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

SUMMARY OF THE 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**
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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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NUCLEAR ENGINEERING LABORATORY

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

SUMMARY OF THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Revision 1

Habil. Dr. P. Poškas

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Revision	Issue Date	Description
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

Abbreviations

D&PT	Dismantling and pretreatment (sorting, size reduction, decontamination, packaging for transportation)
EIA	Environmental impact assessment
INPP	Ignalina nuclear power plant
RWSF	Reactor waste storage facility
ISFSF	Interim spent nuclear fuel storage facility
LILW-LL	Low and intermediate-level radioactive waste – long-lived (Class D and E)
LILW-SL	Low and intermediate-level radioactive waste – short-lived (Class B and C)
LL	Long-lived
LRW	Liquid radioactive waste
NF	Nuclear facility
NPP	Nuclear power plant
RW	Radioactive waste
SL	Short-lived
SNF	Spent nuclear fuel (Class G waste)
SPZ	Sanitary protection zone
SRW	Solid radioactive waste
SSS	Spent sealed sources
SWRF	Solid radioactive waste retrieval facility
SWSF	Solid radioactive waste storage facility
SWTF	Solid radioactive waste treatment facility
VLLW	Very low-level waste (Class A)

1 Location of economic activity, objectives and concept of environmental impact assessment

The site of the Ignalina Nuclear Power Plant (INPP) is located in the northeastern part of the Republic of Lithuania, on the southern shore of Lake Drūkšiai, at a distance of about 6 km from the Visaginas city. The INPP is located approximately 130 km from the capital of the Republic of Lithuania Vilnius, close to the state borders with the Republic of Belarus (approximately 4 km to the east) and the Republic of Latvia (approximately 8 km to the north), Figure 1-1. Other neighbouring countries are more than 200 km (Republic of Estonia, Republic of Poland) and 500 km (Kingdom of Sweden, Kingdom of Denmark) from the INPP.

Figure 1-1. Location of the Ignalina NPP 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, Figure 1-2. The first INPP power unit was put into operation at the end of 1983, and the second was put into operation in August 1987.

In accordance with the commitments set out in the Treaty of Accession of the Republic of Lithuania to the European Union, the first INPP reactor was finally shutdown at the end of 2004 and the second reactor at the end of 2009. The main activity of INPP has become preparation for decommissioning and radioactive waste management.. After the preparation of the necessary infrastructure for the management of the RW, the removal of spent nuclear fuel (SNF) from the power units and placing it in interim storage facilities, the INPP was granted a licence for the decommissioning of both power units and the existing RW storage facilities in 2024. The main stages of INPP decommissioning are shown in Figure 1-3.

Figure 1-2. Panorama of the INPP site

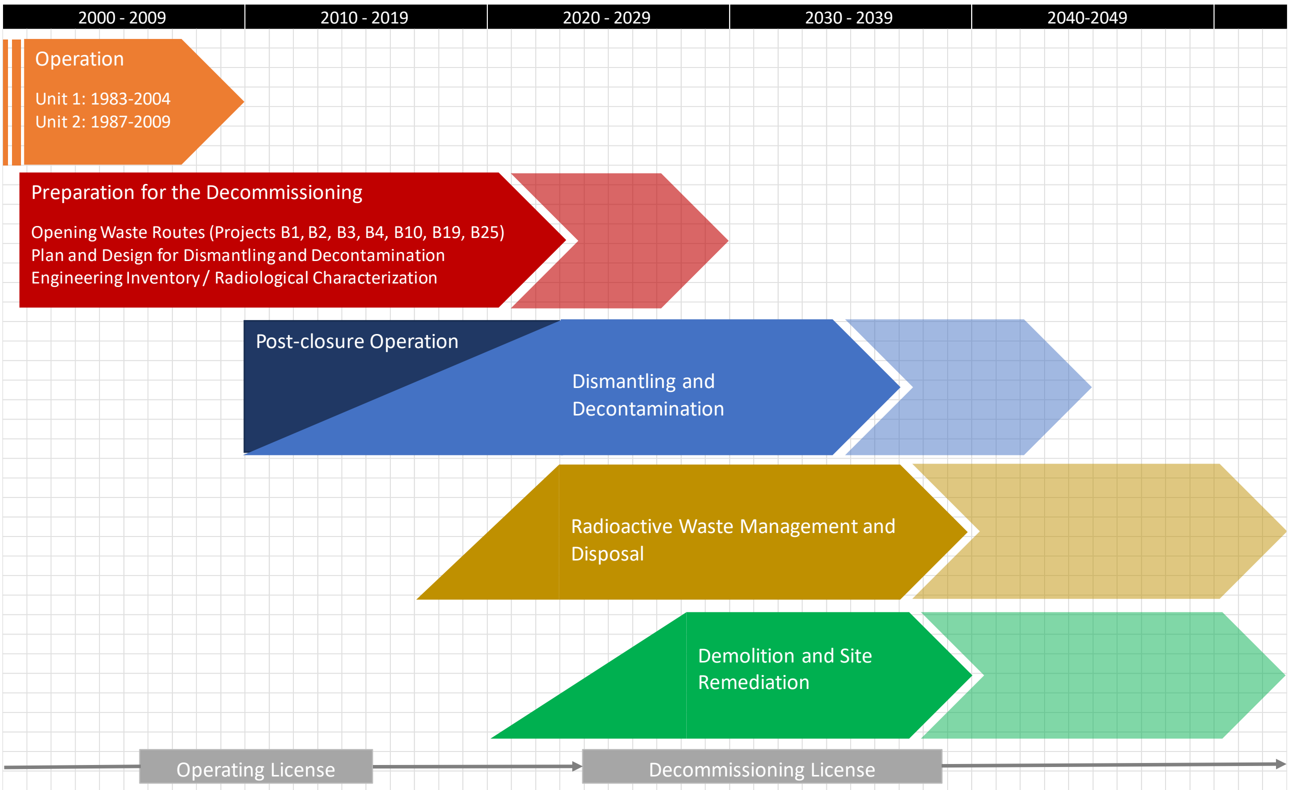

Figure 1-3. The main stages of the decommissioning of the Ignalina NPP

This EIA report [1] assesses the INPP decommissioning preparation and decommissioning periods starting in 2010, when the dismantling and initial management works of the INPP equipment were actually started, and ending in 2045-2050, when the activities envisaged in the final INPP decommissioning plan [3] will be completed and the planned condition of the INPP industrial site will be achieved. The following is planned during the implementation of this 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 [3].

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 Dismantled and managed materials

During the decommissioning of the INPP, about 180 000 tons of equipment and system constructions will have 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.

Solid radioactive waste (SRW) are divided into classes [4]:

- Uncontrolled waste (Class 0);
- Short-lived very low-level radioactive waste (Class A);
- Short-lived low-level radioactive waste (Class B);
- Short-lived intermediate-level radioactive waste (Class C);
- Long-lived low-level radioactive waste (Class D);
- Long-lived intermediate-level radioactive waste (Class E);
- High-level radioactive waste (Class G);
- Spent sealed sources (Class F).

Liquid radioactive waste (LRW) is solidified during their final treatment and further is classified and managed as SRW [4].

The distribution of the mass of materials from structures of equipment and systems to be dismantled during the decommissioning of the INPP according to RW classes is shown in Figure 2-1. About 96% of the mass of materials consists of uncontrolled (Class 0) and short-lived very low-level (Class A) radioactive waste. The remaining about 4-5% of the total mass of the materials to be dismantled consists of low- and intermediate-level short-lived (Classes B and C) and long-lived (Classes D and E) radioactive waste.

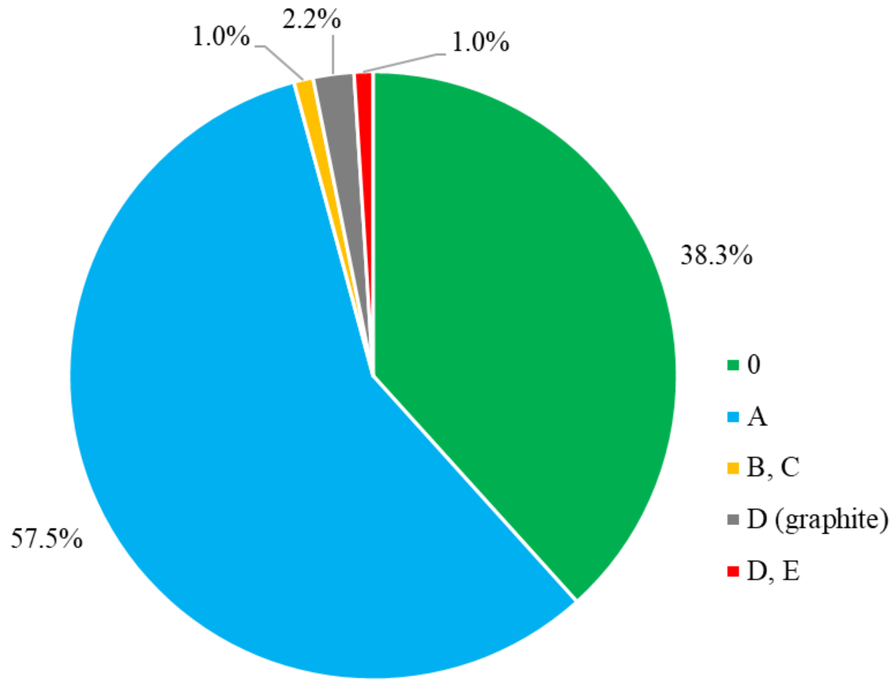

Figure 2-1. The distribution of the mass of materials from structures of equipment and systems to be dismantled during the decommissioning of the INPP according to RW classes

3 Technological processes

3.1 SNF Management

By May 2022, all spent nuclear fuel (Class G SRW) at INPP has been removed from the reactor units and is currently temporarily stored in two dry storage facilities – ISFSF-1 and ISFSF-2 [7].

3.2 Initial treatment and packaging of the INPP operational SRW

A new Solid waste retrieval facility (SWRF) has been built at the INPP [8] for retrieval of the SRW accumulated during the operation of the INPP from the existing storage facilities and for carrying out initial treatment of Class A SRW.

The SWRF consists of three waste retrieval units (RU-1, RU-2 and RU-3 respectively, see Figure 3-1), the VLLW sorting unit and the control building.

The industrial operation of SWRF started in 2019. After the removal of the SRW from the existing storage facilities and the completion of the dismantling of the INPP equipment and systems, the 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 INPP.

Figure 3-1. Storage Building No. 157 of INPP operational SRW with Group G3 SRW Retrieval Unit RU-3

3.3 Collection, storage and treatment of liquid RW

Wastewater from various processes and systems at the INPP is treated using distillation technology. The purified condensate is reused or discharged into the environment. The distillation residue, until 2015, was solidified using bituminization technology, and the solidified waste was placed in the bituminized RW storage facility located at the INPP site. It is planned to transform this storage facility (by installing additional engineering structures and engineering barriers limiting the dispersion of radionuclides) into a surface RW repository [9].

Currently, the distillation residue is solidified using cementation technology. Cementation technology at the INPP is also used for the final treatment of used filtering materials (ion exchange resins, perlite) [10]. Packages of cemented RW are classified as Class C SRW and are temporarily stored in a temporary storage facility for cemented RW.

3.4 Dismantling and initial treatment of equipment and structures

The dismantling of the INPP reactor units' equipment began in 2010 with the dismantling of the Reactor Unit 1 emergency cooling system located in Building No. 117/1 [11]. 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 required for further operation and decommissioning, in accordance with the dismantling strategy, according to which "buildings are dismantled sequentially, one building after another", starting with "buildings least contaminated with radionuclides" and subsequently dismantling "increasingly contaminated" ones [3].

The location and scope of dismantling works are defined by individual decommissioning projects. The scope of dismantling projects, their implementation sequence and timing are specified in the INPP final decommissioning plan [3], which is periodically reviewed and updated if necessary [23].

The environmental impact of the major decommissioning projects implemented or initiated during the final shutdown of the INPP power units (2010-2024) has been assessed in separate EIA studies, see [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22]. By the end of 2024, about 74 000 tons of equipment and systems have been dismantled, accounting for about 42% of the total mass of equipment and systems planned to be dismantled during decommissioning.

The dismantling of equipment and systems is carried out by disassembling them (where possible) and cutting them by mechanical and/or thermal methods. For dismantling work, the aim is to use instruments and equipment that have already been tested and proven. 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 (e.g. [21], [22], [24]), comprises (excluding reactor dismantling) about 37% of the total mass to be dismantled in the controlled zone. Most of this is very low-level radioactive material (class A) and potentially uncontrolled materials (possibly Class 0). Already tested and proven instruments will be used to perform these dismantling works, the experience gained during previous dismantling projects, equipment and purchased tools will be used. For the dismantling of relatively small masses of low- and intermediate-level radioactive materials (classes B, C) it will be necessary to use measures that reduce the impact of ionizing radiation (shielding, limitation of working time) and remotely controlled equipment.

The most complex task from the technological and organizational points of view is the dismantling of reactors. The reactors contain about 80% of the total mass of class B, C materials to be dismantled during the INPP decommissioning and it contains 100% of the mass of class D, E materials. The dismantling of reactors is divided into several separate projects, Figure 3-2:

- Dismantling of the R1 and R2 zones of the reactor [19], [21];
- Dismantling of R3 zones of the reactor.

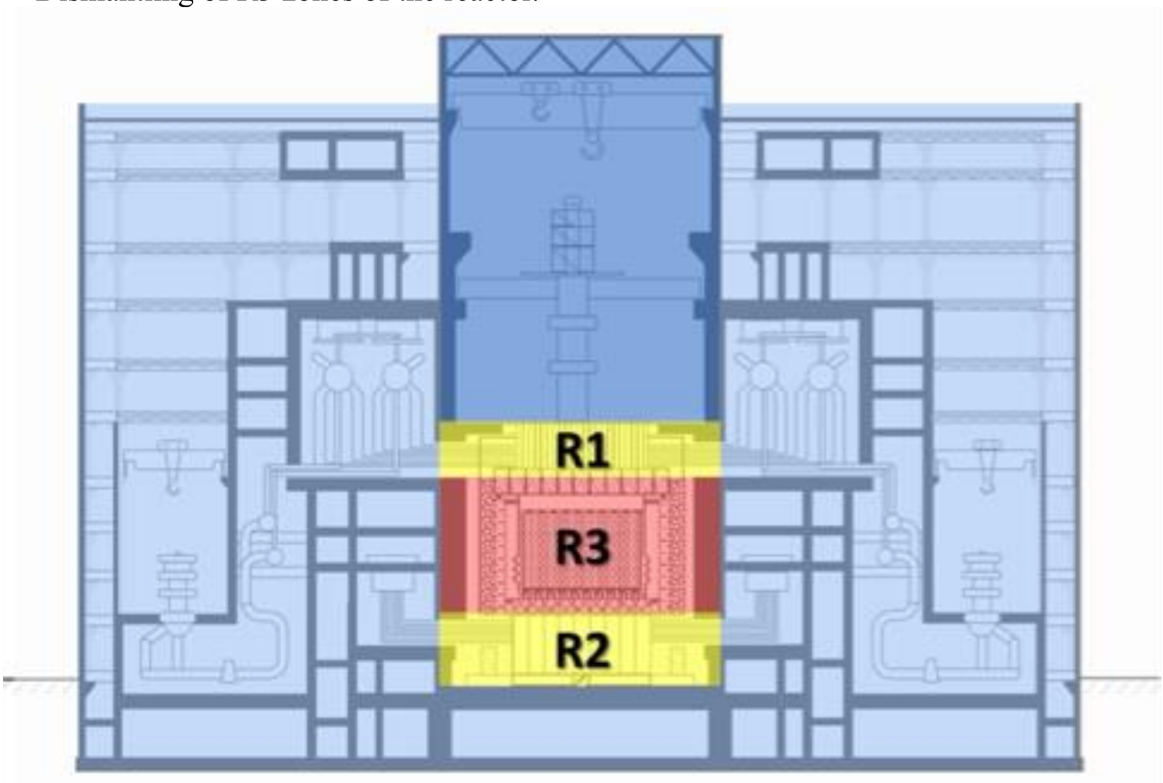

Figure 3-2. Reactor dismantling zones R1, R2 and R3

The ionizing radiation conditions allow personnel to directly access and dismantle most of the elements in the R1 and R2 zones. The use of remotely controlled equipment allows to reduce and optimize the exposure of personnel. The dismantling activities of the R1 and R2 zones of Unit 1 reactor began in 2023. Due to the possible significant exposure to ionizing radiation, the dismantling of the R3 zones of the reactors will require extensive use of remotely controlled equipment.

Specific technical solutions and dismantling technologies for the dismantling of equipment and structures are selected when preparing technological designs for individual D&PT projects. 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 of technological projects. When selecting dismantling and initial treatment methods, the experience gained during the implementation of previous D&PT projects and the best world practice in the field of decommissioning of other NF are used.

3.5 Transport

Dismantled and packaged materials after initial treatment and other radioactive and conditionally uncontrolled waste are further managed (treated, stored, placed in repositories, etc.) at the INPP industrial site and adjacent RW management facilities. A simplified waste streams management scheme is shown in Figure 3-3.

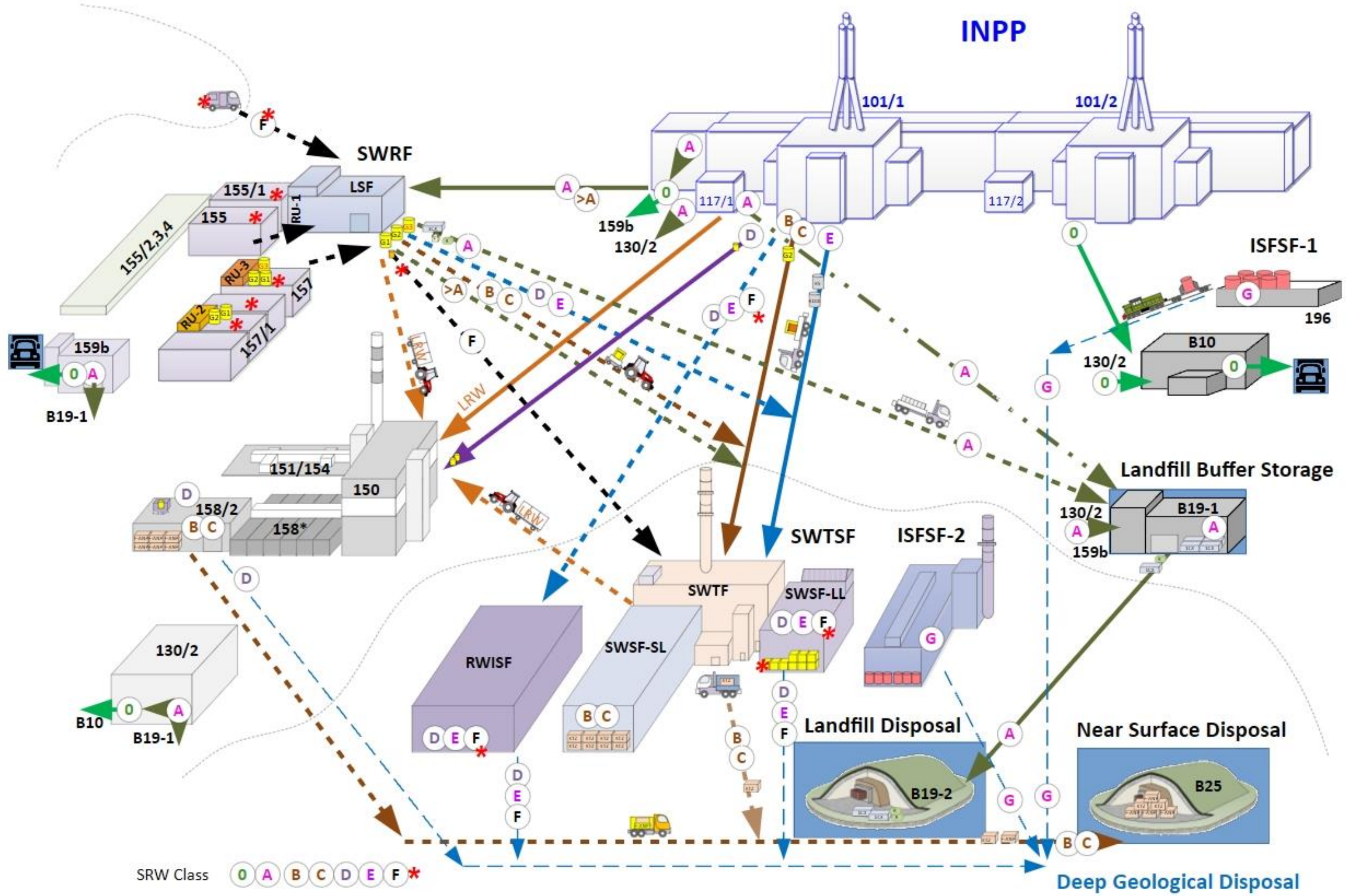

Figure 3-3. INPP scheme for the management of main waste streams

3.6 Main and final treatment of solid RW

The main and final treatment of short-lived SRW (Class B and C), the management of long-lived SRW (classes D, E, F) and the temporary storage of produced packages are carried out at the INPP new Solid Waste Treatment and Storage Facility (SWTSF) [8]. The SWTSF consists of three interconnected buildings: the solid waste treatment facility SWTF and two storage facilities for the storage of SRW packages produced by the SWTF:

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

The industrial operation of the SWTSF started in 2022. The environmental impact of the SWTSF was assessed in a separate EIA study [8]. Transboundary environmental impact assessment procedures were also carried out for this study.

3.7 Disposal of short-lived RW in repositories

The INPP operation and decommissioning short-lived SRW final waste packages will be placed in two repositories, built at a distance of about 1 km from the INPP site:

- Very low radioactive waste (VLLW) repository;
- Low- and intermediate-level short-lived radioactive waste (LILW-SL) repository.

The VLLW repository module site is located next to the ISFSF-2 and SWTSF sites. A total of three modules of the VLLW repository have been installed, which can accommodate about 60 000 m^3 of waste packages. At the end of 2024, about 11 470 m^3 of waste packages were placed in the first module of the VLLW repository, filling approximately 19% of the design volume of the VLLW repository, see Figure 3-4.

Figure 3-4. VLLW repository module with engineering barriers and a protective wall formed after a particular loading campaign

The long-term environmental impact of the VLLW repository facilities throughout their entire life cycle (during institutional supervision periods and beyond) has been assessed in a separate EIA study [25]. Transboundary environmental impact assessment procedures have been carried out for this study.

It is planned to construct the LILW-SL repository and start its industrial operation in 2030. The capacity of the LILW-SL repository is about 100 000 m^3 of waste packages.

The design concept of the LILW-SL repository is based on international practice and experience. Similar repositories are operated in Spain (El Cabril), France (Centre L‘Aube), Slovakia (Mochovice). The long-term environmental impact of the LILW-SL repository throughout its entire life cycle (during institutional supervision periods and beyond) has been assessed in a separate EIA study [26]. Transboundary environmental impact assessment procedures have been carried out for this study.

3.8 Storage of long-lived RW

Long-lived low-level (Class D) waste, intermediate-level (Class E) waste and spent sealed sources (Class F) from the decommissioning of the INPP will be disposed of in a deep geological repository planned to be constructed in Lithuania [6]. Until the repository is constructed, long-lived radioactive waste from the decommissioning of the INPP will be stored in several storage facilities built on the SWTSF site:

- SWSF-LL storage facility;
- RWSF storage facility.

The design documentation of the RWSF has not yet been prepared and the detailed design solutions are not known. However, in terms of fundamental design decisions, the newly planned RWSF will be like the existing SWSF-LL storage facility.

3.9 Demolition of buildings and management of their waste

The buildings of the Ignalina NPP will be demolished only after all the equipment in them has been dismantled, if necessary, the building structures will be cleaned of radioactive contamination (decontaminated) and it will be demonstrated that the contamination of the building structures does not exceed the uncontrolled levels, i.e. such a building is basically no longer a NF and can be demolished like any other building after obtaining a permit for demolition works.

Buildings contaminated with radionuclides, where the contamination of structures exceeds clearance levels of radionuclides for the materials, will be demolished as NF, and a permit for demolition work will be issued in accordance with the rules approved by the Resolution of the Government of the Republic of Lithuania [28].

Once the demolition of individual buildings has been completed and after it has been confirmed that the site where the building was located and the adjacent areas are not contaminated with radionuclides, the recultivation works of that site will be carried out.

3.10 Site cleanup and condition at the end of the activity

The goal of the decommissioning of the INPP is to clean up and transfer for reuse as much of the Ignalina NPP site as possible. After the completion of the decommissioning of the INPP, the entire INPP site will not be able to be converted into a “green” site, as separate NF and other controlled objects will still remain in operation:

- Bituminized radioactive waste repository installed by transforming the bituminized radioactive waste storage facility located at the INPP site into a surface repository [9];

- VLLW repository buffer storage facility, which will be operated for as long as the VLLW repository is in operation – 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 into a repository that meets modern environmental requirements, where the conditional clearance levels of radionuclides for the materials are applied for the waste [5].

There is also uncertainty regarding the buildings being dismantled in the controlled area, the concrete of which is contaminated with radionuclides. Some of these building structures may not be able to be decontaminated to unconditional clearance levels of radionuclides for the materials. If an additional repository for contaminated concrete were to be installed on the place of the reactor unit buildings, the expected state of the INPP site at the end of decommissioning is shown in Figure 3-5.

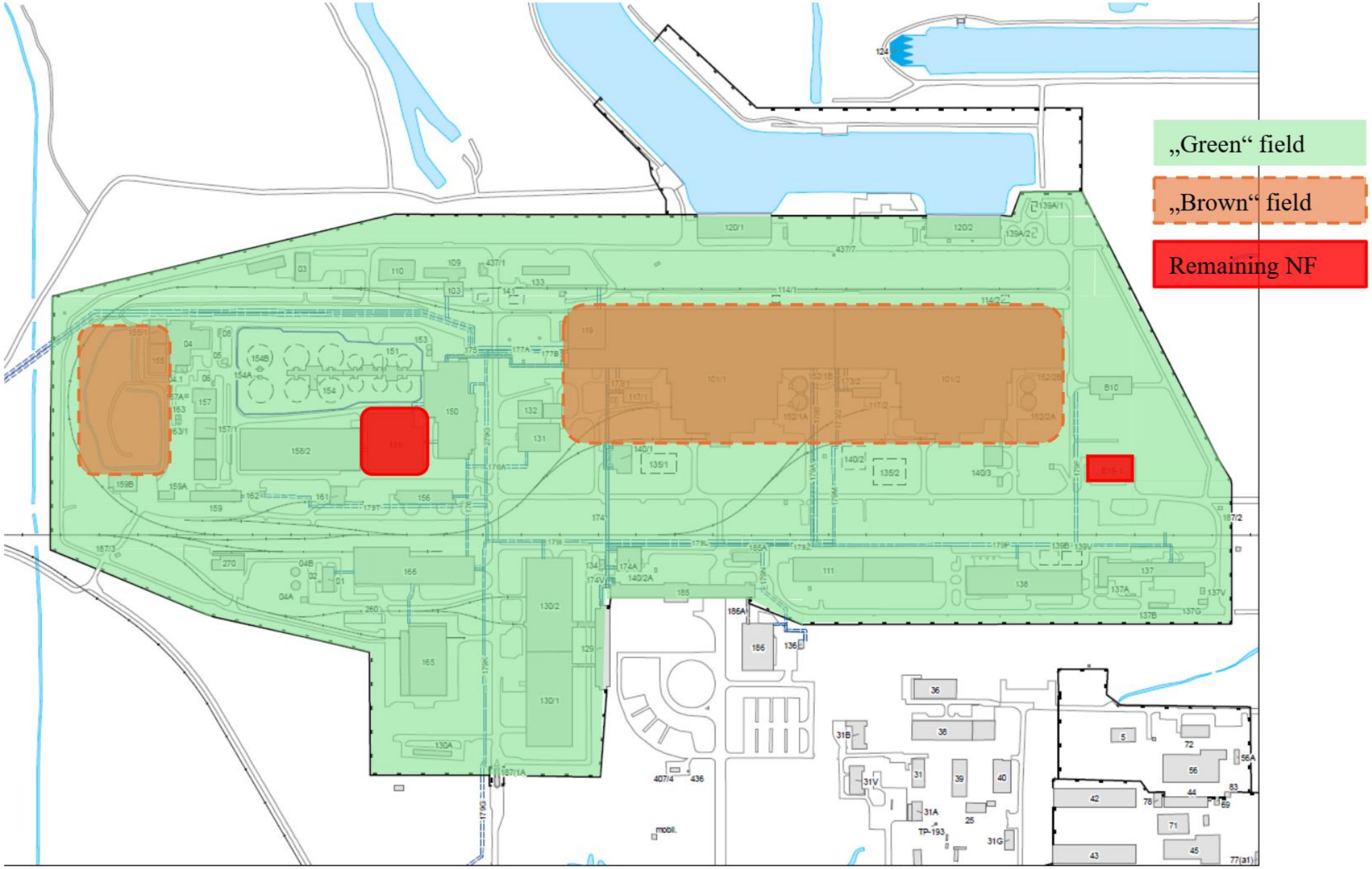

Figure 3-5. Expected state of the INPP industrial site after completion of decommissioning, if conditional uncontrolled levels were established for the location of the reactor unit buildings ("brown site").

4 Environmental components that may be affected by the planned economic activity

During the decommissioning of the INPP, substances will be released into the ambient water and air, the formation of which is determined by the combustion of fuel (natural gas, diesel), the treatment of materials (cutting, cleaning of surfaces), the use of water for technological processes and cleaning/decontamination activities, construction/demolition works, etc. There will be controlled minor releases of radioactive substances into the environment. These potential negative impacts are analysed and evaluated in this EIA report, and measures to mitigate potential impacts are proposed.

The INPP decommissioning activities will not have a negative impact on such environmental components as the land surface, the underground, the landscape, biodiversity, socio-economic environment, and immovable cultural heritage. The EIA report reviews the current condition of these environmental components and discusses possible links with the INPP decommissioning activities. As the economic activity will not cause a negative impact, no mitigation measures are foreseen.

4.1 Water

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

The INPP discharges into Lake Drūkšiai through separate channels:

- surface wastewater collected from the INPP site, the territory of the adjacent individual NF sites and the buildings adjacent to the INPP site;
- industrial wastewater – technological and excess water.

The ecological status of surface water bodies, including lakes, is assessed according to various physico-chemical, hydromorphological and biological quality elements. According to physico-chemical indicators (total nitrogen, total phosphorus, BOD_7), Lake Drūkšiai in 2010-2024 is classified as having a very good or good ecological status [30]. 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 [31].

Water consumption and wastewater discharge during the decommissioning of the INPP are consistently decreasing, see Figure 4-1. Wastewater monitoring and pollution control is carried out in accordance with the requirements of the applicable legislation: Wastewater Management Regulation [32], the Surface Waste Water Management Regulation [33], the environmental monitoring programme of the State Enterprise Ignalina NPP [35], prepared in accordance with the Regulations on the Monitoring of the Environment of Economic Entities [34]. After the installation of the planned new LRW evaporation facilities and the decommissioning of the steam boiler plant at the INPP, the discharge of industrial wastewater into Lake Drūkšiai will be further reduced.

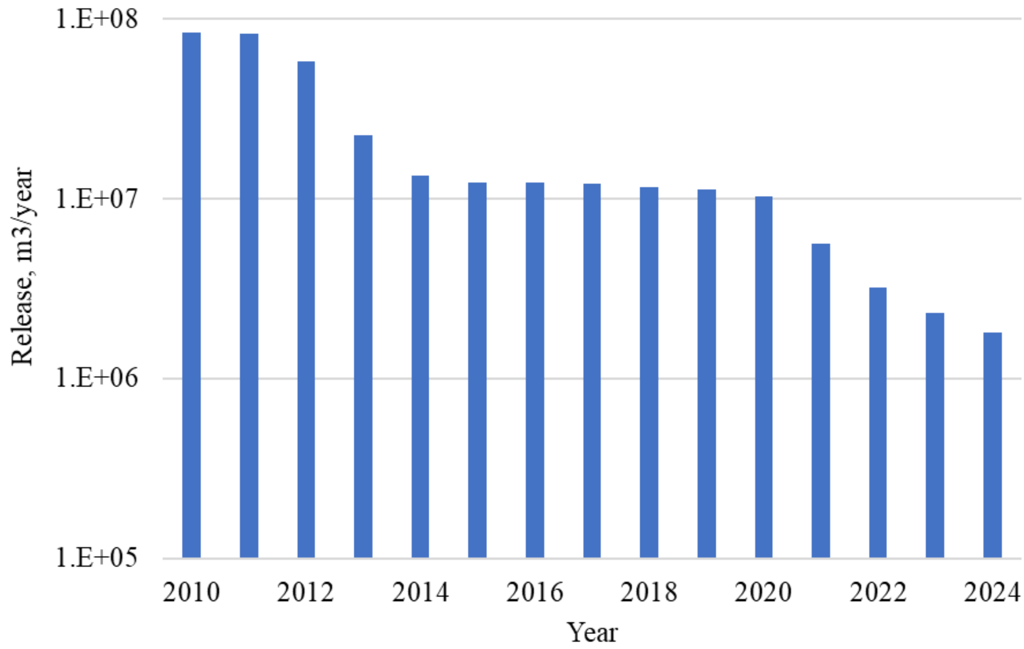

Figure 4-1. Total discharge of technological and excess water from the INPP to Lake Drūkšiai

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 in Lake Drūkšiai are not exceptional and correspond to the values measured in other places.

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 of the population due to the releases of radionuclides into the ambient waters does not exceed 0.1 mSv. In the period 2010 – 2024, annual radioactive releases into ambient waters did not exceed 1–10% of the established limit releases. Radionuclide releases into ambient waters can be considered as insignificant and in line with the ALARA principle.

4.2 Ambient air

Conventional (non-radioactive) pollutants from the INPP are emitted into the atmosphere from more than 70 different stationary sources of pollution (chimneys, vents, breathers, filters). The number of pollution sources at INPP is not constant and changes during the decommissioning process, depending on the activities carried out. Releases due to the combustion of natural gas, diesel fuels, mechanical and thermal treatment of metals are dominant: carbon monoxide (CO), nitrogen oxides (NO_X), sulphur dioxide (SO_2), and particulate matter (PM). The emission and dispersion of these pollutants determines the air quality at the INPP site and the compliance of pollution with the established air pollution standards [36], [37].

As the decommissioning of INPP continues, the number of stationary sources of air pollution at INPP will decrease. Accordingly, emissions of pollutants into the atmosphere will be reduced. During the period 2010–2024, permissible emissions into atmosphere decreased approximately from 200 t/year to 30 t/year. In the future, INPP plans to install new LRW treatment facilities and stop the operation of the present main source of ambient air pollution – the steam boiler station.

In addition to stationary pollution sources, ambient air pollution at the INPP site and adjacent NF sites is also caused by mobile pollution sources, i.e. vehicles transporting various materials. Most of the mobile pollution sources used at the INPP are powered by diesel fuel. During the demolition and dismantling of buildings and structures, the recultivation of the site and other construction works, dust (solid particles) will be generated, the dispersion of which will also affect the air quality at the INPP site. These sources of pollution are local and their impacts are felt in the immediate vicinity of the INPP site.

The sources of radioactive pollution of the ambient air are special ventilation systems operating in buildings located in the controlled areas of the INPP site and adjacent NF sites. Radionuclide releases into atmosphere from the INPP site and adjacent NF are summarized in Figure 4-2. Three release groups have been identified, the release rates of which differ significantly: radionuclides H-3, C-14 and other radioactive aerosols (named as IR group).

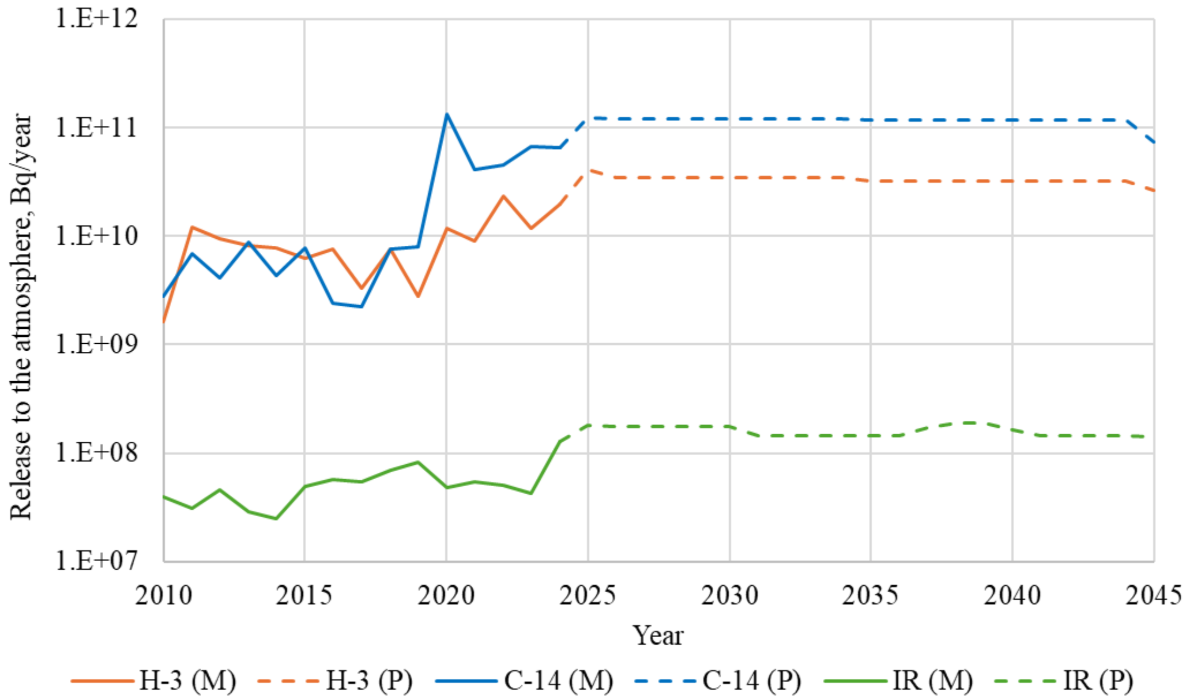

Figure 4-2. Releases of H-3, C-14 and IR group of radionuclides into atmosphere from INPP, (M) – monitoring data, (P) – predicted releases

Radionuclide releases from the INPP into the atmosphere are controlled and limited according to the established limit releases in such a way that the annual effective dose constrain of the population due to the releases of radionuclides into the atmosphere does not exceed 0.1 mSv. In the period 2010 – 2024, annual radioactive releases into atmosphere did not exceed the established limit releases. The currently valid release limits to atmosphere are established based on data from previously prepared decommissioning projects and may be reviewed and optimized in the future by applying the ALARA principle and maintaining a low environmental impact that meets radiation safety requirements.

4.3 Public health

Potential impacts on public health due to the demolition of buildings are related to air pollution and noise. During the dismantling and demolition of building structures, dust will be generated, and demolition equipment and transport vehicles will emit CO, NO_X, SO_2, and particulate matter into the air. Air pollution will be local, covering the area of the demolished building and its surroundings at a distance of about 100 m. According to the data of the chemical and radiological monitoring of the ambient air conducted since the beginning of the operation of the Ignalina NPP, the Ignalina NPP decommissioning activities have not had a significant negative impact on the ambient air so far.

The main requirements for ensuring the long-term health protection of the population from the dangers posed by ionizing radiation are established by the Lithuanian hygiene standard HN 73:2018 [38]. The hygiene standard implements the provisions of the Law on Radiation Protection of the Republic of Lithuania [39) and European Council Directive 2013/59/Euratom [40].

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 NPP and direct exposure from the NPP, the annual effective dose constrain [38] is 0.2 mSv.

The population exposure due to the ongoing and planned decommissioning of the INPP is summarized in Figure 4-3. The annual effective dose of the population in the period 2010–2024 was on average about 0.002 mSv/year, increasing to 0.004 mSv/year in individual years. It is predicted that if decommissioning activities continue, the annual effective dose of the population may be about 0.006 mSv/year, i.e. about 3% of the dose constrain.

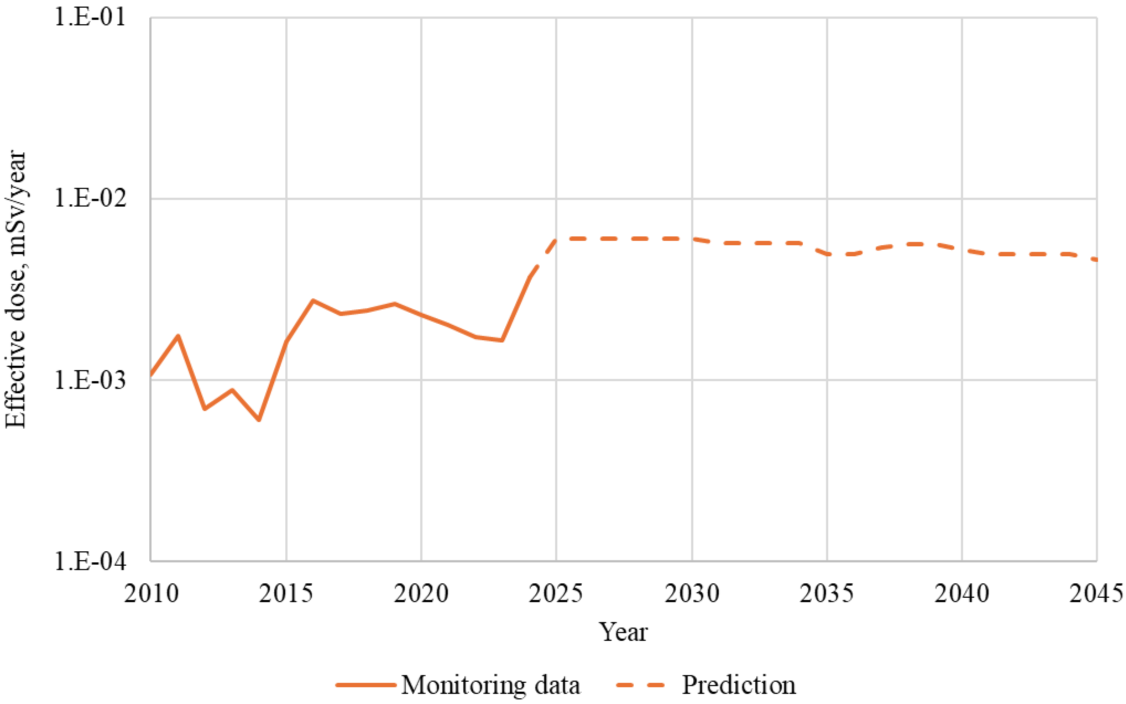

Figure 4-3. Annual effective dose to the population due to the decommissioning of INPP

5 Risk analysis

The risk analysis performed in the EIA report is based on the already performed safety assessments of the Ignalina NPP decommissioning [41]. The EIA report summarises the initiating events that have already been analysed, which can be caused by external (natural phenomena and human activity) and internal (technical and human activity) initial events. Possible accidents related to the handling of spent nuclear fuel (Class G SRW) are not considered 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, loaded into interim storage casks and placed in ISFSF-1 and ISFSF-2 storage facilities. From the point of view of radiological consequences, the bounding accidents during the decommissioning of the INPP are:

- Damage to the container with class D and E SRW during transportation;
- Airplane crash into the reactor building of Unit 2 and the reactor being dismantled therein, see Figure 5-1.

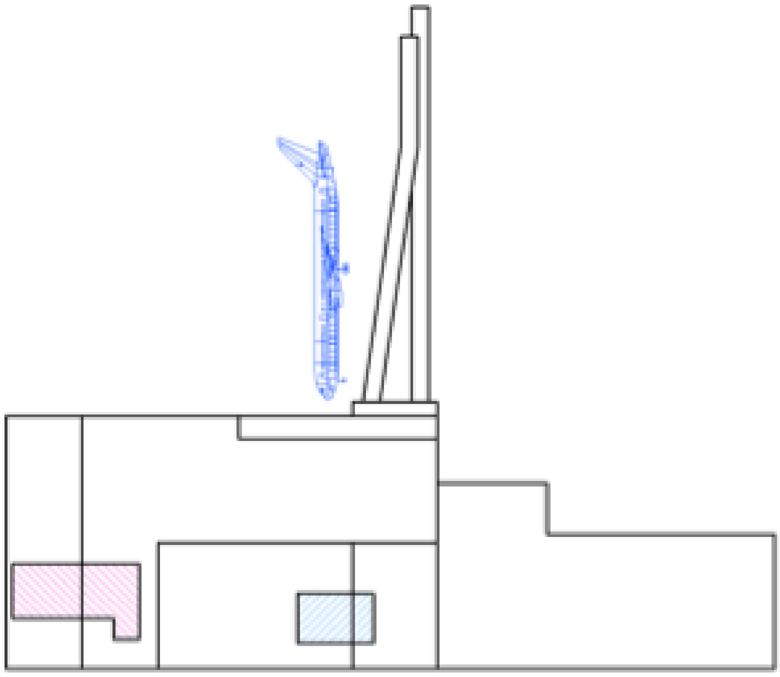

Figure 5-1. Airplane crash into the reactor building of Unit 2, view from the east side of the unit building. The building and plane are shown to the same scale

In the event of an accident in which a transport container is damaged and Class E waste is scattered at the INPP site, the maximum annual effective dose to the population is about 0.3 mSv and does not exceed the established [38]annual effective dose limit for the population – 1 mSv. At a distance of 5.5 km from the accident place and further, the annual effective dose to the population is about 0.1 mSv. The dose caused by the accident can be considered as relatively low, the dose is about 10 times lower than the dose limit.

When a large airplane (analogous to the Boeing 767-400) crashes into the reactor building of the Unit 2, where the reactor dismantling works are being carried out, ionizing radiation will not cause any adverse effects on the population. The highest radiological impact is experienced near the INPP site and within a 3 km radius of the INPP SPZ. According to a conservative scenario of radionuclide dispersion in the environment, the 24-hour effective dose of a resident in the INPP 3 km SPZ is approximately 0.28 mSv and the annual effective dose is approximately 0.31 mSv.

During the first hour of the accident, while intensive radioactive releases into the atmosphere are taking place, the exposure of the population accounts for about 70% - 90% of the annual effective dose. The annual effective dose of a resident outside the current INPP SPZ of 3 km is approximately 0.15 mSv or less.

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) [3] 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.

During the preparation stage 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 assessment of alternatives led to the conclusion 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.

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. Since the beginning of the operation of the power plant, the Ignalina NPP has been carrying out environmental monitoring in accordance with the requirements of the Law on Environmental Monitoring of the Republic of Lithuania [42], radiation protection standards [38], nuclear safety requirements [43] and other legal acts and normative documents of the Republic of Lithuania regulating this activity [34], [44], [45]. The environmental monitoring carried out by the Ignalina NPP consists of:

- monitoring of chemical pollution and state of the environment;
- monitoring of radiological pollution and state of the environment.

Environmental monitoring is carried out at the Ignalina NPP industrial site, within a 3 km radius sanitary protection zone and within a 30 km radius surveillance zone. The INPP environmental monitoring and INPP radiological environment programs are reviewed and updated taking into account ongoing and planned decommissioning activities.

8 Transboundary environmental impacts

Two countries, the Republic of Latvia and the Republic of Belarus, are located relatively close to the INPP site, see Figure 1-1. The state border of the Republic of Lithuania and Belarus is located at a distance of about 5 km to the east and southeast of the INPP industrial site. The state border of the Republic of Lithuania and Latvia is located about 8 km to the north of the Ignalina NPP industrial site. Other neighboring countries are located more than 200 km (Republic of Estonia, Republic of Poland) and 500 km (Kingdom of Sweden, Kingdom of Denmark) from the INPP.

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 2010–2024, the exposure of the population due to radioactive releases into the atmosphere, into the ambient water and due to external ionizing radiation from the INPP site and the adjacent NF sites was small and local. The annual effective dose of exposure of a permanent resident living outside the INPP sanitary protection zone of a radius of 3 km was on average about 0.002 mSv/year, increasing to 0.004 mSv/year in individual years.

It is predicted that with the continuation of the decommissioning activities, the annual effective dose of the resident may be about 0.006 mSv/year. At this dose, the exposure of the resident due to radioactive releases into Lake Drūkšiai is about 0.001 – 0.002 mSv/year. 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 0.01 mSv (10 μSv) and can be considered insignificant from the point of view of radiological impact.

As the assessment of possible radiological accidents shows, even in the case of accidents with the most severe consequences, the radiological impact on the population of other countries will not be significant. In the case of a damage of a container with a Class E SRW, the calculated annual effective dose of radiation to a population at a distance of 5.5 km from the accident place (at the state border with the Republic of Belarus) and further (at the state border with the Republic of Latvia) is about 0.1 mSv and less. In the case of an airplane crash on the reactor of the Unit 2, the highest radiological impact is experienced in the vicinity of the INPP site and the SPZ within a 3 km radius of the INPP. The annual effective dose of radiation to a population living outside the existing INPP SPZ with a 3 km radius is about 0.15 mSv. In the case of radiological accidents, the radiation dose to the population of neighboring countries would be about 10 times lower than the internationally recognized dose constrain of 1 mSv/year.

9 References

1. Assessment of the cumulative environmental impact of the decommissioning process of the Ignalina NPP. Environmental Impact Assessment Report. Lithuanian Energy Institute, Nuclear Engineering Laboratory, 2025.
2. Law on Nuclear Safety of the Republic of Lithuania. No. 1111010ISTA0XI-1539.
3. Ignalina NPP final decommissioning plan. 2018 edition, version 4. Ignalina NPP. Approved by Order No. 1-248 of the Minister of Energy of the Republic of Lithuania on 11/08/2020.
4. Nuclear safety requirements BSR-3.1.2-2017. Management of radioactive waste at nuclear energy facilities until it is placed in the radioactive waste repository. VATESI, 2017-07-31.
5. Nuclear safety requirements BSR-1.9.2-2018. Establishment and Application of Clearance Levels of Radionuclides for the Materials and Waste Generated during the Activities with the Sources of Ionising Radiation in the Area of Nuclear Energy. VATESI. TAR 2018-02-07, i. k. 2018-01924.
6. 2021-2030 Nuclear Energy Facilities Decommissioning and Radioactive Waste Management Development Programme. Approved by the Government of the Republic of Lithuania Resolution No. 76 of 03/02/2021.
7. Interim storage of spent RBMK nuclear fuel from units 1 and 2 of the Ignalina NPP. EIA Report, Version 4. GNS-RWE NUKEM Gmbh Consortium, LEI, 2007.
8. The new solid waste management and storage facility of the Ignalina NPP. Environmental Impact Assessment Report, version 5. NUKEM Technologies GmbH, Lithuanian Energy Institute, 2008.
9. Environmental impact assessment of the reconstruction and transformation of the INPP bituminous radioactive waste storage facility into a repository. EIA Report, Version 5. LEI, 2024.
10. Installation of a cementation plant for the solidification of liquid radioactive waste and construction of a temporary storage facility at the Ignalina Nuclear Power Plant (INPP). Environmental Impact Assessment Report. Framatome ANP GmbH, Lithuanian Energy Institute, 2002.
11. Deactivation and dismantling of the equipment of the Ignalina NPP 117/1 building. Environmental Impact Assessment Report. VT Nuclear Services Ltd., Lithuanian Energy Institute, Nuclear Engineering Laboratory, 2009.

12. Deactivation and dismantling of INPP cogeneration equipment. Environmental Impact Assessment Report. State Enterprise Ignalina Nuclear Power Plant Decommissioning Directorate, 2011.
13. Deactivation and dismantling of the equipment of the turbine hall of the 1st unit of the INPP. Environmental Impact Assessment Report. State Enterprise Ignalina Nuclear Power Plant Decommissioning Directorate, 2011.
14. Deactivation and dismantling of the equipment of the Ignalina NPP V1 unit. Environmental Impact Assessment Report. State Enterprise Ignalina Nuclear Power Plant Decommissioning Unit, 2011.
15. Dismantling and decommissioning of the equipment of the Ignalina NPP 117/2 building (project B9-0(2)). Environmental Impact Assessment Report. Ignalina Nuclear Power Plant, 2012.
16. Deactivation and dismantling of the equipment of the turbine hall of the 2nd unit of the Ignalina NPP (project B9-1(2)). Environmental Impact Assessment Report. Ignalina Nuclear Power Plant, 2013.
17. Environmental impact assessment report on the dismantling and decontamination of unit equipment projects D-1, D-0, D-2. Ignalina Nuclear Power Plant, 2015.
18. Environmental impact assessment report of the project for the dismantling and decommissioning of the facilities of the INPP unit A-1. Ignalina Nuclear Power Plant, 2016.
19. Environmental Impact Assessment Report of the R1 and R2 Work Area Equipment Dismantling and Decontamination Project (UP01, Block 1). Ignalina Nuclear Power Plant, 2016.
20. Dismantling and decommissioning of the equipment of the INPP units A-2 and V-2 (Project 2210, Phase 1). Environmental Impact Assessment Report. Ignalina Nuclear Power Plant, 2019.
21. Dismantling and decommissioning of the equipment of the working areas R1 and R2 of the 2nd power unit of the INPP (project 2102). Environmental Impact Assessment Report. Ignalina Nuclear Power Plant, 2021.
22. Dismantling and decontamination of the residual equipment of INPP building 119, G1, D0, D1, D2 units (projects 2301, 2302). Environmental Impact Assessment Report. Ignalina Nuclear Power Plant, 2022.
23. Nuclear Safety Requirements BSR-1.5.1-2019. Decommissioning of nuclear energy facilities. VATESI, 2015-11-30. TAR 2019-01-24, i. k. 2019-01067.
24. Dismantling and decontamination of the equipment of the low salinity water storage tanks of the INPP units 1 and 2 (building 152/1.2A and 152/1.2B) (project 2219). Environmental Impact Assessment Report. Ignalina Nuclear Power Plant, 2023.
25. Repository of short-lived very low-activity radioactive waste. Environmental Impact Assessment Report. UAB "Specialus montažas-NTP", Lithuanian Energy Institute, 2009.
26. Supplemented report on the environmental impact assessment of the installation of a surface radioactive waste repository. Version 3-2. State Enterprise Radioactive Waste Management Agency. 2007.
27. Construction Technical Regulation STR 1.05.01:2017. Documents permitting construction. Completion of construction. Registration and transfer of an unfinished building. Suspension of construction. Elimination of the consequences of arbitrary construction. Elimination of the consequences of construction according to an illegally issued construction permit document. TAR 2024-08-27, i. k. 2024-14868.

28. Rules for the Issuance of Permits for the Construction, Reconstruction, Major Repair or Demolition of Nuclear Energy Object Structures (Official Gazette Žinios, 24-07-2002, No. 74-3164, new wording TAR 2015-08-17, Official Gazette 2015-12359).
29. Nuclear Safety Regulations BST-1.5.1-2020. Determination of compliance of buildings, engineering structures and site of nuclear energy facilities with uncontrolled radioactivity levels and surface radionuclide activity values. TAR 2020-01-22, No. 2020-00964.
30. Methodology for determining the status of surface water bodies. Approved by the Order of the Minister of Environment of the Republic of Lithuania No. D1-210 of 12.04.2007. TAR 2021-11-04, i. k. 2021-22923.
31. Description of the requirements for the protection of surface water bodies in which freshwater fish can live and breed. Approved by the Order of the Minister of Environment of the Republic of Lithuania No. D1-633 of 21-12-2005. You know. 2006, No. 5-159, I. K. 105301MISAK00D1-633.
32. Wastewater Management Regulation. Approved by the Order of the Minister of Environment of the Republic of Lithuania No. D1-236 of 17.05.2006. TAR 2020-12-03, i. k. 2020-26008.
33. Surface Wastewater Management Regulation. Approved by the Order of the Minister of Environment of the Republic of Lithuania No. D1-193 of 02.04.2007. TAR 2019-06-17, i. k. 2019-09712.
34. Regulations for the Environmental Monitoring of Economic Entities. Approved by the Order of the Minister of Environment of the Republic of Lithuania No. D1-546 of 16.09.2009. TAR 2021-03-31, i. k. 2021-06606.
35. Ignalina NPP Environmental Monitoring Programme, 2023-06-07, MnDPl-342(7.3E).
36. The list of pollutants the amount of which is limited in ambient air in accordance with the criteria of the European Union and the list of pollutants the amount of which in ambient air is limited in accordance with national criteria and the limit values of ambient air pollution approved by the Order of the Minister of Environment and the Minister of Health of the Republic of Lithuania No. 471/582 of 30 October 2000. New wording of 01-07-2007, i. k. 107301MISAK29/V-469.
37. Norms of ambient air pollution by sulphur dioxide, nitrogen dioxide, nitrogen oxides, benzene, carbon monoxide, lead, particulate matter and ozone, approved by Order No. 591/No. 640 of the Minister of Environment and the Minister of Health of the Republic of Lithuania of 11 December 2001. New version of 14-07-2010, i. k. 110301MISAK85/V-611.
38. Lithuanian Hygiene Standard HN 73:2018 "Basic Radiation Protection Standards" (Official Gazette, 2002, No. 11-388, new wording TAR, 2018, No. 2018-13208, as amended).
39. Law of the Republic of Lithuania on Radiation Protection. TAR 2018-07-03, i. k. 2018-11176.
40. Council Directive 2013/59/Euratom laying down basic safety standards to ensure protection against the dangers arising from exposure to ionising radiation and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. Official Journal of the European Union I. 13, 17/01/2014.
41. Ignalina NPP Decommissioning Safety Analysis Report and Safety Periodic Assessment of Unit 2, No. PD-21(19.54E). Ignalina NPP.
42. Law on Environmental Monitoring of the Republic of Lithuania (Official Gazette Žinios, 1997, No. 112-2824, new wording 2006, No. 57-2025, as amended).

43. Nuclear Safety Requirements BSR-1.9.1-2017. Norms for the emission of radionuclides into the environment from nuclear energy facilities and requirements for the plan for the release of radionuclides into the environment. VATESI, 2011-09-27. TAR 2017-10-31, i. k. 2017-17207.

44. Description of the Procedure for Radiological Environmental Monitoring of Economic Entities, approved by Order No. V-3028 of the Minister of Health of the Republic of Lithuania of 26 December 2020 (TAR, 2020, No. 28642).

45. The methodological requirements for the preparation of the groundwater monitoring part of the monitoring programme were approved by the Order No. 1-156 of the Director of the Geological Survey of Lithuania under the Ministry of Environment of 24 August 2011 (Official Gazette Žinios, 2011, No. 107-5092, TAR, 2018, No. 9811).