using very conservative (in relation to the 150 m high INPP ventilation stacks) dose multiplication factors established in the 2020 INPP Radionuclide Release Plan [71]. When modifying the stacks, it is important to maintain the same effective filtration of aerosol and other radioactive particle releases. The 3 km radius of the INPP SPZ must also be maintained, as this condition was assessed when determining dose multiplication factors [71]. In the case of conventional gaseous pollutant releases (due to hot cutting operations, diesel plant operations, during which gaseous CO, NO_x, etc. are generated), when it is necessary to assess the local impact of pollution on the INPP site and the compliance of pollutant concentrations with environmental pollution standards (see Table 4.2-2), additional pollution dispersion calculations may be required. The local impact of releases into the ambient air on the INPP site can be specified when preparing technological projects for individual D&PT works. The safety of technical solutions, including environmental protection (prevention of releases into the environment, monitoring and compliance with the established requirements), is assessed and justified when preparing safety analysis reports for technological projects.

5 RISK ANALYSIS

5.1 Risk assessment

The risk analysis performed in this EIA report is based on the already completed safety analysis assessment of the decommissioning of the Ignalina NPP and its report [104], providing summary information on initiating events, hazards, possible consequences, and risk prevention and consequence mitigation measures.

When preparing previous decommissioning projects, justifying their safety and assessing potential impacts, the following initial events were taken into account, which could have a negative impact on personnel, residents and the environment:

- external natural events (e.g. wind, snow, rain, ice, temperature, flood, lightning, earthquake, etc.);
- external events caused by human activity – accidents caused by an airplane crash, explosions, fires, loss of electricity, etc.;
- internal events that have occurred in the installation or site, such as fire, explosion, destruction of the structure, leakage or spillage, failure of the ventilation system, drop of heavy loads, etc.;
- internal events caused by human activity, such as operator errors, violations of work discipline, etc.

The hazards and risks that may potentially occur during decommissioning are summarised in Table 5.1-1. Possible accidents related to the management of SNF (Class G SRW) are not examined in this report, since at the time of preparation of the report all SNF at the INPP has already been removed from the reactor units, placed in long-term storage casks and placed in storage facilities ISFSF-1 and ISFSF-2, see Section 3.2.1.

Table 5.1-1. Assessment of potential risks during the decommissioning of the Ignalina NPP

Object		Hazard source	Risk	Consequences	Preventive and mitigation measures
No.	Activity				
			Premises of buildings No. 101/1 and No. 101/2		
1.	Transportation of classes A, B, C, D and E SRW inside buildings	Cargoes and fragments of equipment contaminated with radioactive materials	Load drop due to LM failure or personnel error	Exposure of personnel due to the dispersion of radioactive aerosols	Compliance with the applicable safety and health requirements of INPP employees when performing works with LM and means of transport. Operation and maintenance of LM and cargo grabs in accordance with the applicable INPP requirements. Use of standard grippers and containers. Use torque sensors to control the weight of the load being lifted. To develop schemes for the slinging of specific cargoes in the work procedures. Use PPE to protect the respiratory organs. Involvement of qualified

					and trained personnel, instruction of all employees (as well as contractors and subcontractors).
2.	Ventilation of work areas	Ventilation equipment, including mobile filtering units (MFU)	Failure/stopping during the execution of works	Exposure of personnel due to the dispersion of radioactive aerosols	The overall ventilation exchange system is in order, timely changes, repairs and maintenance are carried out, and constant pressure differential control in the filters is carried out. Maintenance of MFU. Warning sound and light alarm in case of reduced flow rate of MFU. The use of PPE for respiratory protection in the thermal and mechanical cutting of equipment. In the event of a breakdown, termination of work and removal of personnel from work areas.
3.	Decontamination of the equipment to be dismantled	Equipment	Desealing a shot blasting device	Exposure of personnel due to the dispersion of radioactive aerosols	The decontamination is based on the successful experience gained in previous D&PT projects. Timely maintenance of the equipment used is carried out. Compliance with the requirements for safe use specified in the instructions for the operation of the equipment plants. Use of PPE. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
4.	Decontamination of the equipment to be dismantled	Equipment	LRW spill	Exposure of personnel. Spread of radioactive contamination.	The decontamination is based on the successful experience gained in previous D&PT projects. Timely maintenance of the equipment used is carried out. Compliance with the requirements for the safe operation and control of the relevant equipment specified in the operating instructions. Use of PPE. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
5.	Dismantling, crushing using thermal and mechanical cutting methods	Equipment contaminated with radioactive materials	Staff negligence	Exposure of personnel when radioactive substances get on the skin of the body.	Compliance with the applicable safety and health requirements for INPP employees. Use of PPE (head, hands and arms, feet and legs, protective clothing, etc.). Maintaining cleanliness and order in the workplace. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
6.	Dismantling, crushing using thermal and mechanical cutting methods	Sparks, hot surfaces, hot slag, smoke, hazardous gases	Ignition of flammable and flammable substances	Burns, inhalation of smoke, hazardous gases and radioactive aerosols. Exposure of personnel. Spread of radioactive contamination.	Fulfilment of the applicable INPP fire safety requirements. Compliance with the applicable safety and health requirements for INPP employees. Removal of flammable materials from the dismantling area until the start of fire work. Work procedures include specific measures and solutions to ensure fire safety (installation of protective screens against sparks during fire work, primary fire extinguishing measures at workplaces, establishment of safe temporary storage places for combustible waste, etc.). Use of slag collectors, fire alarms. Ventilation of work areas, also using MFU. Installation of fencing zones and warning signs. Use of existing active fire extinguishing agent PPE. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
7.	Dismantling, crushing using	Aerosols, dust	Inhalation of radioactive	Internal irradiation by	The use of PPE for the respiratory organs when cutting equipment. Ventilation joint exchange

	thermal and mechanical cutting methods		aerosols, dust	inhalation of radioactive aerosols, dust	system. Use of MFU. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
8.	General factors related to decommissioning works	Radioactive contamination	Sudden deterioration of the radioactive state	Exposure of personnel	Personnel enter the workplace with the permission of the dosimeter. Radiological monitoring of work areas. Use of direct reading electronic dosimeters RAD. Use of PPE. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
9.	General factors related to decommissioning works	Radioactive contamination of surfaces	Formation of diffusing aerosol activity	Exposure of personnel Contamination of premises	Radiological monitoring of the air of work areas. Installation of ventilation and exhaust air purification systems for work areas (HEPA filters). Use of PPE. The use of insulating materials during the transportation of dismantled elements (for example, wrapping in polyethylene). Radiological monitoring of the air of work areas. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
10.	General factors related to decommissioning works	Electrical equipment	Faults in the power supply system. Loss of power supply.	Termination of electrical equipment (ventilation, LM, alarms, etc.). Loss of lighting. Exposure to electric current, fire.	Termination of work, withdrawal of personnel from work areas. Emergency lighting of evacuation routes is planned, ensuring that the luminaires are powered by battery batteries. Compliance with the applicable safety and health requirements for INPP employees. Connection of power tools and electrical equipment through newly installed switchboards complete with automatic switches and automatic shut-off devices. Identification of potentially hazardous areas and determination of measures to protect electrical cables from failure by preparing work procedures (laying of electrical cables-extensions in protective metal boxes or pipes, installation of additional protective structures in places where the cable may be damaged during the work). Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
11.	General factors related to decommissioning works	Electricity	Accidental damage to cables	Short circuit, fire, injury to personnel	Compliance with the applicable safety and health requirements for INPP employees. Identification and marking of hazardous areas, installation of additional protective troughs in places of possible impact on cables, during technological operations. Application of fire protection measures. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
12.	General factors related to decommissioning works	Tools with hydraulic or pneumatic drive	Explosion and loss of tightness in the hydraulic or pneumatic system	Injury to personnel	Timely maintenance and testing of tools is carried out. Compliance with the applicable safety and health requirements for INPP employees. Checking the neatness of the tools before starting work. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).

13.	General factors related to decommissioning works	Mechanical Cutting equipment	Accidental exposure of the cutting parts to the worker	Injury to personnel, loss of capacity to work	Timely maintenance and testing of tools is carried out. Control of the regularity of the tools before the start of work Compliance with the applicable safety and health requirements of the INPP workers. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
14.	General factors related to decommissioning works	Work at height	Employee falling from a height	Injuries, loss of capacity to work	Compliance with the applicable safety and health requirements of INPP workers when performing work at height (use of seat belts, appropriate construction of temporary scaffolding, fencing, control of their condition, etc.). Timely maintenance and testing of tools is carried out. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
15.	General factors related to decommissioning works	Noisy equipment	Noise	Health effects	Compliance with the applicable safety and health requirements for INPP employees. Use of tools and equipment certified under Noise Exposure Limitation. Staff training and briefing. Timely maintenance and testing of tools is carried out. The use of PPE (inserts, headphones) to protect against the effects of noise.
16.	General factors related to decommissioning works	Heavy Items	Heavy Elements Fall	Injuries, loss of capacity to work	Compliance with the applicable requirements for the safety and health of INPP workers (as well as the instruction system). Installation of fencing zones and warning signs. Reliable fastening of movable elements. Safe transport speed Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
Premises of buildings No. 150, No. 155, No. 155/1, No. 157, No. 157/1					
17.	Waste management inside buildings	Sparks, hot surfaces, hot slag, smoke, hazardous gases	Ignition of flammable and flammable substances	Burns, inhalation of smoke, hazardous gases and radioactive aerosols.	Fulfilment of the applicable INPP fire safety requirements. Compliance with the applicable safety and health requirements for INPP employees. Removal of flammable materials from the dismantling area until the start of fire work. Work procedures include specific measures and solutions to ensure fire safety (installation of protective screens for protection against sparks during fire work, primary fire extinguishing measures in workplaces, establishment of safe temporary storage places for combustible waste, etc.). Use of slag collectors, fire alarms. Ventilation of work areas, also using MFU. Installation of fencing zones and warning signs. Active fire-fighting measures are available. Use of PPE. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
18.	Liquid waste management inside the building	Equipment	LRW spill	Staff exposure. Spread of radioactive contamination.	Compliance with the requirements for safe operation and control set out in the operating instructions for the equipment in question. Compliance with the applicable safety and health requirements for INPP employees.

					Timely maintenance of the equipment used is carried out. Use of PPE. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
19.	Transport and transfer of waste inside the building	Radioactive waste cargoes and containers	Load drop due to LM failure or personnel error	Exposure of personnel due to the spread of radioactive aerosols.	Compliance with the applicable safety and health requirements of INPP employees when performing works with LM and transportation equipment. Operation and maintenance of LM and grippers in accordance with the applicable INPP requirements. Use of standard grippers and containers. Use torque sensors to control the weight of the load being lifted. To develop schemes for the slinging of specific cargoes in the work procedures. Use PPE to protect the respiratory organs. Involvement of qualified and trained personnel, instruction of all employees (as well as contractors and subcontractors).
			INPP site		
20.	Transportation of classes A, B, C, D, E and F at the INPP site	Radioactive waste cargoes and waste	Load drop due to transportatio n incident or personnel missteps	Exposure of personnel (during the elimination of consequences), the spread of pollution in the environment	Fulfilment of the requirements of the valid INPP RW transportation documents. Calculations and tests of the load (including dynamic) of the containers used must be carried out with significant reserve factors in accordance with the requirements of the relevant ISO standards for the accepted operating conditions. Transportation is carried out only on the established routes of the INPP. Training and coaching of employees. Ensuring safe speed of transportation Elimination of consequences in accordance with the requirements of the applicable INPP documents.
21.	Transportation of SRW at the INPP site	Radioactive waste cargoes and containers	Load drop due to transportatio n incident or personnel missteps	Exposure of personnel (during the elimination of consequences), the spread of pollution in the environment	Fulfilment of the requirements of the valid INPP RW transportation documents. Calculations and tests of the load (including dynamic) of the containers used must be carried out with significant reserve factors in accordance with the requirements of the relevant ISO standards for the accepted operating conditions. Transportation is carried out only on the established routes of the INPP. Training and coaching of employees. Ensuring safe speed of transportation Elimination of consequences in accordance with the requirements of the applicable INPP documents. No additional population and environmental protection measures are required.

As can be seen from the Table 5.1-1, information provided, some of the risks may arise due to wrong actions of the staff or violation of labour discipline. These risks can be reduced by applying organisational and technical measures for occupational safety and health, including staff training and supervision of work performance. In the event of incidents related to the failure of systems and equipment used in decommissioning works, the personnel performing the works are most negatively affected, as well as the environment of the building where the works are carried out. The consequences can be reduced by applying the following measures: training of personnel, control of the execution of works, use of PPE, timely control of the condition of the equipment and equipment used, organization of maintenance and mandatory tests, compliance with the organizational and technical measures for the safe performance of works provided for in the projects. To protect the environment outside buildings from radionuclide releases, high-efficiency filtration devices are used, which localize radioactive aerosols at the points of their release, as well as stationary ventilation systems with aerosol filters. The transportation of radioactive waste packages will be carried out in accordance with the requirements of the current procedures of the Ignalina NPP and the routes established at the Ignalina NPP site. The impact can be mitigated by means of the technical and administrative measures envisaged.

The decommissioning works will be carried out in accordance with the established procedures for permits to carry out radiation-hazardous works, personal dosimetric control will be carried out on a regular basis, and environmental monitoring will be carried out.

The risks that may arise during the demolition of buildings have been analyzed in Section 4.9.2.1. It should be mentioned that the buildings and structures of the Ignalina NPP will be demolished only after all the equipment in them has been dismantled, and the structures, if necessary, will be decontaminated to the level of radioactivity that is no longer controllable. Thus, when demolishing buildings and structures, there will be no risks related to radiation exposure to personnel, residents and the environment.

5.2 Potential impact

Taking into account the information provided in the previous section on possible initiating events and potential risks in carrying out the planned economic activity, this EIA section assesses the potential impacts on the environment and the population only for events with the most severe consequences. Based on previous safety assessments [104], such events, which are enveloping from the point of view of radiological consequences, are:

- Damage to a container loaded with classes D and E SRW during transportation;
- Airplane crash into the Unit 2 reactor building during the dismantling of the reactor core.

5.2.1 Damage to a container with class D and E SRW during transportation

Damage to container with class D and E waste may be caused by a malfunction of the vehicle transporting the SRW package from building 101/2, human error during transport, or the container drop while being transferred from the truck to the container unloading station. The consequences of this incident and its possible impact on the environment were assessed in a previously prepared EIA report [41], which examined a design accident scenario involving a G-3 type container loaded only with higher-class class E waste, dropping while being transferred from a truck to a container unloading station. It was conservatively accepted that the G-3 type container was damaged, so all class E radioactive waste in it became a source of radiation, the SRW scattered outside the buildings, and the release of radionuclides occurred at ground level.

The calculated maximum annual effective dose (see Table 5.2-1) for the population is 0.299 mSv, which does not exceed the permissible annual effective dose limit of 1 mSv. At a distance of 5.5 km from the accident site (at the state border with the Republic of Belarus) and further (at the state border with the Republic of Latvia), the annual effective dose of the population is about 0.1 mSv. The dose is about 10 times lower than the internationally recognized dose constrain (1 mSv/year). The dose caused by the accident can be considered as sufficiently low. The dose does not exceed the dose constrain value, which is considered the upper limit applied in optimizing radiation safety (depending on the country, the dose constrain is usually in the range of 0.1–0.3 mSv per year).

Table 5.2-1. Exposure of the population due to radioactive release due to the drop of the container G-3 and the scattering of class E waste

Nature of exposure	**Critical weather conditions**	**Distance from the place of radionuclide release, m**				**Note**
		200 [1)]	2200 [2)]	5500 [3)]	8000 [4)]	
		Effective dose, Sv				
Exposure in one year	F stability class, rain	2.99E-04	2.53E-04	1.19E-04	8.91E-05	Dose calculations estimate external and internal exposure pathways.
Exposure for five consecutive years		6.36E-04	4.61E-04	2.21E-04	1.66E-04	

[1)] to the protective fencing of the INPP; [2)] at the border of the INPP SPZ; [(3)] at the state border with the Republic of Belarus, the distance to Visaginas is at least 6000 m; [4)] at the state border with the Republic of Latvia.

5.2.2 Airplane crash into the Unit 2 reactor building during the dismantling of the reactor core

The assessment of the consequences of a large airplane (similar to a Boeing 767-400) crash into the Ignalina NPP Unit 2 reactor building during the reactor dismantling is presented in the analysis report on the consequences of potential accidents [105]. This EIA report provides overview of the main assumptions of the assessment and summarises the results of the radiological consequences assessment.

When analyzing the impact of the airplane crash into Unit 2 reactor (including the graphite stack), it was assumed that damage to the reactor structures, including the graphite stack, occurs. When the airplane crashes, aviation fuel spills into the reactor cavity and ignites. It is assumed that the combustion of aviation fuel takes place in a closed space, the reactor zone (concrete shaft) is not damaged. The inflow of air necessary for combustion is possible only from above, which is also limited by the resulting wreckage of the airplane and the roof. The postulated event occurs when the reactor core dismantling works are carried out (open access to the graphite stack). From the structural and radioactive material dispersion point of view, it is acceptable to consider the airplane falling perpendicular to the roof of the building as a conservative case (see Figure 5.2-1 and Figure 5.2-2). The roof of the reactor unit building is not additionally reinforced and will be pierced by a falling airplane.

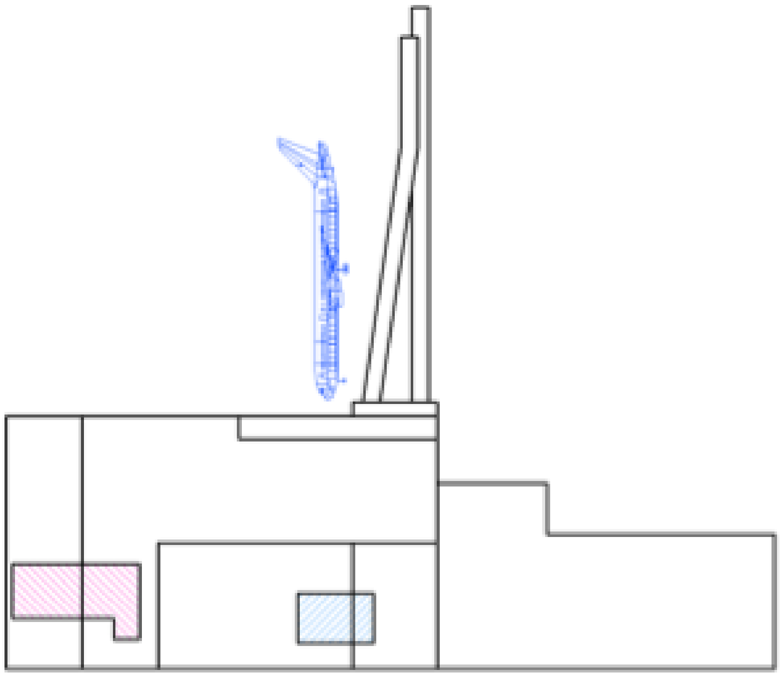

Figure 5.2-1. Reactor building of Unit 2, view from the east side. The building and airplane are shown to the same scale

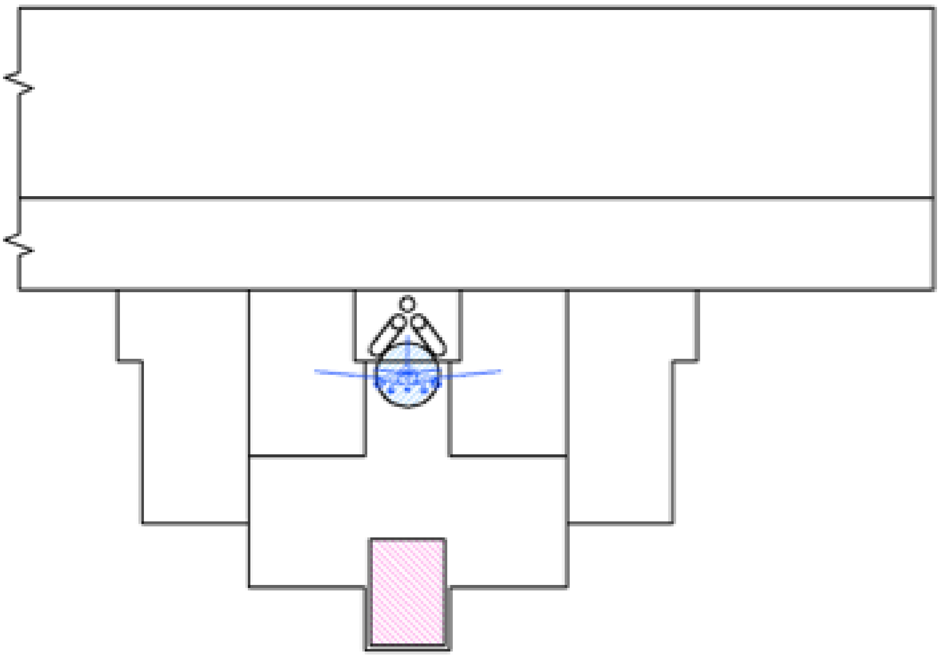

Figure 5.2-2. Reactor building of Unit 2, top view. The building and airplane are shown to the same scale.

The maximum calculated average hourly concentration of radionuclides released during the accident (dominant radionuclides H-3, Kr-85, I-129, Cs-134 and Cs-137) in ambient air in the eastern part of the 3 km SPZ of the Ignalina NPP can reach 6.7E+04 Bq/m^3. Beyond the 3 km SPZ boundary, the concentration of radionuclides in ambient air does not exceed 3E+04 Bq/m^3. At a distance of 10 km, the concentration of radionuclides in ambient air decreases to approximately 8E+03 Bq/m^3.

The highest concentration of radionuclides deposited on the ground surface within one hour is observed in the INPP SPZ and can reach up to 890 kBq/m^2. The concentration of radionuclides decreases with distance from INPP and is about 300 kBq/m^2 at a distance of 10 km.

The assessments made in the report [105] showed that the radiological impact on the population due to the accident of the airplane crash into Unit 2 reactor building due to the release of radionuclides into the ambient air is not significance. Ionizing radiation will not cause the determined phenomena. According to the conservative scenario of radionuclide dispersion in the environment, the 24-hour effective dose of the population within the 3 km SAZ of the INPP is about 0.28 mSv and the annual effective dose is about 0.31 mSv. Outside the current 3 km SPZ of the INPP, the annual effective dose to the population is about 0.15 mSv or less. According to the realistic scenario of radionuclide dispersion in the environment, the 24-hour effective dose to the population is about 0.054 mSv and the annual effective dose is about 0.062 mSv.

During the first hour of the accident, while intensive radioactive releases into the ambient air are taking place, the exposure of the population amounts to approximately 70% - 90% of the annual effective dose. The greatest radiological impact is experienced near the INPP site and within the 3 km SAZ of INPP.

5.3 Mitigation measures

5.3.1 Emergency preparedness

According to Nuclear Safety Requirements [106], the organization operating a nuclear facility (NF) (license holder) must ensure the prevention of accidents and incidents, and, in case of an emergency, be prepared to immediately perform the following actions:

- Apply measures to return the NF to a safe state where the long-term performance of safety functions is ensured;
- Protect people present in the NF and its sanitary protection zone;
- Mitigate the consequences of the accident;
- Perform accident classification;
- Inform VATESI and other state bodies of control and supervision involved in the response to the accident about the accident;
- Mobilize the forces and measures of the civil safety protection system to eliminate the accident;
- Use the necessary services and measures from entities outside the NF site to mitigate and eliminate the consequences of accidents;
- Monitor radionuclide pollution inside the NF and in its sanitary protection zone.

In accordance with the Law on Nuclear Safety [10], an emergency preparedness plan (EPP) has been prepared and coordinated with state institutions at Ignalina NPP [107]. The EPP is the main and most important document that establishes organizational, technical and other requirements for the implementation of accidents and recovery, medical, evacuation, physical protection and other activities. These measures are necessary for the protection of the company's personnel and residents in the event of nuclear and radiation accidents, taking into account the specifics of the decommissioning work performed at the company. The EPP consists of two parts - the general (descriptive) part of the plan with annexes and the working part (instructions). The EPP must be revised if necessary, or if the safety requirements established by legal acts change, but at least once every 3 years.

5.3.2 Fire protection

Various administrative and technical measures are applied for fire prevention, mitigation and liquidation of consequences. Fire safety at the Ignalina NPP was organized in accordance with the General Fire Safety Rules [108], the fire safety requirements of safety-critical structures, systems and components of a nuclear facility [109] and the Law on Fire Safety [110]. Based on these documents, the Ignalina NPP has prepared a general fire safety instruction for facilities [111], which defines the main fire safety requirements for the territory and buildings, establishes the requirements for the storage of flammable materials and preparations, the requirements for the work in which open fire is used or sparks are emitted, as well as the requirements for the actions of the personnel in the event of a fire, the requirements for the training of the personnel, etc. For firefighting (response to design basis accident) at the Ignalina NPP, a plan of the Visaginas Fire Rescue Board has been prepared [112]. If the design basis accident evolves into a beyond design basis accident, the Ignalina NPP has an Emergency Response Plan [113] and emergency response instructions for its working part. The planned economic activity will be carried out in accordance with the above-mentioned instructions, and the fire extinguishing and liquidation plans will be updated. Fire hydrants located on the Ignalina NPP site, intended for external fire extinguishing with water, and fire stands (with p primary fire-fighting means – fire extinguishers, shovels, crowbars, axes, non-combustible fabric, a box with sand) would be used to extinguish for firefighting, if such a fire were to arise during the planned economic activity. Road surfaces adapted for such transport are planned for the access of fire-fighting vehicles.

6 ANALYSIS AND EVALUATION OF ALTERNATIVES

The Ignalina NPP decommissioning process is being carried out in accordance with the "Ignalina NPP Final Decommissioning Plan" (FDP) [7] that was coordinated with state institutions and approved by the Minister of Energy of the Republic of Lithuania. This plan describes in detail the Ignalina NPP decommissioning strategy, provides a schedule for the implementation of various activities, estimates the decommissioning costs and decommissioning methods and technologies. Therefore, a separate analysis of alternatives is not performed in this EIA report, but an overview of previously assessed alternatives is provided. The quantities of decommissioning waste and its management have also been assessed and preliminary safety and environmental impact assessments have been provided. The first version of the FDP was prepared in 2001-2004, and later the FDP was updated several times taking into account the progress of the implementation of the decommissioning projects, the accumulated experience, economic, environmental and other aspects.

The alternatives of the INPP decommissioning were analysed and summarised in the very first version of the FDP. Therefore, this EIA report does not carry out a separate analysis of the alternatives, but provides an overview of the alternatives evaluated before. It should also be noted that various decommissioning works of the Ignalina NPP: deactivation and dismantling of equipment, management of generated waste, demolition of structures, etc. – have been carried out for more than 15 years. Various technological alternatives are applied to these works, the impact of which on the environment is negligible, according to environmental monitoring data.

At the early stage of the preparation of the FDP, based on global practice of decommissioning nuclear power plants, the following alternatives for the Ignalina NPP decommissioning strategy were evaluated:

- immediate dismantling;
- deferred dismantling;
- entombment.

The latter alternative (entombment) was rejected because it would keep radioactive materials inside preserved engineering structures for a very long time (~200 years) until final dismantling, waste treatment and disposal. Due to the high uncertainties, there were doubts whether state institutions, environmental organizations and the public would accept 200 year storage period. Later, after the implementation of the IAEA-Lithuanian technical cooperation project LIT/4/002 "Technical Support for the Decommissioning of Unit 1 of the Ignalina NPP", in 2001 it was concluded that immediate dismantling is the best strategy for decommissioning the Ignalina NPP. On 26 November 2002, the Government of the Republic of Lithuania, in order to ensure that the decommissioning of the Ignalina NPP would not cause serious long-term social, economic, financial and environmental consequences, adopted a resolution that the decommissioning of Unit 1 of the Ignalina NPP is planned and carried out by immediate dismantling.

The immediate dismantling strategy provides that after the final shutdown of the INPP, the decommissioning works of the INPP and the management of radioactive materials shall begin immediately. The equipment in the controlled area, as well as the equipment of the buildings in the observation area, are dismantled. The radioactive waste is finally processed and/or placed in packages that ensure safe conditions for the storage or disposal of this waste. The non-radioactive waste is sorted, reused or disposed of in a conventional industrial way as ordinary waste.

According to the adopted "territorial-geographical" principle of decommissioning of the Ignalina NPP, the dismantling of structures, systems and components is carried out according to individual buildings (blocks). The dismantling of facilities and the primary treatment of waste in buildings (blocks) or in separate block premises are separated into separate D&PT projects. In this way, there are no alternatives to the place of dismantling the equipment. Dismantling of equipment according to each D&PT project is carried out in defined work areas and/or defined workplaces inside buildings (blocks), therefore, only a sequence of dismantling works in work areas/workplaces is selected in the project.

The initial treatment of the radioactive waste generated (shredding, decontamination, packaging, temporary storage, etc.) is carried out in certain pre-treatment bars. Pre-treatment bars can be created within the scope of a specific D&PT project directly next to the equipment to be dismantled, or pre-treatment bars and infrastructure already installed in other buildings (blocks) can be used. Currently, the INPP is equipped with the required number of initial treatment units to ensure the entire cycle of initial treatment of the radioactive waste generated. When new D&PT projects are launched, the possibility of using existing initial treatment units is being explored or, if necessary, new initial treatment units are being developed.

When choosing options for initial treatment of waste, using existing initial treatment units or creating new ones, the following principles are followed:

- reduction of doses of exposure caused by ionising radiation to personnel, residents and the environment during the management of radioactive waste during initial treatment;
- the adequacy of the existing capacity of the initial treatment units;
- the advisability of purchasing new initial treatment equipment.

Section 3.2.4 of EIA report describes the means and technologies used for the dismantling of equipment and structures. Each of the technologies has its advantages and disadvantages, but with the use of appropriate operating procedures and measures to reduce the environmental impact, the environmental impact of any technology used is negligible. The choice of technological solutions follows the basic principles of D&PT's work organization, which help to avoid or reduce negative impacts on personnel, residents and the environment, as well as reduce labor and material costs:

- dismantling technologies and organisation of works must ensure the safety of workers and the functionality of the installations left in operation;
- the individual operations and the entire technological process as a whole must comply with the ALARA principle;
- the use of technologies that generate minimal secondary waste and minimal emissions of harmful substances into the environment;
- the application of automated methods for the dismantling of contaminated equipment, which allows remote control of the technological process;
- localization of welding gases and aerosols at the places of their formation by gas, plasma and mechanical cutting;
- the application of the most efficient and safe technologies of the already implemented D&PT projects and the use of the INPP equipment purchased for these projects;
- dismantling of equipment in large blocks, the sizes of which depend on the lifting capacity of the load lifting mechanisms, the size of the transport openings and the requirements of the equipment of the fragmentation bars.

The final choice of D&PT equipment and instruments depends on the accepted technological methods of dismantling, shredding and deactivating the dismantling equipment and is examined in detail in each individual technological design and safety justification report.

7 MONITORING

Environmental monitoring is a systematic observation, assessment and forecast of changes in the state of the natural environment and its elements and anthropogenic impacts. Law on Environmental Monitoring of the Republic of Lithuania [114] establishes the content, structure, implementation of environmental monitoring, the rights and obligations and responsibilities of the entities involved in the environmental monitoring process. Environmental monitoring observes, evaluates and forecasts:

- the state of the ambient air, water, depths of the earth, soil, living nature;
- the state of natural and anthropogenically affected natural systems (natural habitats, ecosystems) and landscape;
- physical, radiation, chemical, biological and other anthropogenic effects and their impact on the natural environment;
- changes and trends in global processes taking place in the natural environment (acid rainfall, ozone layer variation, greenhouse effect, etc.).

In accordance with the provisions of the Law on Environmental Monitoring [114] Article 4, the environmental monitoring system consists of environmental monitoring of the state, municipalities and entities, in the course of which information on the state of the elements of the natural environment and its changes at the state, municipal and local level is collected and analysed. This section of the EIA report contains information on the performance of the entity, i.e. Ignalina NPP.

Since the beginning of the operation of the power plant, the Ignalina NPP has been carrying out environmental monitoring in accordance with the provisions of the Law on Environmental Monitoring of the Republic of Lithuania [114], radiation safety standards [97], nuclear safety requirements [66] and other legal acts and normative documents of the Republic of Lithuania regulating this activity [65], [115], [116]. In accordance with this legislation and taking into account the provisions of the Radionuclide Release Plan [71] and Pollution Permit TV(2)-3/TL-U.5-13/2016 [58], the monitoring programs of the Ignalina NPP have been prepared and approved [117], [118], [119].

Environmental monitoring is carried out in the territory of the Ignalina NPP industrial site, within the boundaries of the sanitary protection zone and the 30 km observation zone. Monitoring of sources of releases and discharges of radionuclides from all buildings and facilities of the Ignalina NPP is also carried out.

Environmental monitoring of the Ignalina NPP consists of:

- monitoring of the chemical condition of the environment;
- monitoring of the radiological condition of the environment.

Monitoring of the chemical condition of the environment includes monitoring chemical pollutants emitted and discharged from the Ignalina NPP into the ambient air and water, including greenhouse gases, water quality of the water body cooler, groundwater of the Ignalina NPP industrial site and other facilities, surface (rain) wastewater into the environment from the Ignalina NPP industrial site, and odour emission management.

During the monitoring of the radiological condition of the environment, water discharges and gas releases of the Ignalina NPP, radionuclide activity in environmental objects, exposure doses of population, meteorological parameters are controlled. Individual dosimetric control of employees, monitoring of workplaces is also carried out in accordance with the annual Ignalina NPP personnel exposure and workplace monitoring program [102] and the Ignalina NPP radiation safety monitoring schedule [120].

Radiological monitoring of the environment is carried out by taking samples, measuring the dose rate in the area, as well as using automated control systems. Measuring instruments are periodically calibrated and metrological inspection is carried out.

The following principles shall be used in the selection of monitoring and sampling sites for environmental elements:

- planned or existing environmental pollution, demographic characteristics and habits of the population are taken into account;
- all methods and pathways of radionuclide dispersion and population exposure are taken into account in order to assess the annual activity of radionuclides released into the air and water, short-term changes in radionuclide releases and annual effective doses to the population.

Taking into account the results of the annual environmental monitoring, reporting documents shall be prepared, an analysis of the necessity and adequacy of the measurements carried out shall be carried out and, taking into account the decommissioning activities carried out, the necessity to expand or reduce the monitoring program shall be assessed.

According to the data of the chemical and radiological monitoring (see sections 4.1.1, 4.2.1, 4.3.1, 4.6.1, 4.9.3.2 describing the observed state of individual environmental components) of the environment carried out since the beginning of the operation of the Ignalina NPP, the decommissioning works of the Ignalina NPP carried out since 2010 have not had a significant negative impact on the environment – the impact of the decommissioning activities on the environment constitutes only a very small percentage of the limit values established in the legal acts.

During the decommissioning, some of the sources of pollution in the industrial site of the Ignalina NPP will be removed (dismantled, demolished), however, for example, during the dismantling of the reactor cores of the Units 1 and 2 of the Ignalina NPP (zone R3), a temporary reactor waste storage facility will be built at the Ignalina NPP site, where a radiation monitoring system will have to be installed to ensure the control of radiation criteria and the implementation of continuous monitoring. As mentioned earlier, taking into account the decommissioning activities, the need to expand or reduce the monitoring program will be assessed, which will be detailed in the preparation of the technical design and safety justification documents of a specific decommissioning project.

8 TRANSBOUNDARY ENVIRONMENTAL IMPACT

8.1 Neighbouring countries

Two countries, Belarus and Latvia, are relatively close to the site of the planned economic activity (see Figure 8.1-1). The state border between Lithuania and Belarus is located at a distance of about 5 km east and southeast of the Ignalina NPP industrial site. The state border between Lithuania and Latvia is located about 8 km north of the Ignalina NPP industrial site. Other countries are located several hundred kilometres away from the Ignalina NPP.

Figure 8.1-1. The location of the INPP industrial site in relation to neighbouring countries

8.2 Potential transboundary environmental impacts during normal operating conditions

During the decommissioning of the INPP, substances will be emitted into the ambient water and air, the formation of which is determined by the combustion of fuel (natural gas, diesel), material processing (cutting, surface cleaning), use of water for technological processes and cleaning/decontamination works, construction/demolition works, etc. There will be controlled small releases of radioactive materials into the environment. These potential negative impacts are analysed and assessed in Sections 4.1 and 4.2, and measures to reduce the potential impact are proposed.

The INPP decommissioning activities will not have a negative impact on such environmental components as the soil (see Section 4.3), the underground (see Section 4.4), the landscape (see Section 4.5), biodiversity (see Section 4.6), socio-economic environment (see Section 4.7), and immovable cultural heritage(see Section 4.8). Protected areas of neighbouring countries located relatively close to the planned economic activity site are described in Section 4.6.2. The EIA report reviews the current state of these environmental elements and discusses possible relations with the INPP decommissioning activities. Since the economic activity will not cause any negative impacts, no mitigation measures are foreseen.

The main requirements to ensure the long-term health protection of the population from the hazards posed by ionising radiation are set by the Lithuanian hygiene standard HN 73:2018 [97], which implements the provisions of Council of Europe Directive 2013/59/Euratom [99]. The hygiene standard [97] sets the following limit doses for exposure of the population:

- annual effective dose of 1 mSv;
- an annual equivalent dose for the lens of the eye – 15 mSv;
- annual dose equivalent to skin – 50 mSv. The limit dose applies to the average annual dose of any area of 1 cm^2, regardless of the area exposed to irradiation.

Dose constrains are set to optimize radiation safety in the planned exposure situation. For the population exposed to radiation due to the release of radioactive substances into the environment from the NF and direct exposure from the NPP, the annual effective dose constrain [97] is 0.2 mSv. This dose constrain applies to residents living and carrying out economic activities outside the NF sanitary protection zone, but who have access to it (taking into account statistical data on the lifestyle and nutritional characteristics and habits of local residents) or who work in the NF sanitary protection zone while carrying out permitted economic activities not related to the NF construction, operation, decommissioning or maintenance of closed radioactive waste repositories.

The exposure of the population permanently residing outside a 3 km radius of the INPP sanitary protection zone is assessed in Section 4.9.3.2. The assessment of the annual exposure of the population using the results of the INPP environmental radiological monitoring shows that during the INPP decommissioning period from 2010 to 2024, the exposure of the population due to radioactive releases into ambient air, ambient water and external ionizing radiation from the INPP site and adjacent NF sites was small and local. The annual effective dose of the exposure of a permanent resident living outside a 3 km radius of the INPP sanitary protection zone was on average about 2E-3 mSv/year, increasing to 4E-3 mSv/year in individual years, see Figure 4.9-12 in Section 4.9.3.2.

Continuous measurements of ambient gamma radiation dose rate and ambient ionizing radiation dose equivalent measurements in the INPP region show that residents near the 3 km radius SPZ of the INPP and more remote areas do not experience direct ionizing radiation exposure due to the decommissioning activities carried out at the INPP, see Figure 4.9-9 and Figure 4.9-10 in Section 4.9.3.2. The conclusions are confirmed by the results of independent state monitoring, see Section 4.9.3.2.

It is predicted that with the continuation of decommissioning activities, the annual effective dose of the population may be about 6E-3 mSv/year, see Figure 4.9-12 in in Section 4.9.3.2. In this dose, the exposure of the population due to radioactive releases to Lake Drūkšiai is about 1E-3 – 2E-3 mSv/year, see Figure 4.9-4 in Section 4.9.3.2. The planned exposure of the population will not exceed the established dose constrain, which is 0.2 mSv/year. The planned exposure of the population may be about 6% of the dose constrain.

Due to the decommissioning of the INPP, the annual effective dose of a resident of Lithuania, as well as of residents of more distant neighbouring countries, will not exceed 10 μSv and can be considered insignificant from the point of view of radiological impact.

8.3 Potential transboundary environmental impacts in case of accidents

The impacts of potential accidents during the decommissioning of the Ignalina NPP on the environment and population of neighboring countries have been assessed in previously prepared environmental impact assessment reports for various decommissioning projects [121], [122], [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [27], [45], [46], [47].

Due to the selected safe and effective dismantling technologies, planning, organization and execution of work, the resulting solutions for the treatment of all types and classes of radioactive and non-radioactive waste, the preventive measures taken to ensure work safety, monitoring of potential pollution, other measures applied to prevent or reduce potential environmental pollution, and the adoption of worst-case scenario conditions, it was determined in the environmental impact assessments that the radiological impact of various decommissioning projects on the environment and the population in the event of potential accidents is local and insignificant. Considering that the nearest settlements in neighbouring countries are further away from the planned economic activity site (5 and 8 km., i.e. further than the distance taken into account when assessing the radiological impact on the population (3 km), the impact on the health of the population of neighbouring countries would be even smaller when assessing the same methods of radioactive contamination transfer as for the population living in the vicinity of the Ignalina NPP, because, taking into account the dispersion coefficient, with increasing distance from the release source, the activity concentrations of radionuclides and their resulting exposure doses decrease.

Potential risks and accidents that may occur during the implementation of the planned economic activity are described in Chapter 5 of the EIA report. As the assessments show, even the most severe accidents, such as the damage to a container with a class E SRW and the airplane crash on a reactor unit, have a negligible transboundary impact. In the case of a damage to a container with a class E SRW, the calculated maximum annual effective dose to a resident is 0.3 mSv (at the 3 km SPZ boundary of the Ignalina NPP), at a distance of 5.5 km from the accident site (at the state border with the Republic of Belarus) and further (at the state border with the Republic of Latvia), the annual effective dose to a resident is about 0.1 mSv. In the case of an accident of an airplane crash on the Unit 2 reactor, the annual effective dose to a resident outside the existing 3 km SPZ of the INPP is about 0.15 mSv or less. According to a realistic scenario of radionuclide dispersion in the environment, the effective dose of the population during 24 hours is approximately 0.054 mSv and the annual effective dose is approximately 0.062 mSv. In both the case of a damage of the container with class E SRW and the accident of an airplane crash on the reactor unit, the exposure dose to the population of neighbouring countries would be about 10 times lower than the internationally recognized dose constrain of 1 mSv/year.

8.4 Impact mitigation measures

Impact mitigation measures for neighbouring countries and their residents are not foreseen. There will be no significant impact on the environment of neighbouring countries. The impact of INPP decommissioning activities on the environment is minor, local and may be maintained as long as INPP decommissioning activities continue. The impact on potentially vulnerable environmental components (i.e. residents, potential environmental pollution) will be planned and managed during the preparation of D&PT technological projects, and design solutions will be assessed in the safety analysis reports for these projects.

9 DESCRIPTION OF THE PROBLEMS

There were no significant problems during the preparation of the EIA report.

10 REFERENCES

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ANNEXES TO THE EIA REPORT

ANNEX 1: COPIES OF THE HIGHER EDUCATION DOCUMENTS OF THE PREPARERS OF THE EIA DOCUMENTS
ANNEX 2: INFORMATION ON THE REPUTATION OF EIA DOCUMENT PRODUCERS
ANNEX 3: INFORMATION ON THE WORK EXPERIENCE OF EIA PREPARERS

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