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NUCLEAR ENGINEERING LABORATORY

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

DECOMMISSIONING PROJECT FOR IGNALINA NPP UNIT 2 FINAL SHUT DOWN AND DEFUELLING PHASE

Revision 5

Organizer of the Proposed Economic Activity:	**State Enterprise Ignalina Nuclear Power Plant**
Developer of the EIA Report:	**Lithuanian Energy Institute, Nuclear Engineering Laboratory**

July, 2010

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The Ignalina Programme is a financial instrument to support the decommissioning of the Ignalina Nuclear Power Plant and consequential measures in the energy sector for Lithuania

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BRANDUOLINĖS INŽINERIJOS PROBLEMŲ LABORATORIJA

POVEIKIO APLINKAI VERTINIMO ATASKAITA

IAE 2-OJO BLOKO EKSPLOATAVIMO NUTRAUKIMO PROJEKTAS GALUTINIO SUSTABDYMO IR KURO IŠKROVIMO FAZEI

5 versija

Planuojamos ūkinės veiklos organizatorius:	**Valstybės įmonė Ignalinos atominė elektrinė**
PAV ataskaitos rengėjas:	**Lietuvos energetikos institutas, Branduolinės inžinerijos problemų laboratorija**

2010 m. liepos mėn.

Šį projektą remia EUROPOS SĄJUNGA pagal Ignalinos programą
Ignalinos programa yra finansinis instrumentas, skirtas Ignalinos atominės elektrinės eksploatavimo nutraukimui bei susijusioms priemonėms Lietuvos energetikos sektoriuje remti

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This report presents estimations and assessment if the proposed economic activity, by virtue of its nature and environmental impacts, may be allowed to be carried out at the chosen site. Proposed economic activity (decommissioning of the INPP unit 2) concerns INPP unit 2 reactor final shut down, reactor and storage pools defuelling, spent fuel transportation to the interim spent fuel storage facility, activity, related to the system isolation and modifications required for the reactor unit shut down and waste (radioactive and non-radioactive) management during defuelling phase.</td></tr>
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[1)] – Appendixes are attached separately and to Lithuanian version only.

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TABLE OF REVISIONS

Revision /Issue	Issue date	Description
0/0	April 6, 2009	Issued for EIA Developer's internal review
1/1	April 17, 2009	Submitted to Ignalina NPP for review
2/1	June 12, 2009	Updated according to INPP comments; presented to public
3/1	July 16, 2009	Updated after the public presentation
3/2	December 7, 2009	Updated according to comments of EIA Relevant parties; resubmitted to EIA Relevant parties
4/1	March 17, 2010	Updated according to comments of Competent Authority
5	July 7, 2010	Updated after the meeting organized by Competent Authority on clarification of conclusions of EIA Relevant parties

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Appendixes are attached separately and to Lithuanian version only.
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APPENDIX 2. Documents on public informing and public participation in the EIA process
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APPENDIX 4. Responses to comments of EIA relevant parties
APPENDIX 5. Comments of Competent Authority and responses to the comments

ABBREVIATIONS AND DEFINITIONS

ALARA	An acronym for radiation protection principle **A**s **L**ow **A**s **R**easonably **A**chievable (the radiation dose should be minimized to the greatest possible extent, except where the additional cost or impracticality of further dose-reduction measures would be unreasonable)
BWR	Boiling Water Reactor
D&D	Decontamination and Dismantling
DP	Decommissioning Project
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EW	Exempt waste
FDP	Final Decommissioning Plan
FP	Fission Products
IAEA	International Atomic Energy Agency
ILW-LL	Long-Lived Intermediate Level Waste
ILW-SL	Short-Lived Intermediate Level Waste
INPP, Ignalina NPP	Ignalina Nuclear Power Plant
ISFSF	Interim Spent Fuel Storage Facility
LEI	Lithuanian Energy Institute
LL	Long-lived (waste)
LLW-LL	Long-Lived Low Level Waste
LLW-SL	Short-Lived Low Level Waste
LR	Republic of Lithuania
LRW	Liquid Radioactive Waste
LWTF	Liquid radioactive Waste Treatment Facility
MCC	Main Circulation Circuit
NF	Nuclear Facility
NPP	Nuclear Power Plant
PCS	Purification and Cooling System of the MCC
PDP	Preliminary Decommissioning Plan
RAW	Radioactive Waste
RBMK	Water-cooled, graphite-moderated, pressure-tube-type boiling-water power reactor (Russian abbreviation of “Reactor Bolshoy Moshchnosty Kanalny”)
RFS	Reactor Final Shutdown
RM	Refuelling Machine
SAC	Special Areas for Conservation
SAR	Safety Analysis Report
SCI	Sites of Community Importance
SE	State Enterprise
SL	Short-lived (waste)
SNF	Spent Nuclear Fuel
SNFA	Spent Nuclear Fuel Assembly
SNFS	Spent Nuclear Fuel Storage

SPA	Special Protection Area
SPZ	Sanitary Protection Zone
SRW	Solid Radioactive Waste
SSS	Spent Sealed Sources
SWMSF	Solid radioactive Waste Management and Storage Facility
SWRF	Solid radioactive Waste Retrieval Facility
SWSF	Solid radioactive Waste Storage Facility
SWTF	Solid radioactive Waste Treatment Facility
SWTSF	Solid Waste Treatment and Storage Facility
TRU	Transuranics
U1DP0	Decommissioning Project for Ignalina NPP Unit 1 Final Shut Down and Defuelling Phase
U2DP0	Decommissioning Project for Ignalina NPP Unit 2 Final Shut Down and Defuelling Phase (this proposed economic activity)
VATESI	State Nuclear Power Safety Inspectorate (Lithuanian acronym)
VLLW	Very Low Level Radioactive Waste

INTRODUCTION

The only one nuclear power plant in Lithuania, i.e. Ignalina Nuclear Power Plant (INPP) is situated in the Northeastern part of Lithuania close to the borders with Latvia and Belarus and on the shore of Lake Druksiai. The power plant possesses two RBMK-type water cooled graphite-moderated pressure-tube reactors each of a design capacity of 1500 MW(e). They were commissioned (first grid connection) in 1983 and 1987, respectively.

In accordance with the National Energy Strategy [1], the reactor of the 1st Unit of INPP was shut down on December 31, 2004. The shutdown of the reactor of 2nd Unit is scheduled for the end of 2009. The Lithuanian Government by resolution "On State Enterprise Ignalina NPP First Unit Decommissioning Concept" [2] has approved an immediate dismantling concept for the decommissioning of the first power unit of INPP.

According to the INPP Final Decommissioning Plan [3], the INPP decommissioning process is split into several decommissioning projects (DP). Each of these DP is a process covering a particular field of activity, defining scope of works and their specific and providing input for organization of specific activity, safety analysis and environmental impact assessment. In order to ensure that environmental impact assessment (EIA) is based on reliable and detailed information, what becomes available along with the progress in the particular DP, the EIA Program of INPP decommissioning [4] provides to develop EIA reports separately for each DP. Every EIA report of a subsequent DP shall take into account results of previous reports. Thus the overall environmental impact due to INPP decommissioning would be assessed and controlled on the basis of the latest information, and environmental impact mitigation measures would be adequate to the real situation.

The present EIA Report provides information on the likely environmental consequences of the proposed project and mitigation measures that can be implemented in order to prevent, decrease or cease environmental consequences, with a view to provide information for the decision-making process. The EIA process provides a tool for communication and consultation with the public.

The proposed economic activity, to which the present Environment Impact Assessment is associated, considers INPP Unit 2 reactor final shut down, reactor and storage pools defuelling, spent fuel transportation to the interim spent fuel storage facility, decontamination activities (including decontamination of the main circulation circuit) required after reactor shutdown, isolation and modification of the systems, which is required for the unit shut down and waste (radioactive and non-radioactive) management during defuelling phase. The proposed economic activity is one of separate decommissioning projects performed in accordance with the INPP Final Decommissioning Plan [3]. The development of EIA Report for this proposed economic activity is stipulated by the EIA Program of INPP Decommissioning [4].

The objectives of an EIA are defined by the Article 4 of the Republic of Lithuania Law on the Assessment of the Impact on the Environment of the Proposed Economic Activities [5] and shall be as follows:

- To identify, characterize and assess potential direct and indirect impacts of the proposed economic activity on human beings, fauna and flora; soil, surface and entrails of the earth; air, water, climate, landscape and biodiversity; material assets and the immovable cultural heritage, and interaction among these factors;
- To reduce or avoid negative impacts of the proposed economic activity on human beings and other components of the environment, referred to in the paragraph above; and
- To determine if the proposed economic activity, by virtue of its nature and environmental impacts, may be allowed to be carried out at the chosen site.

The structure and content of EIA Report are in accordance to the requirements of the Republic of Lithuania Law on the Assessment of the Impact on the Environment of the Proposed Economic Activities [5] and the Regulations on Preparation of Environment Impact Assessment Program and Report [6].

REFERENCES

1. The Republic of Lithuania Parliament Decision No. IX-1130 dated October 10, 2002, On Approval of National Energy Strategy. State News 2002 No. 99-4397.
2. The Republic of Lithuania Government Resolution No. 1848 dated November 26, 2002, On State Enterprise Ignalina NPP First Unit Decommissioning Concept. State News 2002, No. 114-5095.
3. Final Decommissioning Plan for Ignalina NPP Units 1 and 2. A1.1/ED/B4/0004, Issue 06. INPP Decommissioning Project Management Unit, 2004.
4. Ignalina NPP Decommissioning Environmental Impact Assessment Programme. A1.1/ED/B4/0001, Issue 05. INPP Decommissioning Project Management Unit, 2004.
5. The Republic of Lithuania Law on the Changes of the Law on Assessment of the Impact on the Environment of the Proposed Economic Activities No. X-258, State News 2005 No. 84-3105; 2008 No. 81-3167.
6. Regulations on Preparation of Environment Impact Assessment Program and Report. Approved by the Order of Ministry of Environment No. D1-636 dated December 23, 2005. State News 2006, No. 6-225; 2008 No. 79-3138.

SUMMARY

The proposed economic activity, to which environmental impact assessment (EIA) is evaluated and presented in this Environmental Impact Assessment Report, is named as the Decommissioning Project for Ignalina NPP Unit 2 Final Shut Down and Defuelling Phase.

The proposed economic activity considers the different activities, which will be initiated inside INPP Unit 2 and INPP site after Unit 2 reactor shutdown. The proposed economic activity foresees further maintenance and safety assurance of the reactor and complete unloading of nuclear fuel from the reactor core to spent nuclear fuel storage pools. Isolation, modification and decontamination (including in-line decontamination of the main circulation circuit) of the systems are also considered in the frame of this proposed economic activity. Also radioactive and other waste will be management during the implementation of the proposed economic activity.

The proposed economic activity is one of the separate INPP decommissioning projects. During the implementation period of the proposed economic activity, the separate INPP decommissioning projects related to building and equipment dismantling, radioactive waste and spent nuclear fuel management and storage will be carried out simultaneously. Projects of radioactive waste and SNF management consider the implementation and operation of the following facilities:

- Free release waste measurement facility;
- New Interim Spent Fuel Storage Facility (ISFSF);
- Solid radioactive waste treatment and storage facility;
- Very low level waste Landfill repository (including buffer storage facility);
- Near surface repository for short-lived low and intermediate level waste;
- Radioactive waste cement solidification facility (in operation since 2006);
- Bituminised radioactive waste repository (it is planned that existing storage facility of this waste will be transformed into repository).

The proposed economic activity covers the period between Unit 2 reactor shutdown1 until the second part of 2016 (until the total defuelling of the unit). The Unit 2 defuelling process may be divided into two stages:

- Defuelling Stage 1, which starts after Unit 2 reactor is shutdown and cooled down and ends up when the reactor core is completely defuelled;
- Defuelling Stage 2, which starts at the end of Stage 1 and ends up by the complete defuelling of Unit 2.

During the defuelling Stage 1 the removal of spent nuclear fuel (SNF) from the reactor core to the SNF storage pools, operation and maintenance of the required systems, isolation and modification of the separate systems will be carried out.

Defuelling Stage 2 will start after the complete SNF unloading for Unit 2 reactor core. Modification and isolation works, which cannot be completed while reactor core contains fuel, will be finished. In-line decontamination of the Main Circulation Circuit and decontamination of the Refuelling Machine will be performed during defuelling Stage 2. Management of operational waste will be performed in parallel. During the implementation of ISFSF Project, SNF gradually will be

[1] INPP Unit 2 reactor's shutdown date is 31 December 2009. However, the reactor final shutdown status (i.e. there is no possibility to start reactor in future) will be obtained later when corresponding legal acts will be passed and technical measures will be implemented.

loaded into storage casks and transferred from the Unit for interim storage.

Radioactive and non-radioactive waste generated during the implementation of the proposed economic activity will be managed according to legal acts and rules defined for waste management. Non-radioactive waste generated due to proposed economic activity will be similar to those that are generated during normal operation of Unit 2. The essential changes (in comparison with existing situation at INPP) are not expected. Radioactive waste generated during proposed economic activity will be managed in the existing and newly constructed INPP radioactive waste treatment facilities. The estimation of the amounts of generated radioactive waste shows that capacity of the existing and planned new facilities is sufficient and there will be no problems accepting waste generated during the implementation of decommissioning projects.

Non-radioactive impacts to environment caused by the proposed economic activity will be analogous to activities performed in the INPP under conditions of normal operation. Current conditions specified in the permit for pollution essentially will not change. Current situation at INPP region and direct impact to public health will not change in essence.

During the normal operation conditions of the proposed economic activity radiological impact potentially can be caused by the radionuclides releases to environmental water and air. Dismantling of contaminated INPP equipment is not foreseen in the frame of proposed economic activity. Therefore, other potential impact such as the change (increase or decrease) of radiation fields at INPP site due to the modification or isolation of disused systems, decontamination of closed circuits and other activities, are considered as insignificant or not making radiological situation at INPP site worst.

The highest annual exposure to the member of critical group of population due to the radionuclide releases into environmental water and air during of the proposed economic activity, is expected in 2010–2011. During this period intensive unloading of nuclear fuel from the reactor core, systems modification activities and management of radioactive waste generated by these activities mainly determine the exposure. The maximal annual effective dose determined by radioactive releases to environmental water during this period will be about 1.4 μSv. In later years doses will decrease and will not exceed 1 μSv. The maximal annual effective dose determined by radioactive releases to environmental air will be about 2.9 μSv. In later years doses will decrease and will vary in the interval of 1 – 1.8 μSv.

Taking into account that proposed economic activity does not foresee construction works, dismantling or modification of INPP structures, and all planned activities will be performed inside INPP industrial site and within the Unit 2, also transfer of radioactive and non-radioactive waste will be performed using existing roads at INPP site and waste management will be done in appropriate INPP facilities, it is estimated that there will be no impacts to environmental components such as soil, underground, biodiversity, landscape and cultural heritage during normal operation conditions of the proposed economic activity.

It is not expected that proposed economic activity will impact or significantly change the current social and economic environment. The means coordinated by the state are implemented in the INPP region with the aim to control and mitigate the impact on the socio-economic environment of the INPP region due to the shutdown of the INPP. It is not anticipate that proposed economic activity can influence or initiate the review and corrections of socio-economic environmental development means implemented by the state. Since the existing INPP personnel will be employed during this proposed economic activity, this project will mitigate the impact on the social and economical environment caused by the shutdown of the INPP Units 1 and 2.

Radiological impact assessment presented in this EIA Report considers not only impact from the proposed economic activity, but also impacts from other activities which are simultaneously performed at INPP industrial site and sanitary protection zone and which can increase population exposure. Total annual effective dose due to radioactive releases caused by the proposed economic activity, other INPP decommissioning activities at the INPP site and from operation of the newly planned SNF and solid radioactive waste treatment, storage and disposal facilities during 2010–2016 will be maximal in 2011 and will constitute approximately 19 μSv. This effective dose is determined by the INPP decommissioning activities at the INPP site and the new solid radioactive waste treatment and storage facility.

The estimated annual exposure is significantly smaller than the annual effective dose constraint, set by radiation protection requirements, which is 200 μSv.

Two countries, i.e. the Republic of Belarus and the Republic of Latvia, are relatively close to the INPP site. Results of environmental impact assessment have revealed that impacts from the proposed economic activity will be local and insignificant. The proposed economic activity will have no impacts to environmental components of the neighbouring countries such as soil, underground, biodiversity, landscape, ethnic and cultural environment and cultural heritage, social and economic environment. Impact to Lake Druksiai, a part of which also belongs to Republic of Belarus, will be insignificant. It is anticipated that controlled and small-scale discharge of production and sanitary waste water into the environment will not change the current situation. The maximal annual effective dose to the member of Belarus population determined by radioactive releases to the lake will be about 1.4 μSv. Analogous exposure of the member of Latvia population will be less than 0.3 μSv. Total radioactive impact to population of Belarus and Latvia will be insignificant and less than exemption level of 10 μSv defined by international radiation protection requirements.

Location and time alternatives of the proposed economic activity are defined beforehand, therefore these alternatives are not considered in EIA. Technological solutions for the proposed economic activity are selected and substantiated in the final INPP Unit 1 and 2 decommissioning plan. Unit 1 decommissioning project for defuelling phase which is currently underway essentially is analogous to the proposed economic activity. The same technological solutions will be applied during the implementation of the proposed economic activity.

Existing INPP environment monitoring equipments and methods for monitoring of radioactive discharges, external radiation and exposure, contamination of environmental air, water, soil and food chains can be used during the implementation of the proposed economic activity.

The events and accidents which are possible for proposed economic activity are as follows:

- Leakage of the main circulation circuit decontamination solution;
- Generation of explosive or hazardous gases during decontamination process;
- Failure in ventilation system when reactor is shutdown.

The risk analysis and estimation of the consequences of potential emergencies has shown, that in case of the identified accidents, the annual effective dose to the member of the critical group of the population taking into account the pathways of internal and external exposure will not exceed the permissible limits of radiation safety. The maximum received dose would be at the boundary of the INPP sanitary protection zone, it would not exceed 0.16 mSv, which is considerably lower than the dose limit of 10 mSv established for a design basis accident.

1 GENERAL INFORMATION

1.1 Organizer of the proposed economic activity

The organizer of proposed economical activity is **State Enterprise Ignalina Nuclear Power Plant**:

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1.2 Developer of the EIA Report

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1.3 Title and Description of the Proposed Economic Activity

The title of the proposed economic activity is **Decommissioning Project for Ignalina NPP Unit 2 Final Shut down and Defuelling Phase**.

The proposed economic activity considers the different activities, which will be initiated inside INPP Unit 2 and INPP site after Unit 2 reactor shutdown. The proposed economic activity foresees further maintenance and safety assurance of the reactor and complete unloading of nuclear fuel from the reactor core to spent nuclear fuel storage pools. Isolation, modification and decontamination (including in-line decontamination of the main circulation circuit) of the systems are also considered in the frame of this proposed economic activity. Also radioactive and other waste will be management during the implementation of the proposed economic activity.

The proposed economic activity is one of the separate Ignalina nuclear power plant (INPP) decommissioning projects. In the period of implementation this proposed economic activity a number of dismantling and decontamination works (for example, decontamination and dismantling of 117 building equipment) will be carried out. Also the new facilities required for INPP radioactive waste and spent nuclear fuel management will be built and put into operation (for example, a new SNF storage facility will start its operation and SNF from the both Units will be transferred to this new storage facility).

This EIA Report does not consider the new facilities to be erected during INPP decommissioning process as they are subject to their own separate licensing and EIA processes. However, the total radiological impact assessment during the implementation period of proposed economic activity in this EIA Report takes into account the impacts of these new facilities.

Pure INPP decommissioning works (dismantling and decontamination (D&D) of equipment and structures) are subject to other, forthcoming INPP Decommissioning Projects for which associated EIA Reports will be prepared. Assessment of the total radiological impact during the implementation period of the proposed economic activity at INPP site considers only these D&D projects for which environmental impact assessment is already performed.

1.4 Stages of Activity

Separate stages of the project U2DP0 (this proposed economic activity) are presented in Figure 1.1.

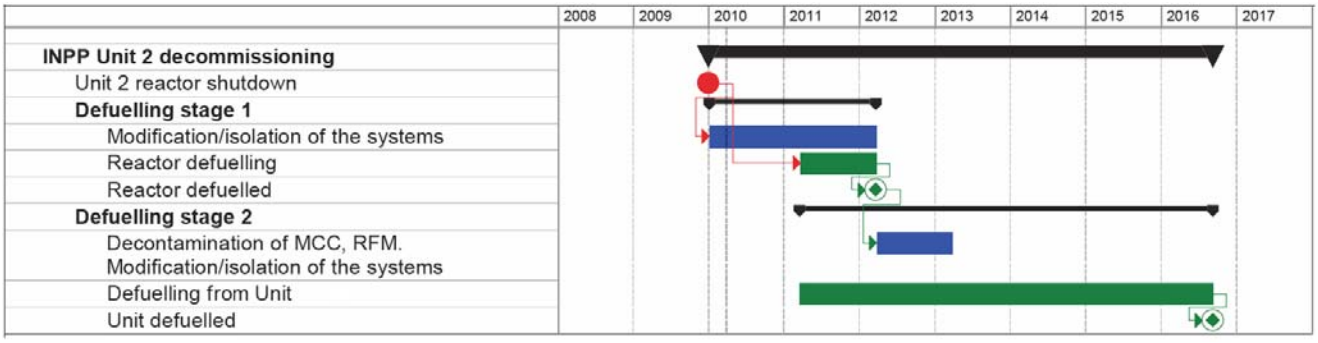

Figure 1.1. Implementation stages of the proposed economic activity (U2DP0)

Ignalina NPP Unit 2 reactor final shut down and defuelling covers the period between December 31, 2009 and the second half of the year 2016 (total defuelling of the Unit 2). Defueling process of spent nuclear fuel at Unit 2 may be divided into two defuelling stages:

- the 1st stage will start after the Unit 2 reactor final shutdown and cooling and will last until the total defuelling of the reactor;
- the 2nd stage will start after the 1st stage and will last until complete defuelling of the Unit 2.

1.5 EIA Connection with Planning and Designing Stages

According to the INPP Final Decommissioning Plan [1], the INPP decommissioning process is split into several decommissioning projects (DP). Each of these DP is a process covering a particular field of activity, defining scope of works and their specific and providing input for organization of specific activity, safety analysis and environmental impact assessment. IMPP decommissioning licensing strategy and provisional schedule of the different decommissioning projects is presented in Figure 1.2.

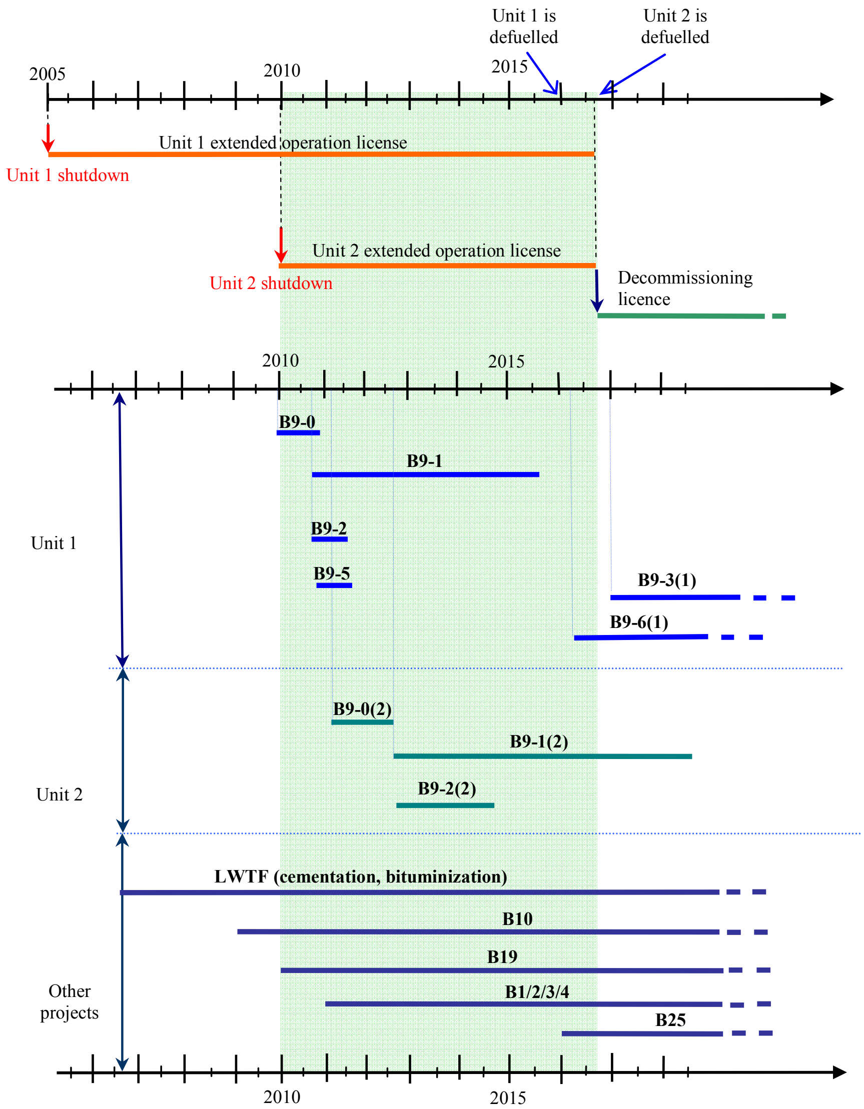

Figure 1.2. INPP decommissioning licensing strategy and works schedule

The following licenses are required for INPP decommissioning:

- INPP Unit 1 Extended Operation License (obtained);
- INPP Unit 2 Extended Operation License;
- INPP Site Decommissioning License.

Authorizations to be given under the licenses are listed below.

Under the INPP Unit 1 Extended Operation License:

- B9-0 – Dismantling and decontamination (D&D) of equipment in building 117/1;
- B9-1 – D&D of equipment in turbine hall in Unit 1 (G1);
- B9-2 – D&D of building V1;
- B9-5 – D&D of heating unit;
- B9-3 – D&D of equipment in building A1 (excluding reactor);
- B9-4 – D&D of Unit 1 reactor.

Under the INPP Unit 2 Extended Operation License:

- B9-0(2) – D&D of equipment in building 117/2;
- B9-1(2) – D&D of equipment in turbine hall in Unit 2 (G2);

- B9-2(2) – D&D of building V2;
- B9-6(1,2), B9-3(2) – D&D of buildings B1, B2, A2 (excluding reactor);
- B9-4(2) – D&D of Unit 2 reactor.

Under the INPP Site Decommissioning License:

- B9-7(1,2), B9-8(1,2), B9-9, B9-10 – decontamination and dismantling activities in buildings D0, D1, D2, in the remaining buildings on the site, and removal of the Units 1 and 2 stacks, INPP buildings conventional demolition.

Licences and permissions for appropriate decommissioning activities are issued by State government and regulatory institutions in accordance to the Law on Nuclear Energy [2], Regulations for Licensing of Nuclear Power Related Activities [3] and Requirements for Decommissioning of Nuclear Power Objects [4].

Aside the environmental issues considered in the EIA Report, safety issues are covered by a Safety Analysis Report (SAR). The approval processes for the two documents are different: the SAR is finally approved by the State Nuclear Power Safety Inspectorate (VATESI) while the Ministry of Environment based on EIA Report makes motivated decision about the admissibility of the proposed economic activity. The licensing process of the decommissioning project (including associated DSAR and EIA Report) and reactor final shutdown is presented in Figure 1.3.

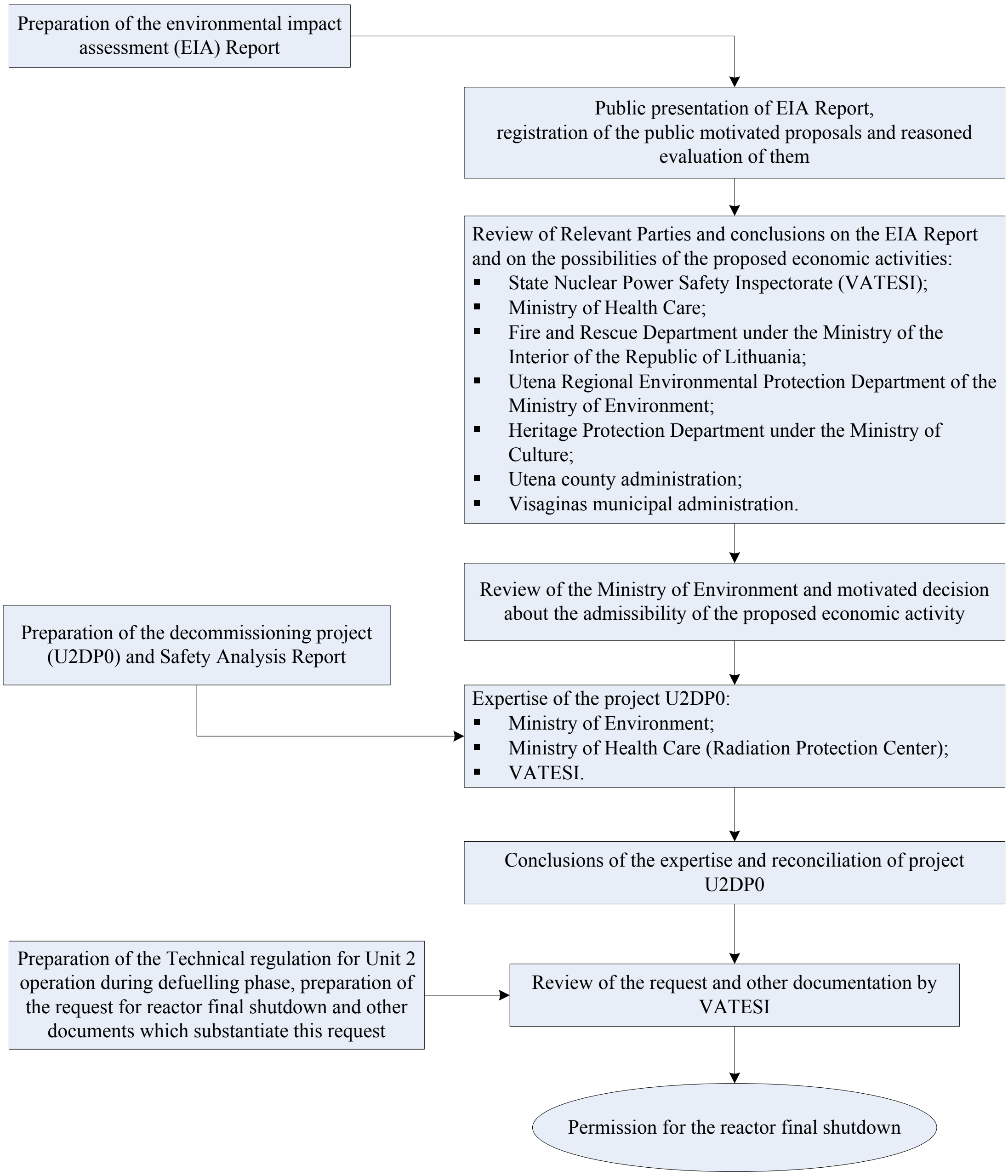

Figure 1.3. The licensing process of decommissioning project and reactor final shutdown

As it could be seen from Figure 1.3 the EIAR, the SAR and the DP documents are prepared in parallel. The EIAR has to be approved first before accompanying the other documents in the licensing procedures.

Preparation and reviewing process of the EIA Report according to regulations of the Law on Assessment of the Impact on the Environment [5] is summarized in Figure 1.4.

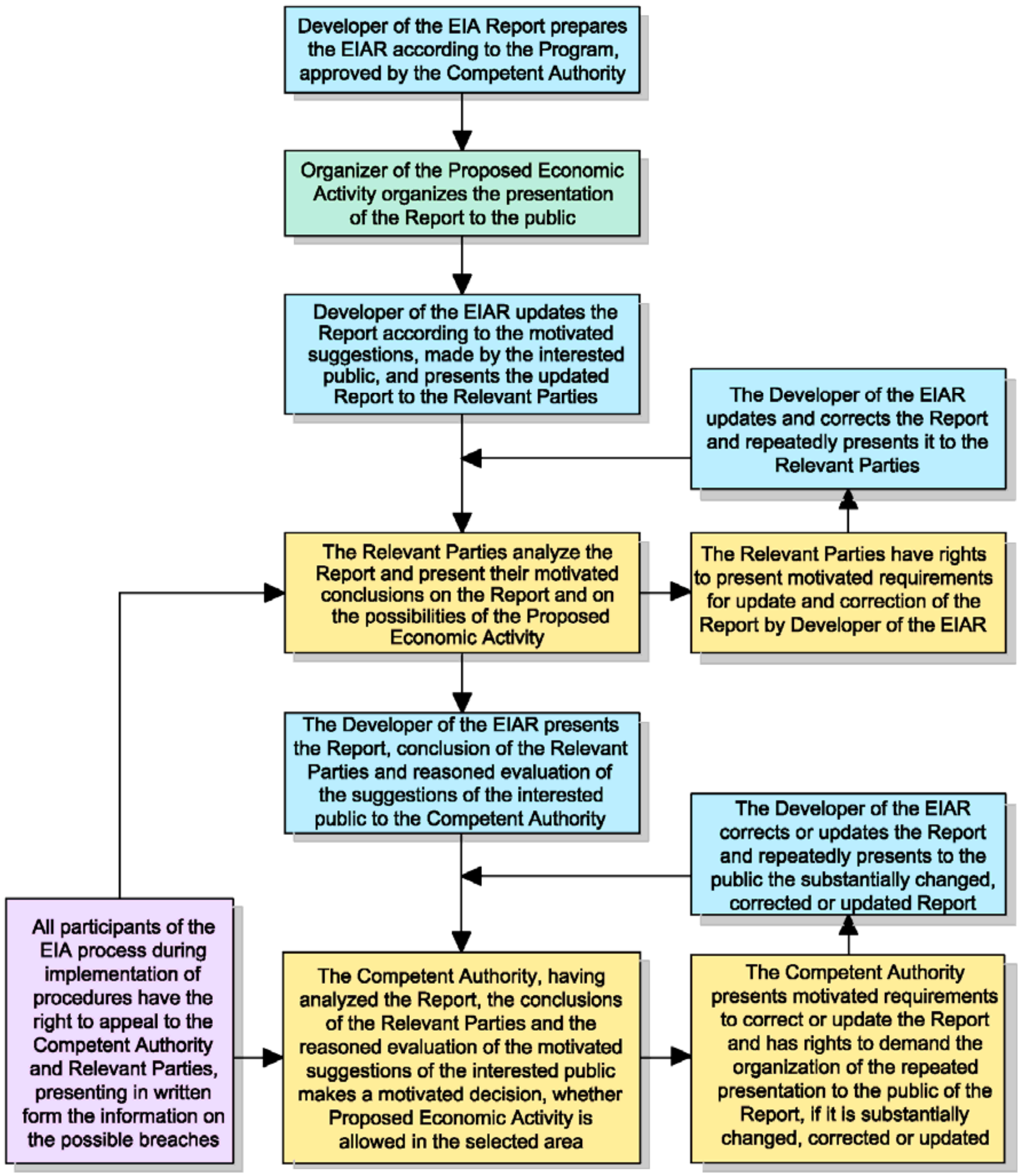

Figure 1.4. Preparation and reviewing process of EIA Report

Competent Authority of the environmental impact assessment process for this proposed economical activity is Ministry of Environment. According to the Clause 6 of the Law on Assessment of the Impact on the Environment of the Proposed Economic Activities [5] Competent Authority coordinates the process of EIA, analyses the reasoned evaluation of the public proposals, EIA Report, conclusions of the EIA Relevant parties on EIA Report and on the possibilities of the proposed economic activity and makes motivated decision about the admissibility of the proposed economic activity in the selected place.

EIA Relevant Parties for this proposed economical activity are as follows:

- State Nuclear Power Safety Inspectorate (VATESI);
- Ministry of Health Care;

- Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania;
- Utena Regional Environmental Protection Department of the Ministry of Environment;
- Heritage Protection Department under the Ministry of Culture;
- Utena county administration;
- Visaginas municipal administration.

According to the Clause 9 of the "Law on Assessment of the Impact on the Environment of the Proposed Economic Activities" [5], EIA Report is prepared by the Developer of the EIA documents according to the EIA Program [6] approved by the Competent Authority. The Organizer of the proposed economic activity according to the order, established by the Ministry of Environment, organizes the presentation of the Report to the public. The Developer of the EIA documents, according to the motivated proposals made by the interested public, presents the updated Report to the EIA Relevant Parties (since EIA Program of this proposed economic activity was prepared by Organizer of proposed economic activity, it is foreseen that EIA Report will be submitted to EIA Relevant Parties and Competent Authority by Organizer himself).

The Relevant Parties analyze the Report and present their motivated conclusions on the Report and on the possibilities of the proposed economic activity to the Developer of the EIA documents. The Relevant Parties have the right to present motivated requirements for update and correction of the Report by the Developer of the EIA documents.

The Developer of the EIA documents presents the Report, conclusion of the Relevant Parties on the Report and the possibilities of the proposed economic activity, and reasoned evaluation of the proposals of the interested public to the Competent Authority.

After analyzing the Report, the conclusions of the Relevant Parties on the possibilities for the proposed economic activity, the reasoned evaluation of the motivated proposals of the interested public and motivated proposals, presented in a written form by the interested public, presents motivated requirements to correct or update the Report or makes a motivated decision, whether the proposed economic activity, with the respect to requirements of relevant laws and regulations, the character of activity and (or) environmental impact, is allowed in the selected area.

Because INPP is located close to state borders of the Republic of Latvia and the Republic of Belarus, Transboundary Conventions [7] are taken into account in EIA Report.

1.6 Demand for Resources and Materials

The proposed economic activity is one of the decommissioning projects with the overall aim – final INPP decommissioning. Since it is quite difficult and not really reasonable to present demand of resources for separate Unit 1 and 2 decommissioning projects, the total demand for resources for the whole INPP is presented in this subchapter. When implementing the proposed economic activity existing infrastructure and equipment will be used, which will supply necessary amount of electrical and thermal power and water resources. Therefore, no new equipment, water suction boreholes or intake channels are required. Electrical power will be supplied from external power source. For daily purposes (e.g. for drinking, showers, toilets etc.) and for treated technological water artesian water will be used, which is provided by SE "Visagino energija". It is planned than required water amount from SE "Visagino energija" will be 750000 m^3/year in 2010. The water of Lake Druksiai will be used for the cooling of technological equipment and for boiler plants. It is estimated that cooling water needs in the period of the INPP decommissioning will be about 6000 m^3/h [8]. For indicative purpose it could be noted that the real measured water consumption during operation of the INPP both units was about $3x10^9$ m^3 per year or about 340000 m^3/h [9].

Ignalina NPP has made estimations and calculated the demands of power resources during the first 5 years after INPP shutdown. Detailed results of the calculations are presented in the report [10] and according to data presented in this report the summarized annual demands are provided in Table 1.1.

Table 1.1. Demand of power resources during the first 5 years after INPP shutdown

Energy and technological resources	Year					Source
	2010	2011	2012	2013	2014	
Electrical power, MWh/year	192333	148074	141431	132675	132326	External source of electrical power
Thermal power, MWh/year	246380	178935	170435	170435	170435	INPP heat boiler plant (design capacity 717000 MWh/year)
Natural gas, mln.Nm^3/year	37.93	32.43	24.3	23.9	23.5	Lietuvos energija, AB

As regards specifically the proposed economic activity, fuel demand will be insignificant. About 75 t of diesel oil per year (per unit) is used for diesel fired generators, which are used for safety reasons. Fuel necessary for steam and heat productions in the Steam Boiler and Heat Only Boiler plants of INPP is not considered in this EIA Report, since EIA for these boiler plants are performed separately. However, necessary volume of the natural gas provided in Table 1.1 also considers demands of these boiler plants.

Taking into account that decommissioning operations at the reactor Unit 2 will be analogical to the operations planned for Unit 1 and these operations will be performed applying analogous technologies, as performed or is planned to perform at Unit 1, estimated demand of raw materials, chemical substances or preparations during U2DP0 activities is presented in Table 1.1. The main activity related to decommissioning that need such substances is in line decontamination during defuelling. The substances used for demineralization are also presented in the table, based on current yearly consumptions; these consumptions will decrease with time, up to the complete defuelling when they will become insignificant.

Table 1.2. Information about raw materials, chemical substances or preparations used during defuelling activities

Name of the raw material, chemical substance or preparation	Annual amount (tons)	Classification and labelling of the chemical substance or preparation [6]	
		Classification	Labelling
For in line decontamination activities* (only for year 2012)			
Permanganic acid ($KMnO_4$)	2.0	O; R8 Xn; R22 N; R50-53	Symb.: O, Xn, N R: 8-22- 50/53 S: (2-)60-61
Oxalic acid ($H_2C_2O_4$)	42.9	Xn; R21/22	Symb.: Xn R: 21/22 S: (2-)24/25
Nitric acid (HNO_3)	1.2	O; R8 C; R35	Symb.:O, C R: 8-35 S: (1/2-)23-26-36-45

For systems remaining in operation			
Reagents used for the conditioning of the heating plant and the regeneration of the resins of the plant water makeup system: H_2SO_4 (100%) NaOH	365.0 14.0	C; R35 C; R35	Symb.: C R: 35 S: (1/2-)26- 30-45 Symb.: C R: 35 S: (1/2-)26- 37/39-45

*– Presented materials and amounts will be used for MCC decontamination if this will be justified during MCC in line decontamination at Unit 1.

Information about the storage of chemical substances or preparations at Ignalina NPP additionally necessary for U2DP0 project is summarized in Table 1.3.

Table 1.3. Storage of raw materials, chemical substances or preparations at Ignalina NPP

No.	Name of the raw material, chemical substance or preparation	Transportation method	Storage place	Storage method
1	Permanganic acid ($KMnO_4$)	By car	INPP storage facility for chemical materials, bld. 166	In polythene or glassy container
2	Oxalic acid ($H_2C_2O_4$)	By car	INPP storage facility for chemical materials, bld. 166	In polythene bags
3	Nitric acid (HNO_3)	By railroad	INPP storage facility for chemical materials, bld. 166	In special tank
4	Sulphuric acid (H_2SO_4, 100%)	By railroad	INPP storage facility for chemical materials, bld. 166	In special tank
5	Caustic soda (NaOH)	By railroad	INPP storage facility for chemical materials, bld. 166	In special tank

Hazardous materials necessary for the proposed economic activity will be stored in the existing INPP storage facility for chemical materials (building 166) in the existing or new containers in accordance to requirements specified in INPP instruction “Operational instruction of the unit for acceptance, storage and distribution of acids and alkalis, INPP code PTOэд-0912-129” and other procedures. It should be noted, that INPP B12 project “Decontamination equipment and expendable materials for Unit 1” currently is in signing phase, and it is planned that this project will be finished at the beginning of 2011. At this time exact amounts of hazardous materials necessary for decontamination and their storage methods will be known.

1.7 Site Status and Area Planning Documentation

The INPP is located on the north-east edge of Lithuania, close to the Latvian and Byelorussian borders, on the shore of Lake Druksiai (see Figure 1.5). The Plant is part of the so-called INPP region which covers the Ignalina and Zarasai districts (part of the Utena County) and is located on the territory of the Visaginas municipality. The nearest major cities are Vilnius at 130 km and Daugavpils in Latvia at 30 km.

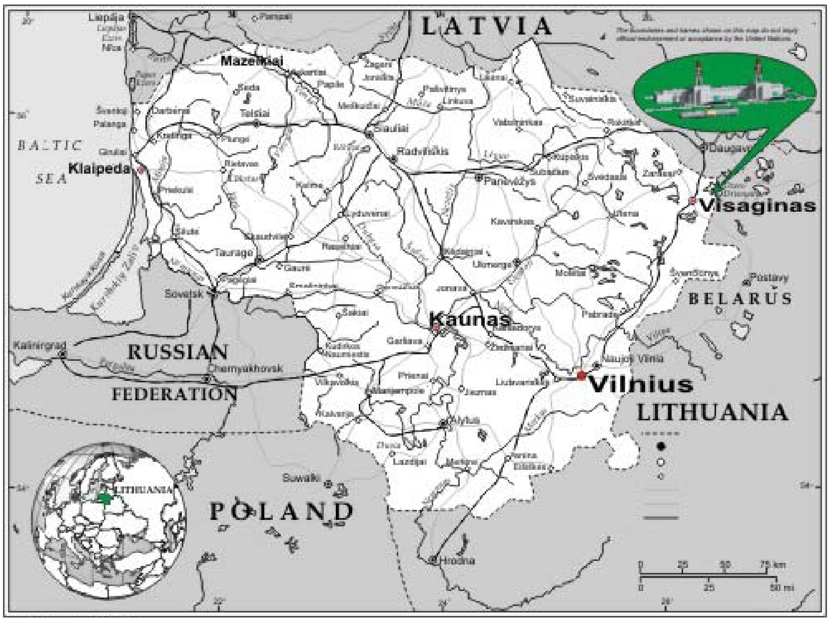

Figure 1.5. Location of Ignalina NPP in Lithuania

INPP Unit 2 is located within the site allocated for the State Enterprise Ignalina NPP (cadastre No. 4535/0002:5, total area of the site 899.0794 ha [12]). According to the State Land Exploitation Agreement No. PN 45/03-0071 [13] dated from July 2, 2003, the State Enterprise Ignalina NPP uses the site under term-less conditions. The land usage purpose is defined as “of other special purpose (production and distribution of electric energy, operation of nuclear power units, nuclear fuel storage, supervision and maintenance of energetic installations and other)”. The proposed economic activity will use the land in accordance with the defined land usage purpose.

On December 12, 2006 Director of Visaginas municipality administration by the order No. IV-652 “Concerning to approval of detailed plan” has approved the new revision of a detailed plan for the land parcel No. 4535/0002:5, which was prepared by UAB “Urbanistika” and coordinated by the State Enterprise Ignalina NPP. The main goal was to optimize land usage. The changes in the new revision of the detailed plan will not affect the status of the Ignalina NPP site.

The main buildings and installations at Ignalina NPP site are presented in Figure 1.6.

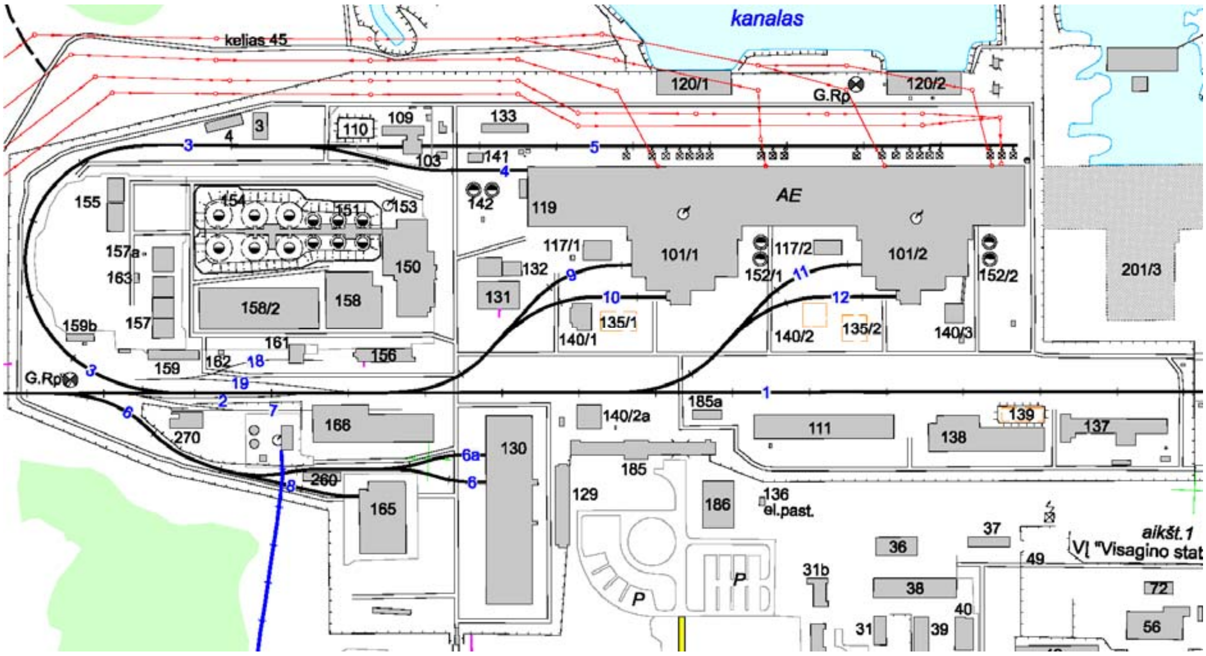

Figure 1.6. Ignalina NPP site

Main INPP buildings:
101/1 – plant Unit 1, 101/2 – plant Unit 2, 201/3 – structures of Unit 3, 117/1 and 2 – Pressurised tanks of the ECCS, 119 – Heat supply station, 120/1 and 2 – Service water pump station, 129 – Administrative building, 130 – Repair building, 135/1 and 2 – Gas holding chambers, 140/1 and 3 – Sanitary passageways, 140/2 – Industrial waste storage, 150 – Liquid waste treatment building, 151 – Waste water tanks, 152/1 and 2 – Low-salt water tanks, 154 – Operational water reservoirs, 155 – Solid low-level waste storage facility, 156 – Special laundry, 157 and 157a – Solid radwaste storage facilities, 158 – Bituminized radwaste storage facility, 159 – Vehicle washing facility, 159b – Free release facility for industrial waste, 165 – Fresh fuel storage, 185 – Administrative building.

The limits of the INPP sanitary protection zone (SPZ) (with the diameter of 3 km) and the nearby objects are presented in Figure 1.7. The limits of the SPZ of the Ignalina NPP were established in the seventies of the last century when designing the power plant and based on legal acts and norms, valid at the time. Later during the preparation of the Law on Nuclear Energy of the Republic of Lithuania [2] the point 33 of this law determined that a sanitary protection zone had to be established surrounding nuclear energy objects, the limits of which were marked in the design documents of the construction of the object. Also it should be mentioned that when defining land-tenure in the renewed detailed plan of the site of the Ignalina NPP (cadastre No. 4535/0002:5) it is indicated that that the SPZ of the Ignalina NPP composes a ring of a diameter of 3 km, which includes the whole site of the NPP with the council area of the city of Visaginas on the south side of the site and neighbouring territories beyond the site limit. When describing the management and use of the territory, it is indicated in the detailed plan that in the 3 km of the SPZ it is forbidden to perform activities and construction of equipment and buildings that are not related to the object maintenance. Land, forest, and water basins in the 3 km of the SPZ may be used for economic uses only after receiving the agreement of the organisation operating the object and permits from the Ministry of the Environment and Ministry of Health. Cattle may be feed, and agricultural cultures may be grown in the SPZ zone, provided radiation control is performed.

In 2010-2016 during the implementation of this specific proposed economic activity all planned works will be performed inside the buildings on the territory of the Ignalina NPP, deplanting works of buildings and equipment or construction works of other dangerous objects will not be performed. Therefore this proposed economic activity will not raise questions of revision or review of the existing size of the SPZ of the INPP. The SPZ will remain the same, as indicated in the detailed plan of the site No. 4535/0002:5.

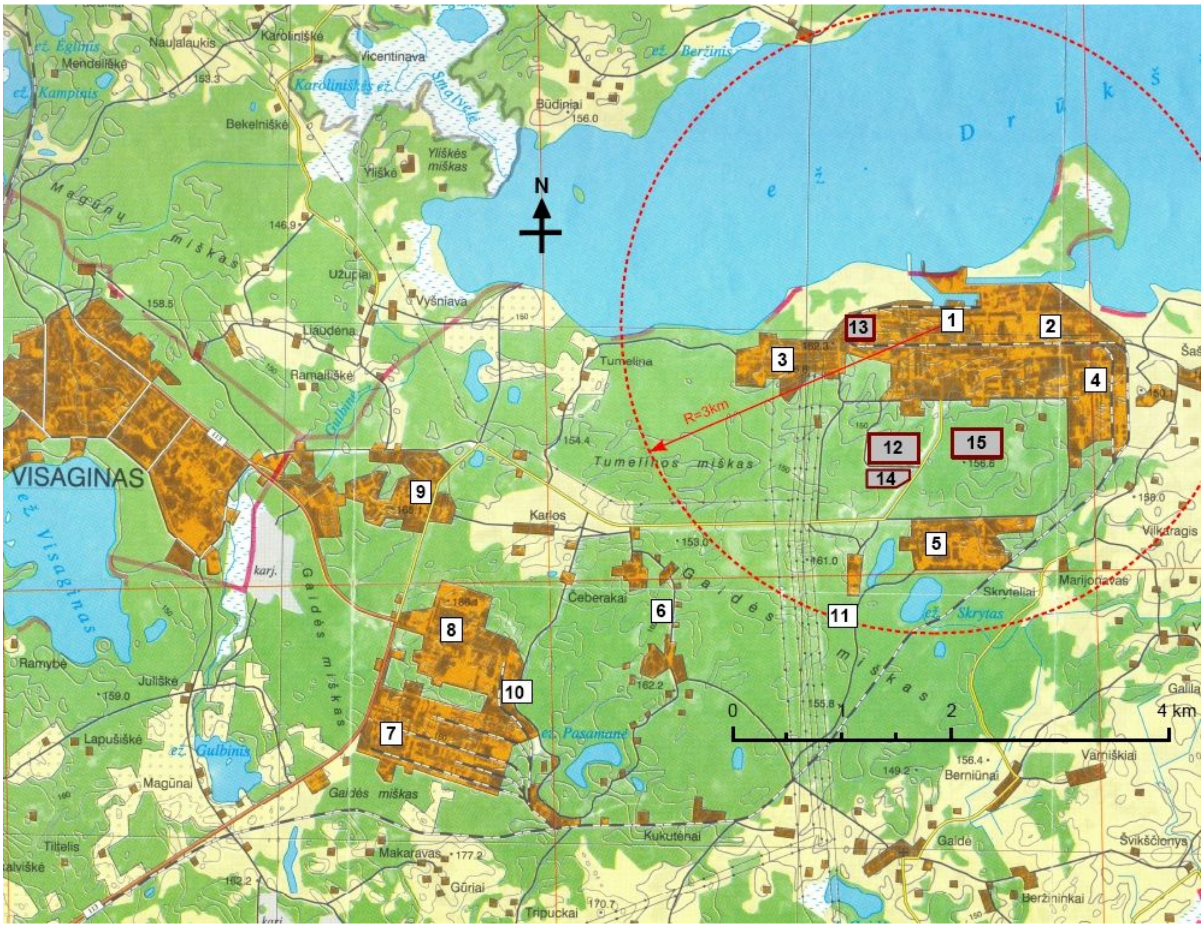

Figure 1.7. INPP sanitary protection zones and facilities located in the neighbourhood

1 – INPP Power Units, 2 – existing Spent Nuclear Fuel Storage Facility, 3 – open distributive system, 4 – supply base, 5 – sewage purification constructions, motor transport department, 6 – Visaginas waterworks (city artisan well site), 7 – construction base, 8 – industrial construction base, 9 – former military base, 10 – heat boiler station, 11 – Visaginas dump site, 12 – SWTSF and ISFSF site, 13 – SWRF site; 14 – very low level waste near surface repository site; 15 – near surface repository site for short-lived low and intermediate level waste.

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2 TECHNOLOGICAL PROCESSES

2.1 INPP Description

The Ignalina NPP contains two similar RBMK-1500 reactors. General Units arrangements are presented in Figure 2.1. Each unit consists of five construction buildings; namely, buildings designated as A, B, V, G and D. Reactor buildings A1 and A2 are adjacent to a common building D1 and D2 housing the control rooms, the electric instrumentation rooms and the de-aerator rooms. D buildings are adjacent to a common turbine hall G. The main buildings of the plant are situated about 400-500 m from the banks of Lake Druksiai.

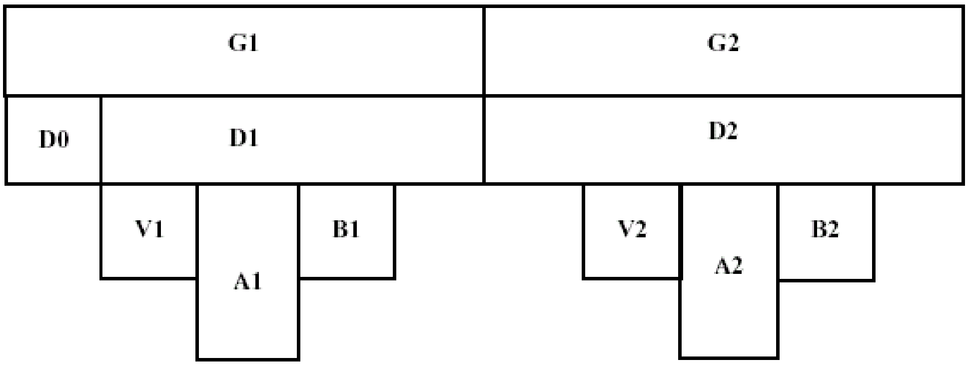

Figure 2.1. General Units arrangements:

A1, A2 – reactor buildings; B1, B2 – demineralised water treatment facilities of the MCC; V1, V2 – reactor gas circuit and special venting system;, G1, G2 – turbine generators with auxiliary systems, feed facilities and heat supply facilities; D1, D2 – control, electrical and de-aerator rooms; D0 – heat pipe service and fire fighting facilities

The Ignalina NPP belongs to the category of "boiling water" reactors, a simplified thermal diagram of which is provided on Figure 2.2. As it passes through the reactor core the cooling water is brought to boiling and is partially evaporated. The steam - water mixture is then routed to the large separator drums (3), the elevation of which is above the reactor. Here, the water settles down, while the steam proceeds to the turbines (4). The condensate is returned via the de-aerator (8), by the feed pump (9) to the water of the same separator drum (3). The coolant mixture is returned by the main circulation pumps (10) to the core, where part of it is again converted to steam.

This fundamental heat cycle is identical to the Boiling Water Reactor (BWR) cycle extensively used throughout the world, and is analogous to the cycle of thermal generating stations. However, compared to BWRs used in Western power plants, the Ignalina NPP and other plants with the RBMK-type reactors have a number of unique features.

The Ignalina NPP uses an RBMK – channel-type reactor. This means that each nuclear fuel assembly is located in a separately cooled fuel channel (pressure tube). There are a total of 1661 of such channels and the cooling water flow rate must be equally divided among associated feeder pipes. After crossing the core, these pipes are brought together to feed the steam-water mixture to the above - mentioned separator drums.

The RBMK reactors belong to the thermal neutron reactor category. Due to the large number of metal piping in the core of this type of reactor, the neutronic characteristics of the reactor are degraded. To improve the neutronic characteristics, the reactors of Ignalina NPP use graphite to moderate the fast fission neutrons. This requires a large amount of graphite, so that the graphite stack of the reactor becomes its dominant component, at least by volume.

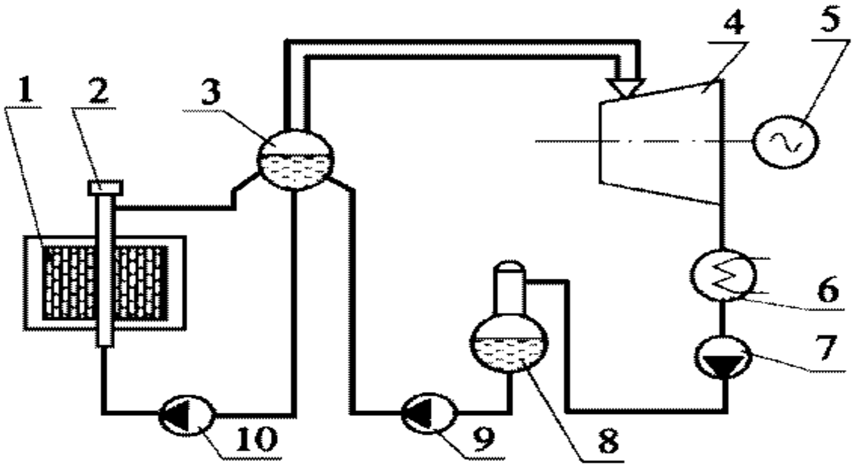

Figure 2.2. Heat cycle diagram:

1 – reactor, 2 – fuel assembly, 3 – separator drum, 4 – turbine, 5 – generator, 6 – condenser, 7 – condensate pump, 8 – deaerator, 9 – feedwater pump, 10 – main circulating pump

The nuclear fuel assemblies of the Ignalina NPP are changed without shutting down the reactor. This is possible only for channel type reactors. Since there are many channels, it is possible to disconnect one of them at a time from the reactor cooling system, change the fuel assembly, and then reconnect the channel.

Schematic top view of installations at Unit 2 is presented in Figure 2.3.

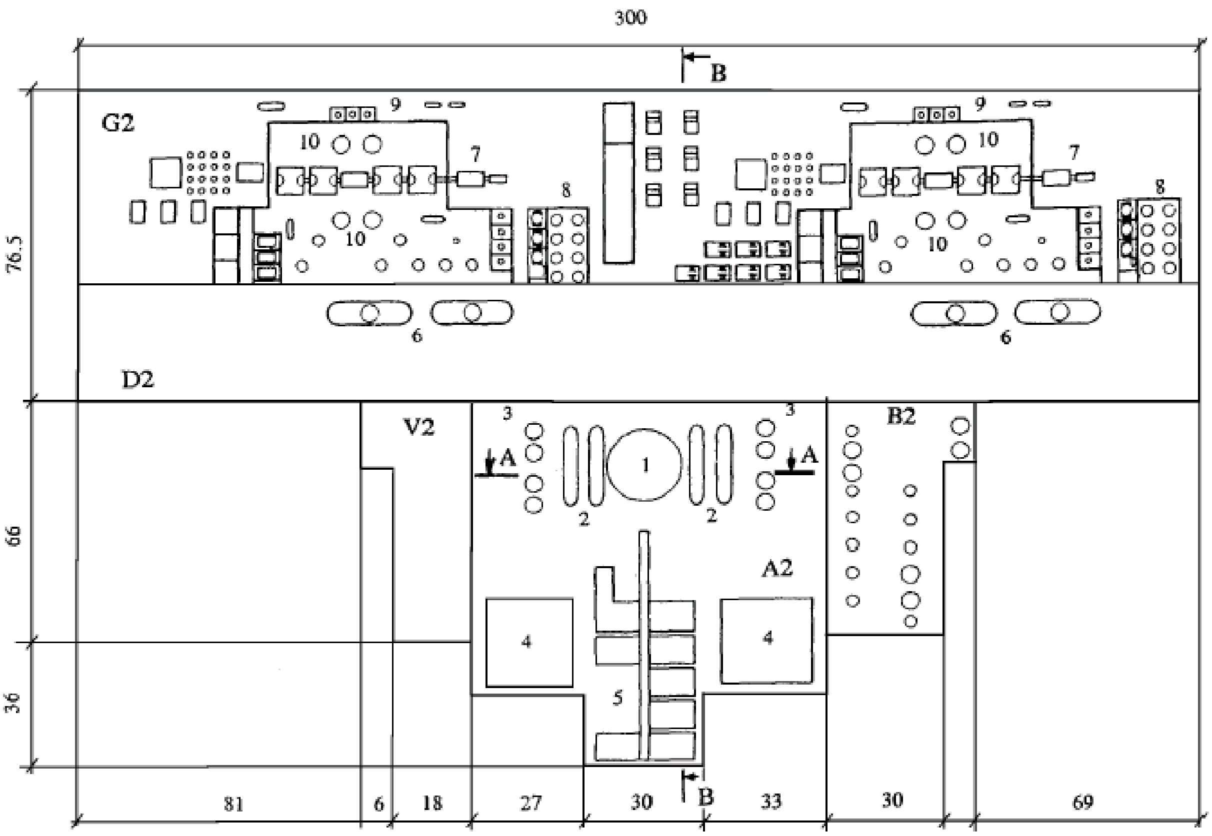

Figure 2.3. Schematic top view of installations at Unit 2

1 – Reactor; 2 – Pressure and suction headers; 3 – Main circulation pumps; 4 – Accident confinement system; 5 – Spent nuclear storage pools; 6 – Deaerators; 7 – Turbine generators; 8 – Condensate cleaning filters; 9 – First stage condensate pumps; 10 – Separator - reheater.

The most important INPP parameters which are relevant to proposed economic activity are provided in

Table 2.1. The most important INPP parameters

Parameter	Value
Thermal power, MW_{th}	4800 (design) ~2,5 (after reactor shutdown)
Electrical power, MW_e	1500 (design)
Nuclear fuel	uranium dioxide
Initial fuel enrichment for U-235, %	2.0; 2.4; 2.6; 2.8
Average fuel burnup (for 2.0%; 2.4%; 2.6%; 2.8% fuel respectively), MWdays/kg	22.2; 27.0; 27.0; 29.0
Maximum permissible fuel cladding temperature, ^{o}C	700 (during reactor operation) 300 (after reactor shutdown)
Coolant	water-steam mixture
Number of main circulation pumps, pcs.	8 (during reactor operation) 0 (after reactor shutdown) 3 (during MCC in line decontamination)

Parameter	Value
Coolant temperature at fuel channel inlet, °C	260–266 (at 4200 MW_{th} power) <100 (after reactor shutdown)
Pressure in MCC, atm.	67–87 (during reactor operation) 1 (after reactor shutdown)
Water temperature of SNF storage pools, °C	<50
Cooling water from Lake Druksiai consumption, m^3/h	340000 (during reactor operation) 6000 (after reactor shutdown)

2.2 Contamination with Radionuclides Caused by the Technological Processes

The contamination of the Main Cooling Circuit (MCC) as well as of the auxiliary circuits functionally linked to the MCC result from the following phenomena:

- the in-core activation of the erosion-corrosion products of the MCC pipe system, equipment (drums-separators, main coolant pumps, headers) and of the in-core channels;
- the presence of fission products (FP), including the U and TRU nuclides (nuclides of the Uranic and trans-Uranic groups (^{235}U, ^{238}U, Pu, Am and Cm isotopes)), as a result of the tramp ^{235}U fission and of release of those nuclides via the fuel cladding defects.

The MCC contamination levels of the activated corrosion products, of the FP, U and TRU nuclides determine:

- the contamination of the operational waste;
- the contamination of the decommissioning waste, i.e. the contamination of the to be dismantled equipment and, when relevant, of their spent decontamination solutions, of the contaminated process (i.e. spent filters, ion-exchange resins and perlite, evaporator concentrates) and operational (i.e. all the miscellaneous solid waste) waste generated during the different phases of the decommissioning.

Activated corrosion products

The short term contamination of the operational and decontamination waste will be governed by short lived γ emitters (such as: Mn^{54}, Co^{58}, Co^{60}, Fe^{59}, Zr^{95} and Nb^{95}), while the long term activity of this waste will be governed by weak β-γ emitters (such as: C^{14}, Ni^{59}, Ni^{63} and Nb^{94}). These latter nuclides belong to the so-called category of "difficult – to – measure" critical nuclides (DTM critical nuclides).

Fission products (FP), U and TRU nuclides

The contamination of the MCC and of the auxiliary circuits by FP, U and TRU nuclides result from the occurrence of the following phenomena:

- The fission of tramp U^{235}, taking place outside of the fuel elements, i.e. the fission of uranium particulates deposited on the external walls of the fuel cladding and of uranium particulates present in the MCC and circulated through the core. The presence of short lived I^{134} in the MCC is an indicator of tramp uranium fission;
- The release of FP from the fuel pellets by diffusion via the cladding defects.

The above mechanisms lead to quite different spectra of FP in the MCC and in the auxiliary circuits. The methodology developed to assess the inventories of the FP, U and TRU nuclides in the operational and decommissioning waste is given in Chapter 6 of the FDP [3].

2.3 Technological process description

INPP Unit 2 reactor's shutdown date is 31 December 2009. However, corresponding legal acts will not be passed and technical measures will not be implemented at this shutdown date, which are required for Reactor Final Shutdown (RFS) status. Therefore, reactor shutdown will obtain RFS status after a while.

The proposed economic activity (i.e. project U2DP0) covers the separate activities within the Unit 2 and at INPP site which will start after the Unit 2 reactor shutdown and will be finished when spent nuclear fuel is completely removed from the Unit.

The proposed economic activity may be divided into two main phases as follows:

- Defuelling stage 1, which starts after Unit 2 reactor shutdown, when the reactor is cooled down and ends up when the reactor is completely defuelled;
- Defuelling stage 2, which starts at the end of Stage 1 and ends up by the complete defuelling of Unit 2.

The main phases of the proposed economic activity are scheduled in Figure 1.1.

Taking into consideration the experience of planning and preparation for Unit 1 decommissioning, INPP employs similar phases and processes during transition from normal operation conditions to decommissioning conditions, related to defuelling process of spent nuclear fuel at Unit 2.

After shutdown of the reactor, many systems and components will stay in operation because the spent fuel and all other radioactive inventory will remain in place at that time. This is necessary for continuous safety assurance (for example, for prevention of the criticality, for fuel cooling, to prevent spread of radioactive contamination and etc.). In the course of the relocation of the Fuel Assemblies from the core to the pools and from the pools to the Interim Spent Fuel Storage Facility and, later on also, after removal of the radioactive (gaseous and liquid) materials from the components, the systems can be shut down step by step. Other systems, which are needed for further operational purposes or which, for dismantling purposes, should remain in operation will be modified if needed.

During this project the following activities, which can impact the personal and environment, will be carried out:

- Operation of the systems, left in operation after the shutdown of Unit 2 reactor, including periodical tests and maintenance;
- Removal of nuclear fuel from the reactor core to the storage pools;
- Systems isolation and modification activities;
- Decontamination of systems / equipment (including in-line decontamination and decontamination of the "housekeeping" type);
- Management of operational waste.

During the implementation of project B1, the whole spent nuclear fuel stored in Unit 2 storage pools will be unloaded and transferred to ISFSF.

2.3.1 Defuelling Stage 1

The 1st defuelling stage includes:

- Operation, isolation and modification of the corresponding systems;

- Removal of nuclear fuel from the reactor core to the storage pools;
- Management of operational waste.

2.3.1.1 System Operation, Isolation/Modification

During the development of the project, the analysis of systems identifies safety functions which are no more requested for core defuelling, and therefore which safety systems could be definitively isolated, knowing that fuel will never be reloaded in the core. Systems, required for the decommissioning purpose will be left in operation and modified, if needed. Operation of the systems, left in operation will be the same as it was during normal operation of the INPP.

Isolation/modification activities of the systems within this project generally include:

- Isolation of systems by closing boundary fittings and implementing appropriate measures that do not allow to open them;
- Drainage of the isolated parts of the systems and handling of the drained liquid in compliance with the methods of waste treatment (vaporization, bituminization, etc.);
- Disconnection of system users from power supply, earthing and bridging of appropriate electrical circuits;
- Disconnection of function-related equipment used for selecting and transmitting signals, sensors, registering devices and other technical means, employed for measuring and indication of the parameters.

2.3.1.2 The Reactor Core Defuelling

The reactor core defueling encompasses transfer of the fuel assemblies from the reactor core to the SNF storage pools. Spent nuclear fuel will be transferred according to the existing SNF transfer and transportation procedures as it was performed during normal operation of the INPP.

2.3.2 Defuelling Stage 2

The 2nd defuelling stage includes:

- In-line decontamination of the Main Circulation Circuit (MCC) and decontamination of the Refuelling Machine (RM);
- Operation, isolation and/or modification of the corresponding systems;
- Management of operational waste.

During the implementation of project B1, the whole spent nuclear fuel stored in Unit 2 storage pools will be unloaded and transferred to ISFSF.

The mentioned activities are presented in more details in the subsections below with exception of decommissioning waste management, which is described in Chapter 3.

2.3.2.1 Decontamination

Decontamination can decrease the dose rates and this eases the personnel access to working areas, minimizes radioactive waste amounts and reclassify them as lower level radioactive waste which disposal costs are lower. Decontamination activities in the frame of the project U2DP0 will be performed in order to reduce dose rates during activities on:

- Modification of systems, which will still be operated after reactor final shutdown, during defuelling phase of Unit 2;
- Maintenance and repair of systems, which will still be operated after reactor final shutdown;
- Isolation/modification of systems, which are being decommissioned.

In the frame of project U2DP0 two type decontamination activities will be performed:

- Decontamination of rooms and equipment surfaces using ordinary decontamination means (cleaning, washing and etc.);
- In-line decontamination of MCC and related circuits and decontamination of refuelling machine by washing.

All major turbine systems like Main Condensate and Feed Water System, Live Steam Line System, Steam Withdrawal and House Supply Steam can be dismantled after RFS and after reactor defuelling, the MCC, PCS, CPS cooling circuit and refuelling machine can be object of in-line decontamination.

System analysis, performed in the frame of the project U1DP0 [4], has shown that it is not reasonable to decontaminate all systems, because desirable decrease of radioactivity level is not achieved and analysis of cost-benefit shows that in-line decontamination for some systems/equipment is not substantiated economically. Therefore the only systems to be in-line decontaminated are Main Circulation Circuit, Purification and Cooling System of the MCC and refuelling machine. Internal decontamination can start after final defuelling of the Unit 2 reactor core. However, according to the cost-benefit analysis made in the Unit 2 Decommissioning Project Studies, the in-line decontamination operations of the turbine systems and the CPS are not economically justified [5].

The chemical environment and the materials of INPP main circuits are comparable to those of a BWR. The oxide layers built up at the surface of the equipment inner surfaces, and containing the deposited radionuclides, exhibit similar properties in both the BWR and RBMK plants. Therefore, the CORD (Siemens) process has been selected, as this latter has been proven to be extremely efficient (DF >> 20) during decontaminations carried out in several European, US and Japanese BWRs for both routine operations and decommissioning purposes. This process involves a chemical oxidation by $KMnO_4$ (0.5 g/l) in an acidic environment (pH~1.0) followed by a dissolution step with oxalic acid (10 g/l). The decontamination is carried out at ~ 90 ºC. Then, the spent decontamination solution is processed by the existing evaporators. The evaporator concentrates are bituminised by the existing installations.

After completion of the in-line decontamination of the MCC at Unit 1 (project B12), this conception can be reconsider, taking into account the gained experience. The decontamination of the Unit 2 left and right loops of the MCC will be accomplished in a separate project (B24).

The in-line decontamination of the refuelling machine (RM) includes decontamination of the refuelling machine itself and decontamination of two tanks (2PM14B03 and B04), which are used to collect the spent decontamination solutions in case of decontamination of the RM machine after handling of leaking (non-hermetic) fuel assemblies. The decontamination of the RM will be carried out in accordance with the routine practice at INPP and implementing additional means in order to improve the efficiency of this operation. The spent decontamination solution will be sent to the liquid waste storage tanks by-passing drainage tanks 2PM14B03 and B04. The objective is to avoid the transfer of contamination from the highly radioactive deposits onto the bottom end of those tanks to the weakly contaminated RM machine spent decontamination solution. The tanks will be cleaned by use of a high pressure water jet. The re-suspended cruds can be drained down via the existing line. If the cruds are tightly adherent or if they form a crust, concrete can be poured onto the crusts to fix these latter. The tanks will then be removed by the reactor hall bridge and transported to a dismantling area for cutting. The final decision on the tanks decontamination process will be made after defuelling of the Unit 2 and tanks contamination analysis.

2.3.2.2 System Operation, Isolation/Modification

The systems analysis performed during development of the project will identify which safety functions are no more requested for Unit 2 storage pools defuelling, and therefore which safety systems could be definitively isolated, knowing that fuel will never be reloaded in the storage pools. Modification/isolation activities of the systems during the second defuelling stage basically include the same main activities, as during the first stage (see Chapter 2.3.2.1).

2.3.2.3 Spent Nuclear Fuel Transfer from the Storage Pools

Operations related to the spent nuclear fuel loading onto cask and cask transportation outside the INPP Unit 2 are considered in the frame of the Project B1 investment project (Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2). By the project B1 about 36000 spent RBMK-1500 nuclear fuel bundles from the Units 1 and 2 will be loaded into storage casks of CONSTOR® RBMK1500/M2 type (from about 18000 of nuclear fuel assemblies). Then the casks will be transferred into newly constructed ISFSF for long-term interim storage.

Spent nuclear fuel bundles together with other constructional elements form spent fuel assembly. For loading into the casks, the spent nuclear fuel bundles have to be separated from other constructional elements of spent fuel assembly, which do not contain nuclear fuel. The bulk of spent fuel assemblies are leak tight and without mechanical defects. They will be processed in the existing INPP Hot Cell. The Hot Cell is licensed for such activity and is in successful operation for years.

However a small proportion of the SFA has suffered (or is expected to suffer) damage. in the In frame of the Project B1 special equipment will be designed and installed in the Storage Pools Hall for processing of mechanically damaged SFA. The fuel debris collection equipment is also provided for removing of resident fuel pellets from the storage pools and for collecting and removing of fuel pellets accidentally lost during damaged fuel handling.

A certain number of SFA can have cladding leakage. Handling of SFA with cladding leakage and the following storage at ISFSF is also included in the scope of the project B1. These, mechanically not damaged SFA will be processed by existing INPP Hot Cell.

All fuel bundle transfers will be performed in the pool under the cover of water in a safe and controlled manner in full compliance with Lithuanian legislation and regulations.

The transfer of casks from INPP Reactor Units to ISFSF main storage building will take place by rail transport. A new railway line constructed and connected to the existing railway system at INPP.

A detailed description of the spent nuclear fuel unloading from the storage pools procedure can be found in the project B1 environmental impact assessment report [6], which was approved in 2008.

2.4 Projects Related to INPP Decommissioning

During implementation period of the proposed economic activity the separate projects will be executed in parallel and impacts from these projects are taken into account, i.e. their impacts in the period of implementation of the proposed economic activity (2010-2016) are considered. Name of projects and their implementation periods are provided in Table 2.1. All projects provided in the table are grouped into two groups:

- decommissioning projects;
- radioactive waste management projects.

The proposed economic activity (U2DP0) and analogous activity (U1DP0), which is already initiated in the Unit 1, separate decontamination and dismantling projects are the integrated parts of the INPP decommissioning. Existing INPP radioactive waste treatment and management facilities and also the new investment projects that are necessary for INPP decommissioning are included in radioactive waste management projects. For each project, listed in the table, associated environmental impact reports are/will be prepared.

Table 2.2. Activities planned during implementation of the proposed economic activity and their implementation period [7]

Project	Start date	End date
Decommissioning projects		
Decommissioning Project for Ignalina NPP Unit 2 Final Shut Down and Defuelling Phase (U2DP0) – this proposed economic activity	31.12.2009	2016
Decommissioning Project for Ignalina NPP Unit 1 Final Shut Down and Defuelling Phase (U1DP0)	2009	2015
Dismantling and decontamination of equipment in building 117/1 (B9-0)	2009	2010
Dismantling and decontamination of equipment in turbine hall at Unit 1 (B9-1 (1))	2010	2015
Dismantling and decontamination of equipment in building V1 (B9-2)	2010	2011
Dismantling and decontamination of heating unit (B9-5)	2010	2012
Dismantling and decontamination of equipment in building 117/2 (B9-0 (2))	2011	2012
Dismantling and decontamination of equipment in building V2 (B9-2 (2))	2012	2014
Dismantling and decontamination of equipment in turbine hall at Unit 2 (B9-1 (2))	2012	2017
Dismantling and decontamination of equipment in building B1 (B9-6 (1))	2016	2023
Dismantling and decontamination of equipment in building A1 (excluding reactor) (B9-3 (1))	2016	2022
Radioactive waste management projects *		
Existing liquid waste treatment facility	in operation	2030
Bituminised waste storage facility (repository**)	in operation	2063
Cement solidification facility	in operation	2029
Free release measurement facility (B10)	2009	-
Very low level waste storage (a part of project B19)	2010	2040
Solid radioactive waste retrieval facility (a part of project B2)	2011	2021
Interim Spent Fuel Storage Facility (B1)	2011	2068
Solid radioactive waste treatment facility (B3)	2011	2030
Solid radioactive waste storage facility (B4)	2011	2061
Very low level waste separation unit (a part of project B2)	2011	2032
Very low level waste repository (a part of project B19)	2013	2043
Near surface repository for short-lived low and intermediate level waste (B25)	2016	-

* INPP decommissioning should be finished in 2030, but repositories and storage facilities further will be under surveillance/in operation.

** Study of possibilities to transform the interim storage of bituminised radioactive waste storage facility into a final repository is under preparation for the moment.

REFERENCES

1. The Republic of Lithuania Parliament Decision No. IX-1130 dated October 10, 2002, On Approval of National Energy Strategy. State News 2002 No. 99-4397.
2. The Republic of Lithuania Government Resolution No. 1848 dated November 26, 2002, On State Enterprise Ignalina NPP First Unit Decommissioning Concept. State News 2002, No. 114-5095.
3. Final Decommissioning Plan for Ignalina NPP Units 1 and 2. A1.1/ED/B4/0004, Issue 06. INPP Decommissioning Project Management Unit, 2004.
4. Ignalina NPP Unit 1 Final Shut Down and Defuelling Phase. Decommissioning Project U1DP0. A1.4/ED/B4/0004, INPP DS. Issue 06, 2006.
5. Decommissioning Project for Ignalina NPP Unit 2 Final Shut Down and Defuelling Phase (U2DP0). INPP DS, 2009.
6. Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2. Environmental Impact Assessment Report, Revision 4, Issue date October 24, 2007. Consortium GNS – NUKEM, Lithuanian Energy Institute, 2007.
7. U2DP0. Projects implementation period. INPP letter of 2009-03-27. Information Provision Following the Agreement 10SP-997(13.52)/14-1037.8.9.

3 WASTE

3.1 Non-radioactive Waste

3.1.1 Requirements of the Legal Acts of the Republic of Lithuania

The Law on Waste Management of the Republic of Lithuania [1] defines the general requirements for waste prevention, accounting, collection, storage, transportation, use, and disposal, as well as the main principles of organising and planning waste management systems in order to avoid the negative impact on human health and environment. This law does not regulate pollutant discharge into the air, the water, and radioactive waste management.

The Rules on Issuing, Renewal and Cancelling of Permits for Integrated Pollution Prevention and Control [2] define the order of issuing, renewal, correction, and cancellation of permits to operate economical activity objects or to perform economical activity, indicated in the Law on Environmental Protection of the Republic of Lithuania [3], and the implementation of waste preventive measures, defined in the Law on Waste Management of the Republic of Lithuania [1]. These rules consolidate the system of integrated pollution prevention and control that joins the means of water, air, ground (as well as Earth entrails) protection, waste management, noise reduction. According to paragraph 11.5 of these rules, waste generation shall be eluded. As waste is generated, it shall be managed by processing, and if this is impossible technically and economically, waste is managed, seeking to elude negative environmental impact or to decrease it.

Waste Management Rules [4] define the order of waste collection, storage, transportation, use, disposal, accounting, identification, declaration, sorting, and marking. It is forbidden to use and remove waste in ways, not defined in the rules. According to paragraph 5.2 of these rules, any materials or things, that waste owners dispose of, want to dispose of, or must dispose of, and that belong to waste categories, identified in Annex 1 of these rules, and belong to the Waste List in Annex 2 of these rules, are considered waste. Based on paragraph 47 of these rules, enterprises that have integrated pollution prevention and control permits must collect waste, identified in the permit, separately and give it over to waste use and (or) disposal enterprises, indicated in the permit. Based on paragraph 52 of these rules, manufacturers of hazardous waste must identify owned hazardous waste, determine its composition and declare its generation in an application to receive the Integrated Pollution Prevention and Control Permit.

3.1.2 Management of Non-radioactive Waste in the INPP

INPP non-radioactive waste is managed according to the Integrated Pollution Prevention and Control Permit, issued by the Utena Regional Environment Protection Department [5], the Technical Regulation of INPP Waste Management [6], the IAE Non-radioactive Waste Management Manual [7], and the INPP Environmental Protection Management Procedure [8]. The following activities of non-radioactive waste management are permitted at the Ignalina NPP:

- Waste sorting in places of its generation, its storage inside the territory of the nuclear power plant, later giving it over to waste use and (or) disposal enterprises;
- Interim storage of hazardous waste for not more than 3 months after its generation;
- Interim storage of non-hazardous waste for not more than 1 year after its generation;
- Disposal of non-hazardous waste to the landfill (refuse dump or so called “polygon”) of industrial type waste.

The diagram of non-radioactive waste management in the INPP territory is presented in Figure 3.1.

INPP wastewater and surface water are managed based on the Integrated Pollution Prevention and Control Permit [5]. Wastewater is managed based on the requirements of the Regulation on Wastewater Management [9], and surface water is managed according to the requirements of the Regulation on Surface Water Management [10].

The Laboratory of Environmental Protection of the INPP Employee Safety and Health Service receives quarterly reports from subdivisions on initial waste accounting, and, based on them, it prepares and presents the following reports for the reporting year before January 25 (on the Internet) to the Utena Regional Environment Protection Department:

- Initial INPP waste accounting report according to the requirements of the legal act [11];
- Accounting report for waste, disposed of into the INPP industrial waste landfill (refuse dump), based on the requirements of the legal act [11];

Data presented in waste accounting reports are collected and stored in a database of the information system for waste accounting.

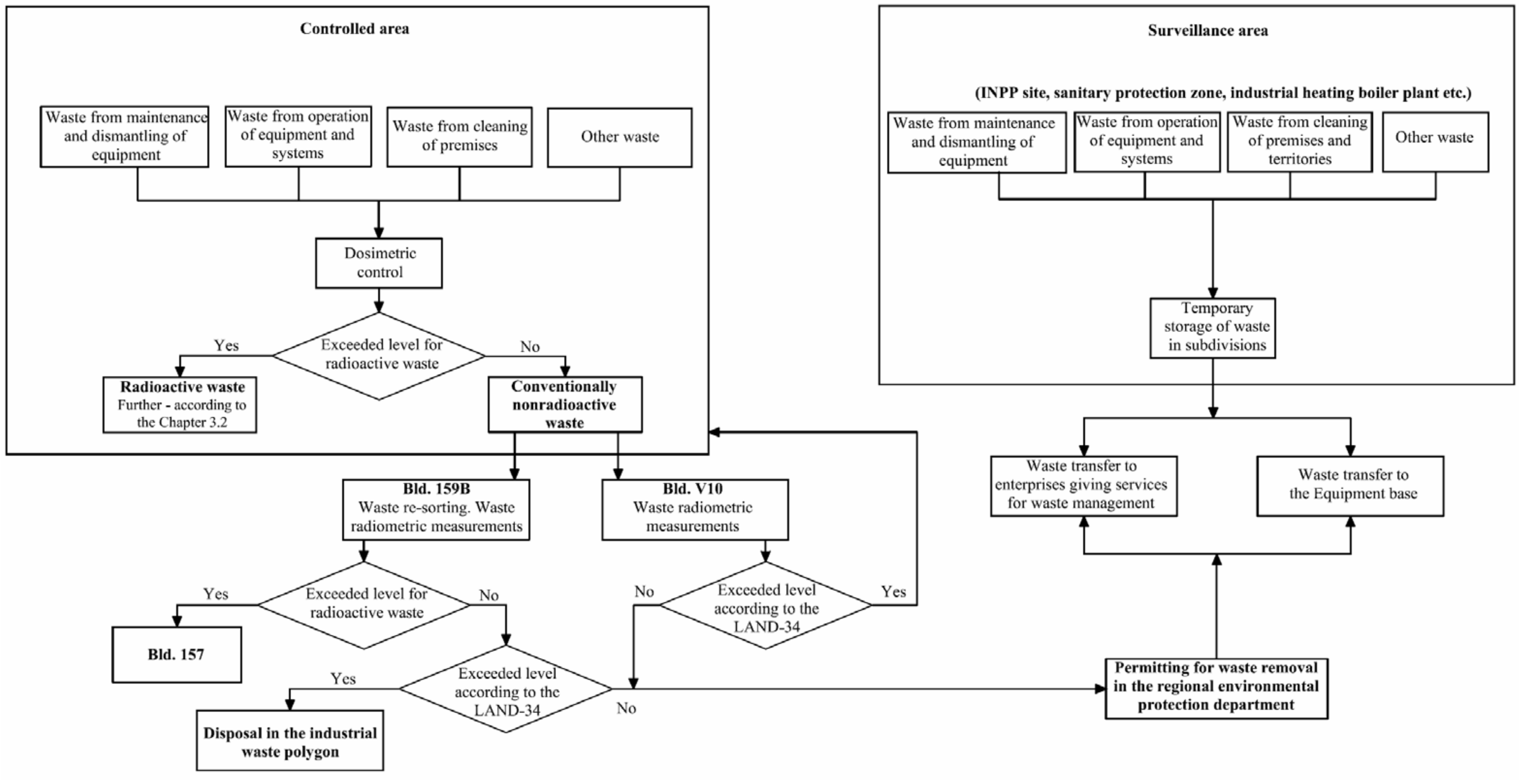

Figure 3.1. Diagram of non-radioactive waste management in the territory of the INPP [7]

3.1.3 Unit 2 Decommissioning Waste

It is planned that during stages 1 and 2 of the defuelling phase of unit 2 decommissioning during system modification and isolation similar hazardous non-radioactive waste will form as during normal operation of a nuclear power plant. During engineering inventory of dismantling and decontamination projects data is collected about hazardous materials and their quantities in the dismantling zone.

During the defuelling phase of unit 2 decommissioning the operating organisation will apply all possible and economically justifiable means to decrease waste amounts and hazardous impact on human health and the environment. Preventive measures will be used to decrease waste generation; amount and hazardousness of waste that reaches landfills will be decreased. In places where this is technically and economically purposeful, low waste technologies that do not generate secondary or hazardous waste will be implemented.

3.2 Radioactive Waste

3.2.1 Classification of Radioactive Waste

Solid and radioactive waste will be generated during the implementation of technological processes of the Unit 2 decommissioning defueling phase which are described in Chapter 2.

Currently the INPP generated and/or accepted for storage solid radioactive waste is classified according to radiological properties into three groups: G1 (low active waste), G2 (intermediate active waste) and G3 (high active waste), see Table 3.1.

Table 3.1. "Old" (existing) INPP radiological classification for solid radioactive waste, used for waste segregation and storage at INPP. Whichever parameter is applicable, [12]

Waste group	**Equivalent dose rate at the distance of 10 cm from surface, mSv/h**	**Surface contamination, Bq/cm^2**	
		Beta activity	**Beta activity**
G1 (low active waste)	0.0006–0,3	8–333	0.017–33
G2 (intermediate active waste)	>0.3–10	>333–330000	>33–33000
G3 (high active waste)	>10	>330000	>33000

Solid radioactive waste (SRW) generated during unit 2 defuelling phase shall be classified according to the waste classification system, presented in Table 3.2 [13].

Table 3.2. Solid radioactive waste classification system [13]

Waste class	**Definition (abbreviation)**	**Surface dose rate, mSv/h**	**Conditioning option**	**Disposal method**
0	Exempt waste (EW)	–	Not required	Management and disposal as per requirements set in [1]
Short-lived low and intermediate level waste*				
A	Very low level waste (VLLW)	≤0.5	Not required	Very low level waste repository (*Landfill* repository)
B	Low level waste (LLW-SL)	0.5–2	Required	Near surface repository
C	Intermediate level	>2	Required	Near surface repository

Waste class	Definition (abbreviation)	Surface dose rate, mSv/h	Conditioning option	Disposal method
	waste (ILW-SL)			
Long-lived low and intermediate level 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
Spent sealed sources				
F	Spent sealed sources (SSS)	–	Required	Near surface or deep geological repository***

* Containing beta and/or gamma emitting radionuclides with half-lives less than 30 years, including Cs-137, and/or long-lived alpha emitting radionuclides with measured and/or calculated, by using approved methods, activity concentration less than 4000 Bq/g in individual waste packages on condition that an overall average activity concentration of long-lived alpha emitting radionuclides is less than 400 Bq/g per waste package.

** Containing beta and/or gamma emitting radionuclides with half-lives more than 30 years, not including Cs-137, and/or long-lived alpha emitting radionuclides with measured and/or calculated, by using approved methods, activity concentration more than 4000 Bq/g in individual waste packages on condition that an overall average activity concentration of long-lived alpha emitting radionuclides exceeds 400 Bq/g per waste package.

*** Depending on acceptance criteria applied to spent sealed sources.

Comparison between old and new solid radioactive waste classification systems if only surface dose rate is considered is presented in Figure 3.2. To comply with the new classification also the nuclide composition must be considered (see remarks below Table 3.2).

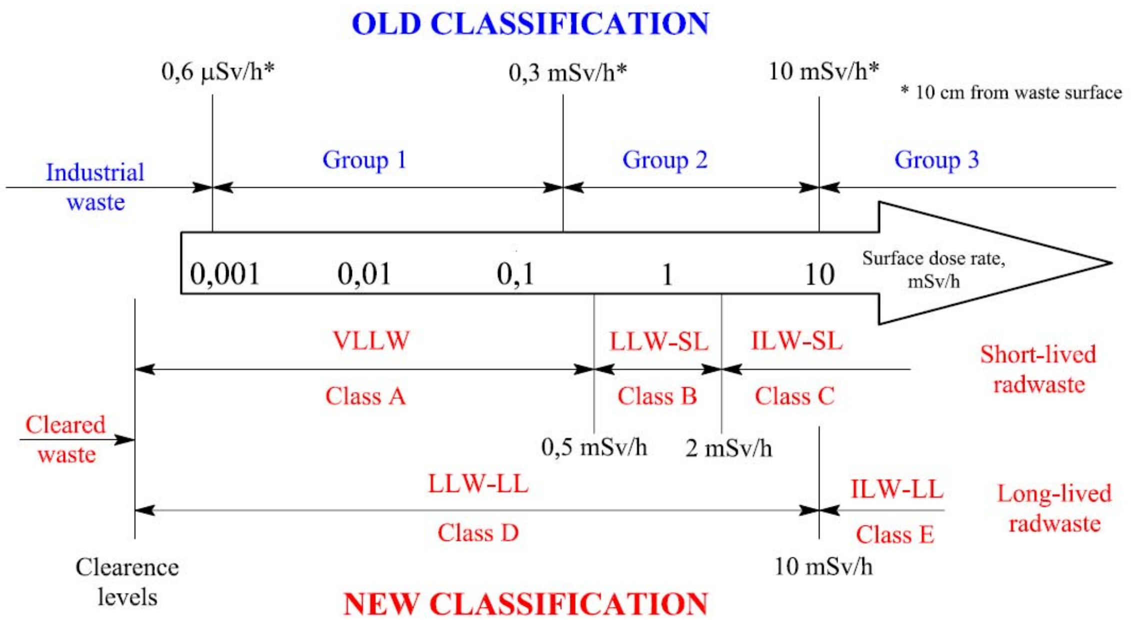

Figure 3.2. Comparison between old and new solid radioactive waste classification systems if only surface dose rate is considered

Taking into consideration methods of radioactive waste treatment implemented at the INPP, solid radioactive waste will be additionally classified into combustible, non-combustible, compactable, non-compactable and non-treatable waste.

Liquid radioactive waste are classified into low level (≤$4 \cdot 10^5$ Bq/l) and intermediate level (>$4 \cdot 10^5$ Bq/l) waste [13].

3.2.2 Radioactive Waste Management

Various activities performed during the unit 2 defuelling phase will determine the generation of liquid and solid radioactive waste.

Liquid radioactive waste is collected into appropriate containers and is later processed at the liquid waste treatment facility (LWTF). Radioactive liquids in this facility are evaporated and this allows to separate the major part of clean liquid from the radioactive sludge. Non-radioactive liquids further can be treated as non-radioactive liquid waste or reused as technological water for INPP needs. It is permitted to dispose of evaporated wastewater by directly diluting them in the environment (to discharge them into the environment) only based on the normative document LAND 42-2007 [16]; contamination by radionuclides shall not exceed limit activities, indicated in the radionuclide discharge permit. Radioactive waste management methods and installations are described in Section 3.2.3.1.

After treatment liquid radioactive waste (the left concentrates) are solidified, inserting them into a binding material – bitumen. Bituminized waste is stored in the existing storage facility for which the long-term safety feasibility study for transformation of this storage facility into repository currently is in preparation. Description of bituminized waste storage facility is provided in Section 3.2.4.1.

The mixture of conditioned ion exchange resins, perlite and sediments (pulp) is collected into appropriate containers and later solidified in a cementation facility. Packages of conditioned grouted waste are stored in the existing INPP cemented waste storage facility. Cementation equipment and facility are described in Sections 3.2.3.5 and 3.2.4.5.

Solid waste, generated during the unit 2 defuelling phase, will be treated from 2011 in the new solid waste treatment and storage facility (SWTSF). Also radioactive waste, generated during INPP operation, removed from existing storages (buildings 155, 155/1, 157 and 157/1, see Figure 1.6), will be treated in the solid waste management and storage facility (SWMSF). Solid radioactive waste management methods, facilities and planned repositories are described in Sections 3.2.3.2, 3.2.3.3, 3.2.3.4 and 3.2.4.4.

Solid radioactive waste generated during unit 2 defuelling phase will be treated, stored and disposed of in one of the following ways:

- Waste, which will be recognized as corresponding to unconditional free release levels after detailed measurements in the free release measurement facility, will be managed and disposed of as non radioactive waste;
- The bigger part of very low level radioactive waste will be packaged into packages suitable for disposal and will be disposed of in the new very low level waste disposal facility of the INPP;
- Currently low and intermediate level waste is put for interim storage in the INPP existing solid radioactive waste storage facility. After the commissioning of the INPP new solid radioactive waste treatment (SWTF) and storage (SWSF) facility, all short-lived waste, accumulated and newly generated in the INPP, will be managed in this facility. Here waste will be conditioned and packed into packages, suitable for disposal. Packages will be further stored in the storages of the facility (SWSF) until it will be possible to dispose of them in the new INPP short-lived waste disposal facility;
- After the commissioning of the new INPP solid radioactive waste treatment and storage facility, all long-lived waste, accumulated and generated in the INPP, will be

brought to this facility and re-packed into interim storage containers. Containers will be further stored in the facility storages waiting for a further decision regarding the best final way of treatment for this waste;

- Long-lived graphite (class D) waste and class E waste (material, activated in an active zone) will be temporarily stored without conditioning in the long-lived waste storage (SWSF), the operation of which is planned in 2011, waiting for further decision regarding the best conditioning methods [15].

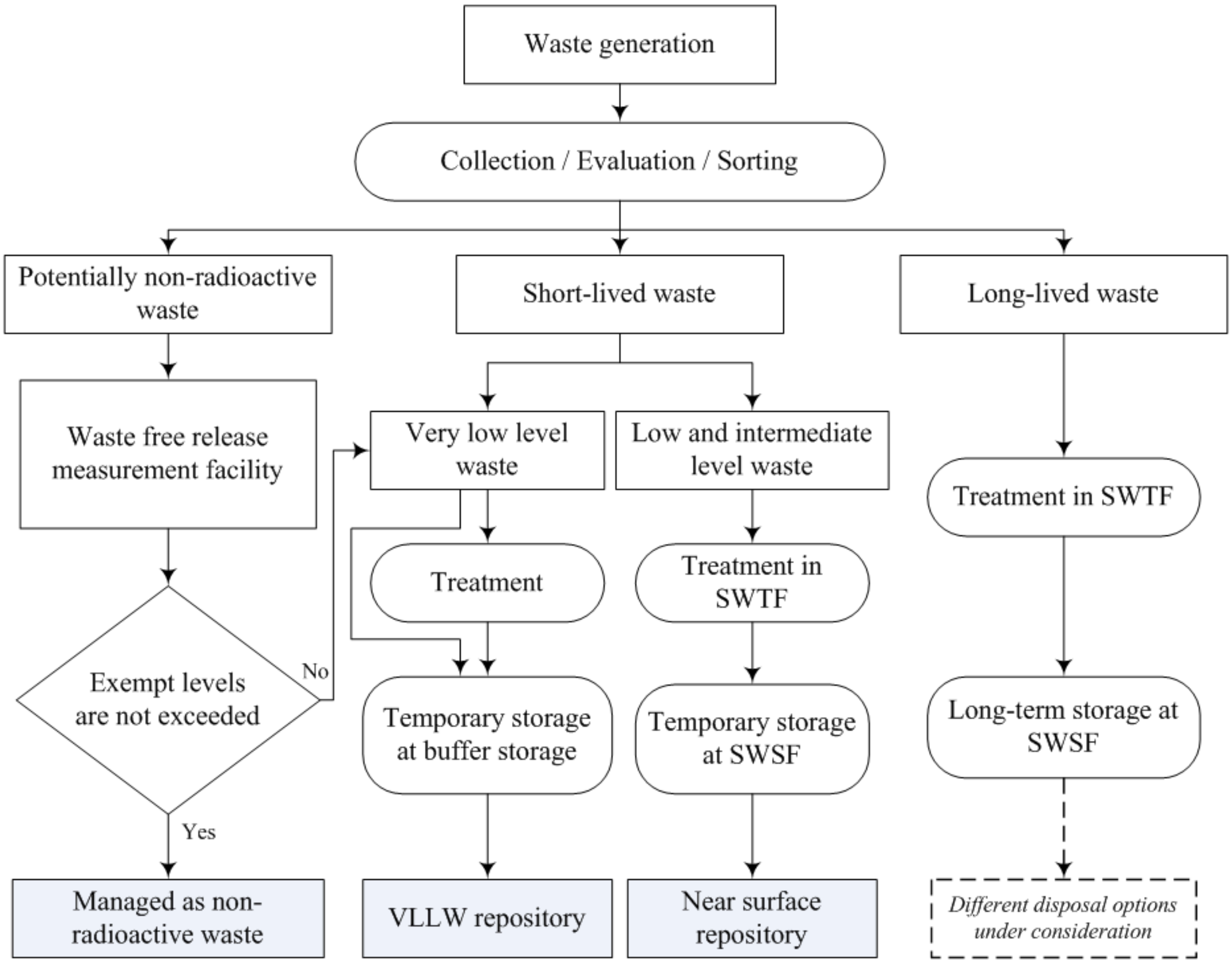

Figure 3.3. Management scheme of the solid radioactive waste generated during implementation of the proposed economic activity

3.2.3 Radioactive Waste Generated During the Defuelling Stage Because of Unit 2 Decommissioning Activities and Management of this Waste

During the preparation of the Design of the INPP Decommissioning for the stages of Unit 1 reactor final shutdown and SNF defuelling [17], a detailed assessment of generated radioactive waste was performed. Since analogous decommissioning operations will be performed in Unit 2 using analogous techniques (see Chapter 2.3), as performed or planned in Unit 1, and the design for Unit 2 reactor final shutdown and SNF defuelling stage is in preparation, generation of different flows of radioactive waste because of Unit 2 decommissioning activities during the defuelling phase, their radiological characterisation and conformance to waste acceptance criteria were calculated based on data presented in Annex 3 of document [17]. With regard to the timetable of works planned for Unit 2 reactor final shutdown and SNF defuelling phase it was accepted in the assessment that system modification and (or) isolation started right after the final shutdown of Unit 2 reactor, i.e. from the beginning of 2010.

During the implementation of Unit 2 defueling phase activities, amount of the radioactive waste for defueling Stage 1 (in 2010–2011, i.e. during reactor defuelling) will be significantly higher than during defueling Stage 2 (the period of 2012–2016, when the reactor will be defuelled and fuel will be stored in fuel storage pools).

3.2.3.1 Generation of Liquid Waste and their Treatment in LWTF

All discharge, generated because of decontamination by washing, i.e. primary liquid waste, generated after collecting decontamination and washing solutions, and secondary liquid waste, generated because of preparatory works and because of employee presence in the controlled zone (i.e. wastewater, used in the washing room and showers), are collected into big containers. Having neutralized pH, liquid waste is evaporated in the liquid waste treatment facility (LWTF). The received concentrates are passed to the bituminization equipment, and vapours of the evaporator are condensed and cleaned with ion exchange resins. The cleaned condensate may be released into the lake or reused for the needs of the nuclear power plant. In this EIA Report, like in EIA Report for Unit 1 final shutdown and defuelling phase, conservatively is assumed that cleaned condensate will not be reused, it will be released into Lake and this gives the maximum release of the radionuclides into environment.

The amounts of liquid waste to LWTF, generated because of decommissioning activities of unit 2 during the defuelling phase, are presented in Figure 3.4. Waste generation during unit operation, distinguished here and in other figures, encompasses waste that is generated because of operation of left systems, including their maintenance, and fuel transfer operations; “block modifications” mean waste, generated while isolating/modifying systems; and unit decontamination waste is waste, related to equipment and premises decontamination (including decontamination before the modifications and in-line decontamination of the main circulation circuit (MCC)).

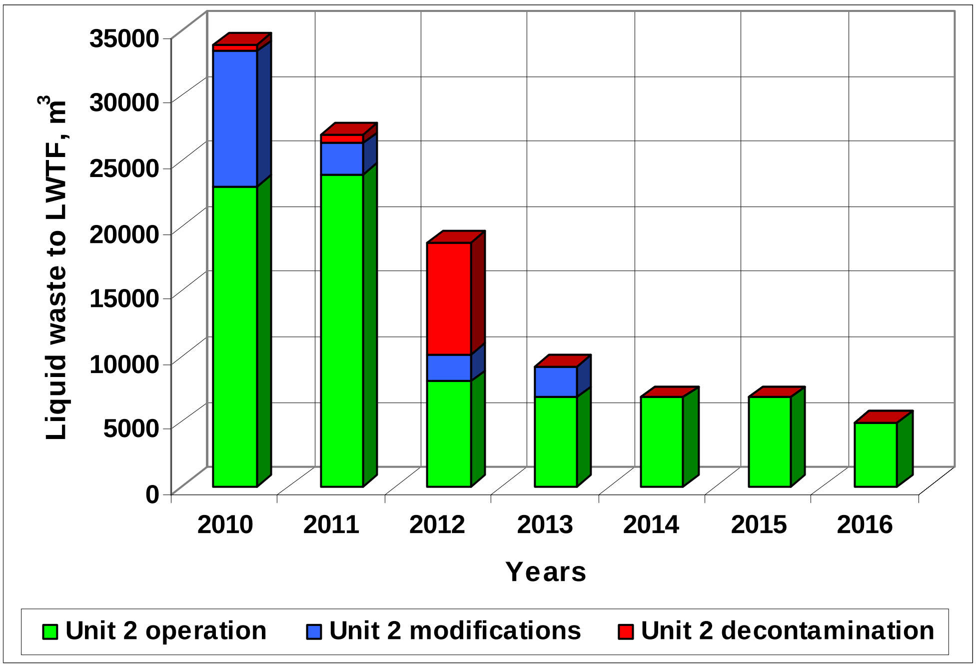

Figure 3.4. Liquid waste to LWTF, generated because of decommissioning activities of unit 2 during the defuelling phase

It may be seen from data presented in Figure 3.4 that during the first stage of unit 2 defuelling phase (in 2010–2011) the biggest amounts of liquid waste are generated because of operation, and in 2012, when inner decontamination of the main circulation unit will be performed, the amount of liquid waste, generated because of decontamination, will increase significantly. Only during the decontamination of the MCU approximately 8270 m^3 of liquid waste will be generated. In 2013 all modification and (or) isolation works will be finished, therefore the amounts of liquid waste, generated in 2014–2016, will be small (approximately 6000 m^3 per year).

The generated bituminized waste is stored in the existing bituminized waste storage facility in building 158. Amounts of bituminized waste, generated because of unit 2 decommissioning activities during the defuelling phase, are presented in Figure 3.5.

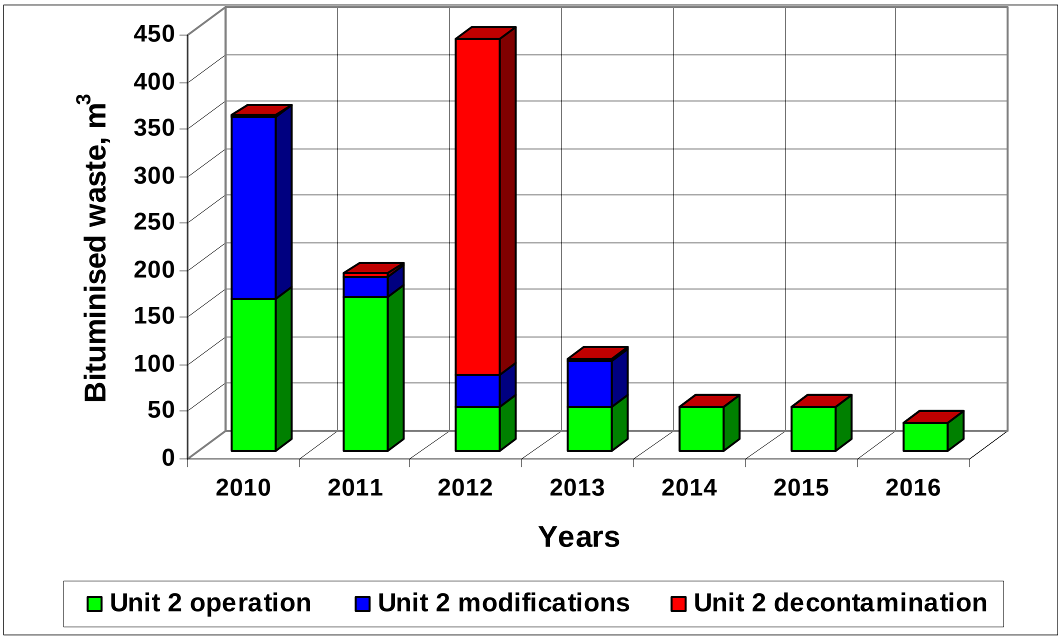

Figure 3.5. Bituminized waste, generated because of unit 2 decommissioning activities during the defuelling phase

It may be seen from data presented in Figure 3.5 that the biggest volume of bituminized waste will be generated in 2012, when inner decontamination of the main circulation unit (MCU) will be performed (approximately 438 m^3 in total, approximately 357 m^3 of it will be bituminized waste due to bituminization of solutions used during decontamination through washing).

Due to unit 2 decommissioning activities during the defuelling phase the total amount of generated bituminized waste will be approximately 1170 m^3, i.e. approximately 13 % of the volume left in the storage facility on 1 January 2010 (8800 m^3). Preliminary radiological waste acceptance criteria, prepared for the near surface repository [18], will be applied to disposal of bituminized waste, i.e. the minimal amount of bitumen, necessary for conditioning evaporator concentrates, generated during each decommissioning work, will be the higher of these values, [17]:

- Minimal amount, necessary to sustain salt concentration ≤30 % (weight) in the bituminized waste matrix;
- Minimal amount, necessary to sustain specific activity of critical radionuclides (Bq/m^3) in the waste matrix, less than levels presented in [18].

In the latter case it has been confirmed that specific activities, received in this way, do not exceed design values.

3.2.3.2 Solid Waste to Free Release

Because of unit 2 decommissioning activities during the defuelling phase 102 tons of solid waste that conforms to unconditional free release radiological levels will be generated (Figure 3.6). This waste will consist mostly of used spent clothes, packing materials and protective plastic sheets, i.e. waste related with the presence of personnel in the controlled area, also (mostly in 2010–2011) metal scraps, metallic components, wood, concrete, brickworks, wires, etc. Currently this waste is sent to the INPP industrial waste disposal sites ("polygons"). It is expected that a major fraction of this waste will comply with the unconditional free release criteria [19].

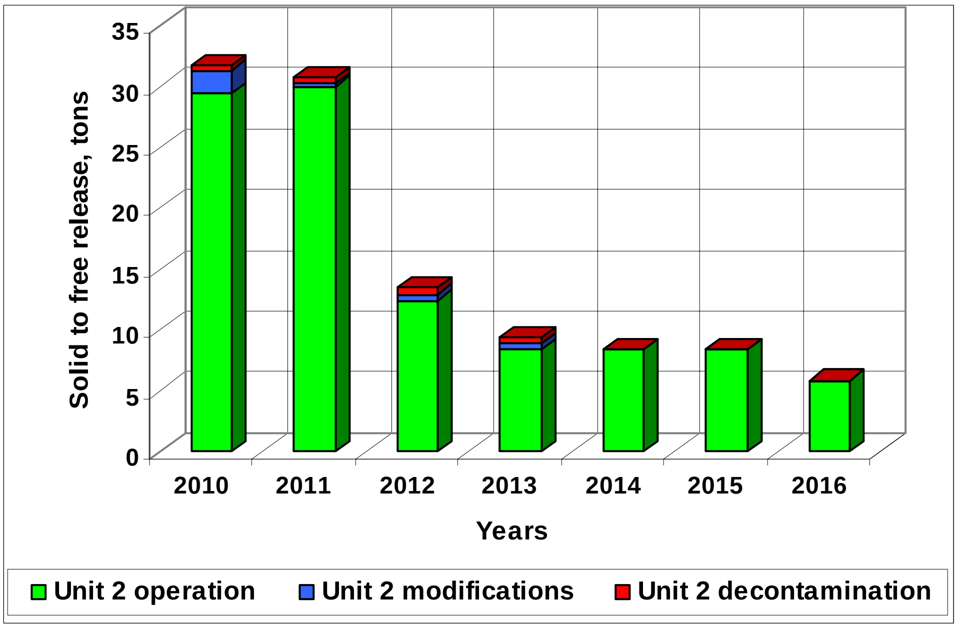

Figure 3.6. Solid waste to free release, generated because of unit 2 decommissioning activities during the defuelling phase

As it was mentioned, the operation of the new waste free release measurement facility (project B10) is planned in 2009.

3.2.3.3 Solid Waste to Very Low Level Waste Repository

According to project B19, executed by the INPP, a new disposal facility for very low level waste (VLLW) for disposal of short-lived very low level waste, generated during the INPP operation, as well as during its decommissioning, shall be designed and built [20]. The whole VLLW disposal facility will consist of disposal modules (disposal facility) and storage facility where waste will be stored until its disposal. Disposal modules and storage facility will be installed on two separate sites.

It is planned to install the VLLW disposal facility's storage facility on the site of unit 3 of the INPP next to waste free release measurement facility. The VLLW treatment facility as well as the disposal modules of the VLLW disposal facility are planned in the industrial territory for the INPP needs. The purpose of the VLLW storage facility is waste activity measurement, waste accumulation and reliable interim storage between VLLW disposal campaigns, performed not less than once per 2 years. The VLLW storage facility will hold up to 4,000 m^3 of packages with radioactive waste [20, Annex 1].

It is planned to install the VLLW repository disposal modules on the site near the INPP, next to the new interim spent nuclear fuel storage facility (ISFSF) site and solid waste treatment and storage facility (SWTSF). The purpose of disposal modules is disposal of very low level waste according to safety requirements [14], ensuring the necessary environmental protection. It is planned that the VLLW repository will consist of three disposal modules, and the volume of each of them is 20,000 m^3 of packed radioactive waste [20, Annex 1].

The operation of VLLW storage facility is planned in 2010. According to the Final INPP Decommissioning Plan [21], after finishing the projects of decontamination and dismantling of buildings on the INPP industrial site, no more very low level waste will be generated. After this the operation of VLLW storage facility will be ended, and the storage facility will be dismantled.

The commissioning of the first module of VLLW repository is planned in 2013. Disposal of very low level RW, i.e. operation of disposal modules, will continue until the INPP decommissioning activities will be finished. After the last disposal campaign in the VLLW the repository will be closed, and its institutional supervision period will start. According to paragraph 16 of the Requirements of Very Low Level Radioactive Waste Disposal [14], the period of active institutional supervision of the VLLW repository shall last for not less than 30 years, after it passive repository supervision shall be performed. The duration of active and passive institutional supervision shall be determined in the repository licence [14], based on the project and results of safety analysis.

Amounts of very low level waste, generated because of unit 2 decommissioning activities during the defuelling phase, accumulated in the VLLW storage facility and deposited in the VLLW repository, are presented in Figure 3.7.

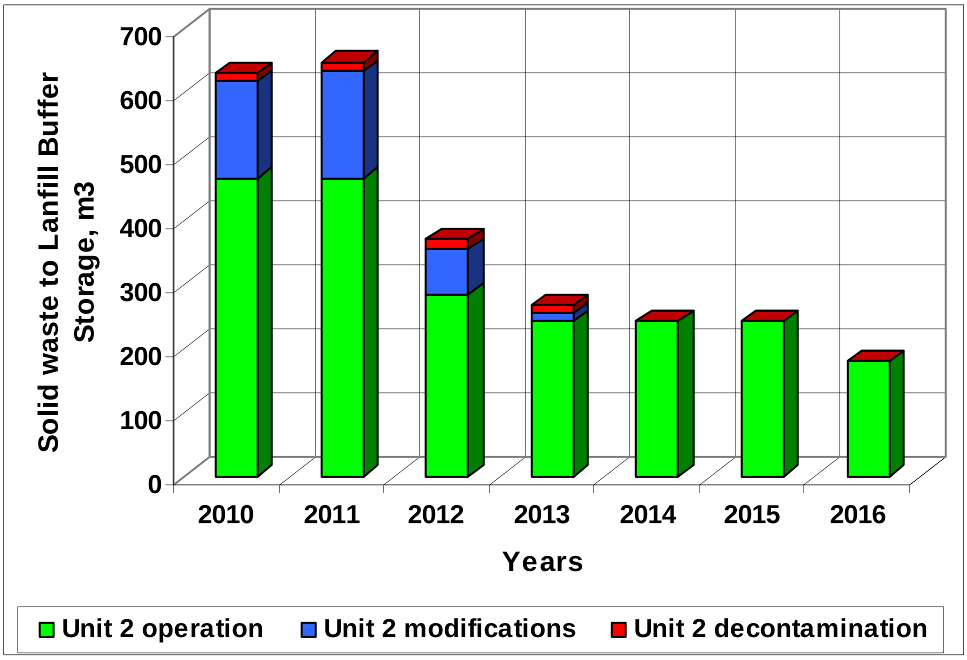

Figure 3.7. Solid waste to the VLLW repository storage facility, generated because of unit 2 decommissioning activities during the defuelling phase

It may be seen from data presented in Figure 3.7 that the biggest amounts of very low level waste are generated because of unit 2 decommissioning during the first stage of the defuelling phase, whereas these amounts are significantly smaller due to unit modifications and (or) isolation.

The total amount of very low level waste that conform to the acceptance criteria for disposal in the VLLW repository, generated due to unit 2 decommissioning activities during the defuelling phase in 2010–2016, will be approximately 2600 m^3, i.e. approximately 65 % of the volume of the VLLW storage facility (4000 m^3).

3.2.3.4 Solid Waste for Treatment in the SWTSF

According to the agreement between the European Bank for Reconstruction and Development (administrator of the International INPP Decommissioning Support Fund) and the Government of the Republic of Lithuania a new solid waste management and storage facility (SWMSF) will be built [22]. The new SWMSF will ensure for the INPP a contemporary management and storage system for existing and future operational and decommissioning solid radioactive waste [15]. It will conform to requirements of the laws of the Republic of Lithuania and other legal acts, also it will enable to achieve that management of radioactive waste in Lithuania would conform to IAEA principles of radioactive waste management and the existing good practice in countries of the European Union.

The new facility is meant for retrieval, sorting, transportation, treatment (according to provided technologies), packing, characterization and storage of short-lived and long-lived solid radioactive waste that is presently stored on the INPP site, which will be generated in the INPP until the final shutdown of unit 2, and which will be generated during the INPP decommissioning.

SWMSF consists of several facilities that will be on two separate sites [23, 24]. The solid waste retrieval facility (SWRF) will be built on the INPP site, next to the existing solid radioactive waste storage buildings. The solid waste treatment and storage facility (SWTSF) will be built on a new site near the INPP, next to the new interim spent nuclear fuel storage facility (ISFSF) [25].

In the solid waste treatment facility (SWTF) there will be equipment and installations, necessary for treatment of solid radioactive waste [23, 24]. SWTF will consist of various sorting cells and equipment for further treatment of sorted waste. Waste will be treated in parallel streams in the sorting cells, with regard to its radiological properties. After waste sorting, waste size reduction and other preparatory works before incineration, high force compaction and/or grouting will be performed. After sorting waste will be divided into classes B–F based on their further management.

SWSF will consist of two separate storage facilities, directly connected with SWTF: one storage facility for short-lived (SL) waste and another one for long-lived (LL) waste.

SL waste storage facility will be designed to contain approximately 2500 m^3 of conditioned short-lived waste (net weight of waste without containers, grout, space taken by the crane, etc.) and to store waste packages for approximately 50 years. This storage facility will be designed in such a way so that it could be expanded, building up to three similar additional modules, thus increasing the general volume to 10000 m^3.

LL waste storage facility will be designed to contain approximately 2000 m^3 of long-lived waste (net weight of waste without containers, space taken by the crane, etc.) and to store waste packages for approximately 50 years. It will also have the possibility of module expansion.

The necessity of expansion of short-lived and long-lived waste storage facilities will depend on the whole implementation of the INPP decommissioning process (the course of building repositories, type and amount of waste, generated during dismantling and decommissioning, etc.).

The operation of solid waste retrieval equipment and waste sorting equipment for VLLW repository (part of project B2) and solid waste treatment and storage facility (SWTSF, project B3/4) is planned in 2011.

Amounts of solid waste, generated due to unit 2 decommissioning activities during the defuelling phase, which will have to be treated and stored in the SWTSF, are presented in Figure 3.8.

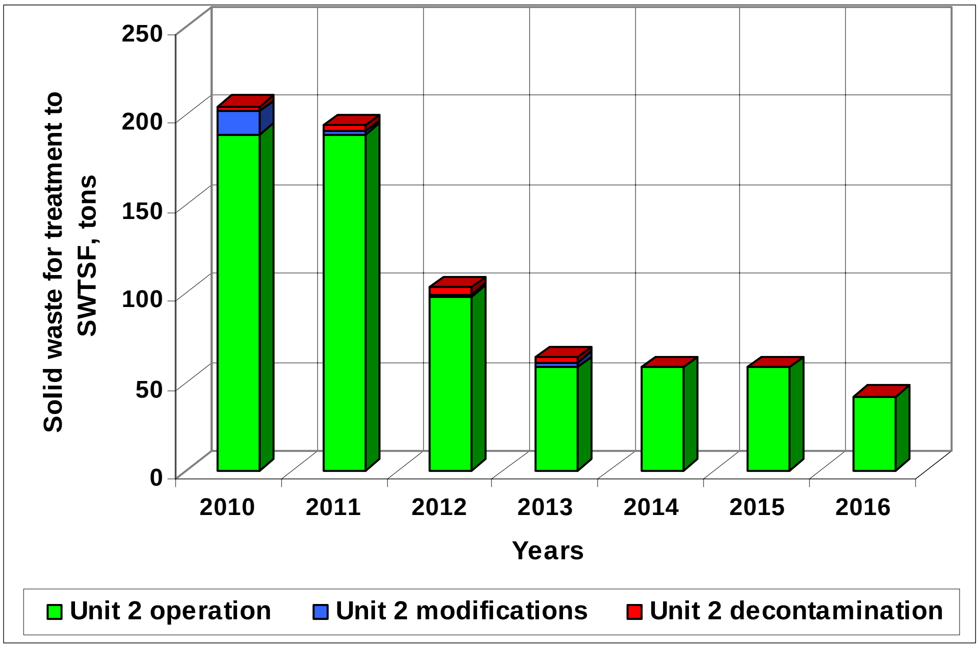

Figure 3.8. Solid waste for treatment in the solid waste treatment and storage facility, generated due to unit 2 decommissioning activities during the defuelling phase

It may be seen from data presented in Figure 3.8 that the main amounts of solid waste, which will have to be treated in the SWTSF, are generated due to unit 2 equipment operations after the final reactor shutdown, and significantly bigger annual amounts of waste are generated during the first stage when compared with the second stage. In total approximately 680 tons of solid waste, which will have to be treated in the SWTSF, will be generated due to unit 2 decommissioning activities in 2010–2016.

3.2.3.5 Cemented Waste for Storage in the Cemented Waste Storage Facility

The cementation equipment, which is a part of the existing liquid waste treatment facility (LWTF), is installed in the building 150 of the INPP. The cementation equipment in the INPP can process approximately 450 m^3 of spent ion exchange resins, perlite and sediment mixture annually. The interim storage facility can accommodate the storage of waste packages, received after processing 6000 m^3 of liquid radioactive waste [26]. This amount includes approximately 4500 m^3 of liquid resins of INPP operation until 2010 and approximately 1500 m^3 of spent resins, which will be generated during INPP decommissioning. The interim storage facility is a facility for intermediate storage; solidified waste will be stored in it until a near surface repository for short-lived low and intermediate level waste will be built.

The operation of the near surface repository is planned only in 2016; therefore conditioned waste of spent ion exchange resins, perlite and sediments, generated due to unit 2 decommissioning activities during the defuelling phase, will be stored in the existing cemented waste storage facility.

Amounts of cemented waste, generated due to unit 2 decommissioning activities during the defuelling phase, are presented in Figure 3.9.

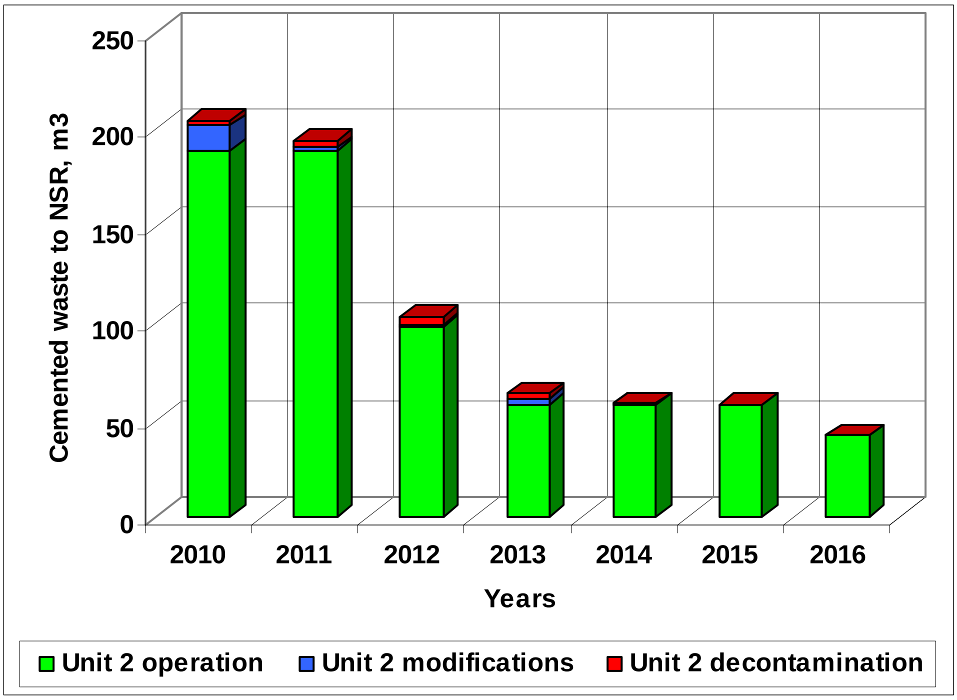

Figure 3.9. Cemented waste for the near surface repository to the cemented waste storage, generated due to unit 2 decommissioning activities during the defuelling phase

It may be seen from data presented in Figure 3.9 that insignificant amounts of conditioned waste of spent ion exchange resins, perlite and sediment mixture will be generated due to unit 2 decommissioning activities during the defuelling phase; the total amount will be approximately 70 m^3.

3.2.4 Radioactive Waste Generated due to All Activities, Performed During the Defuelling Phase of Unit 2 Decommissioning and Management of this Waste

This chapter assesses radioactive waste, generated not only during the first and second defuelling stages of unit 2 decommissioning, but also generated during unit 1 decommissioning project's defuelling phase and other activities in Table 2.1 at "Projects of Radioactive Waste Management", which will be performed during the period of planned economical activity (in 2010–2016). EIA reports have not been prepared yet for the decommissioning projects B9-X (see Table 2.1), currently planned in the INPP, but an approximate assessment may be made of probable generated waste amounts based on masses/volumes in the buildings and measurements of radiation dose rates and radiological contamination of equipment. These amounts will be revised during the preparation of corresponding project documentation. Probable waste amounts, presented in Tables 3.5, 3.6, 3.8 and 3.10 in this section, generated during the implementation of B9-X projects, are presented together with waste, retrieved in the solid waste retrieval facility (B2), because total amounts of this waste must not exceed the working volume of the VLLW repository storage (B19), capacity of the new solid waste treatment facility (B3) and capacity of the existing grouting equipment. If factual amounts of waste in B9-X projects are bigger than planned, the rate of waste retrieval in the solid waste retrieval facility (B2) should be decreased in such a way that the working volume of the VLLW repository storage, the capacity of solid waste treatment facility, and the capacity of the grouting equipment would not be exceeded. Regulating institutions may also consider the possibility to allow interim waste storage in units or to demand the delay of dismantling works. Amounts of solid waste, intended for disposal in the VLLW and near surface repositories, during the unit 2 defuelling phase are mostly determined by conditioning of operational waste, accumulated in the territory of the nuclear power plant, which is assessed in this chapter together with waste of projects B9-X.

3.2.4.1 Generation of Liquid Waste and Their Treatment in LWTF

Generated amounts of liquid waste, which will be treated in the liquid waste treatment facility, are presented in Table 3.3.

Table 3.3. Liquid waste to LWTF evaporation equipment, m^3

Flows of generated waste	2010	2011	2012	2013	2014	2015	2016	Total (2010-2016)
Unit 2 decommissioning project for the defuelling phase – U2DP0	33930	27000	18730	9220	6830	6830	4900	107440
Unit 1 decommissioning project for the defuelling phase – U1DP0	19060	11320	6830	6830	6830	6830	0	57700
Operation of cementation equipment and interim storage facility building	194	194	194	194	194	194	194	1358
Operation of interim SNF storage facility – B1	0	1050	1848	1848	1848	1848	1848	10290
Operation of solid waste management and storage facility – B2/3/4	0	510	1040	1040	1040	1040	1040	5710
Operation of VLLW repository storage facility – B19	95	217	217	217	217	217	217	1397
Operation of VLLW repository – B19	0	0	0	174	174	174	174	696
In total	**53279**	**40291**	**28859**	**19523**	**17133**	**17133**	**8373**	**184591**

It may be seen from data presented in Table 3.3 that the biggest amounts of liquid waste will be generated in 2010 and 2011, and in 2014–2016 these amounts will already be approximately 2.5–3 times smaller. LWTF will be able to process these amounts with no problems, even if they increased due to other dismantling (B9-X) projects, because efficiency of LWTF equipment is significantly bigger.

Amounts of generated bituminized waste, directed to the existing storage, are presented in Table 3.4.

Table 3.4. Bituminized waste to the bituminized waste storage, m^3

Flows of generated waste	2010	2011	2012	2013	2014	2015	2016	Total (2010-2016)
Unit 2 decommissioning project for the defuelling phase – U2DP0	356	188	438	98	46	46	30	1202

Unit 1 decommissioning project for the defuelling phase – U1DP0	480	130	46	46	46	46	0	794
Operation of cementation equipment and interim storage facility building	14.2	14.2	14.2	14.2	14.2	14.2	14.2	99.4
Operation of interim SNF storage facility – B1	0	6	12	12	12	12	12	66
Operation of solid waste management and storage facility – B2/3/4	0	3	7	7	7	7	7	38
Operation of VLLW repository storage facility – B19	0.7	1.5	1.5	1.5	1.5	1.5	1.5	9.7
Operation of VLLW repository – B19	0	0	0	1.2	1.2	1.2	1.2	4.8
In total	**851**	**343**	**519**	**180**	**128**	**128**	**66**	**2214**

The bituminized waste storage facility consists of 11 canyons, of 2000 m^3 of operating volume each, and 1 canyon of 800 m^3 of operating volume, in total 22800 m^3 of operating volume. It is planned that 8800 m^3 of free operating volume will be left in the storage on 1 January 2010. In total 2214 m^3 of bituminized waste, or approximately 25 % of free storage volume will be generated due to all activities, performed during the defuelling phase of unit 2 decommissioning. In the future during other dismantling works a very small amount of bituminized waste will be generated, therefore the left free operating volume of the existing storage will be sufficient for it, too.

The performed viability research of the long-term safety assessment of the existing bituminized waste storage facility enabled to conclude that having performed certain modernisation works, the existing storage facility could be turned into a long-term safe near surface repository [27]. The INPP has started long-term safety assessment study of the bituminized waste storage facility.

3.2.4.2 Solid Waste to Free Release

Amounts of solid waste to free release, generated due to all activities, performed during the defuelling phase of unit 2 decommissioning, are presented in Table 3.5.

Table 3.5. Solid waste to free release, tons

Flows of generated waste	2010	2011	2012	2013	2014	2015	2016	Total (2010-2016)
Unit 2 decommissioning project for the defuelling phase – U2DP0	31.7	30.7	13.5	9.3	8.4	8.4	5.8	107.8
Unit 1 decommissioning project for the defuelling phase – U1DP0	13	10.2	8.4	8.4	8.4	8.4	0	56.8
Operation of cementation equipment and interim storage	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.4

facility building							
Operation of interim SNF storage facility – B1	0	0.6	0.6	0.6	0.6	0.6	0.6	3.6
Operation of solid waste management and storage facility – B2/3/4	0	2.5	2.5	2.5	2.5	2.5	2.5	15
Operation of VLLW repository storage facility – B19	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1,4
Operation of VLLW repository – B19	0	0	0.2	0.2	0.2	0.2	0.2	1
In total	**45**	**44**	**26**	**21**	**21**	**21**	**10**	**187**

It may be seen from data presented in Table 3.5 that due to all activities, performed during the defuelling phase of unit 2 decommissioning, very small amounts of solid waste to free release will be generated – only 187 tons in total. The efficiency of the new free release measurement equipment (project B10), the operation of which is planned in 2009, will be significantly bigger, therefore no problems will arise accepting waste, generated during decontamination and dismantling projects (B9-X).

3.2.4.3 Solid Waste to Very Low Level Waste Repository

Amounts of very low level waste that conforms to the VLLW repository waste acceptance criteria, generated due to all activities, performed during the defuelling phase of unit 2 decommissioning, are presented in Table 3.6.

Table 3.6. Solid waste to the VLLW repository storage facility, m^3

Flows of generated waste	2010	2011	2012	2013	2014	2015	2016	Total (2010-2016)
Unit 2 decommissioning project for the defuelling phase – U2DP0	630	647	370	267	243	243	180	2580
Unit 1 decommissioning project for the defuelling phase – U1DP0	342	292	243	243	243	243	0	1606
Operation of cementation equipment and interim storage facility building	4.9	4.9	4.9	4.9	4.9	4.9	4.9	34,3
Operation of interim SNF storage facility – B1	0	12	16.2	16.2	16.2	16.2	16.2	93
Operation of solid waste management and storage facility – B2/3/4	0	8	17.4	17.4	17.4	17.4	17.4	95
Operation of VLLW repository storage facility – B19	3	6	6	6	6	6	6	39

Operation of VLLW repository – B19	0	0	0	4.8	4.8	4.8	4.8	19.2
Final production and waste of solid waste retrieval facility (B2) from projects B9-X to the VLLW storage facility	0	200	300	300	1400	1400	1400	5000
In total	**980**	**1170**	**958**	**859**	**1936**	**1935**	**1629**	**9467**

It may be seen from data presented in Table 3.6 that due to activities (except SWRF final production and waste from projects B9-X), performed during the defuelling phase of unit 2 decommissioning, quite significant amounts of very low level waste will be generated, especially in 2010–2013 (3167 m^3). Operation of VLLW storage facility is planned in 2010, but its capacity is only 4000 m^3, and the operation of the VLLW repository itself is planned only in the second half of 2013, although operation of equipment of SWRF waste separation for VLLW repository is planned in 2011. Therefore in 2011–2013 VLLW storage facility will be able to accept only approximately 800 m^3 of final SWRF production and waste from decontamination and dismantling projects (B9-X). In 2014 and later this amount will increase to 1400 m^3 annually.

Campaigns of disposal of waste, accumulated in the VLLW storage facility, in the VLLW repository are planned not less than once per 2 years. Since the first campaign is possible only in 2013, the second campaign is planned in 2015 (Table 3.7). 7838 m^3 of packages of very low level waste will take up approximately 13 % of operating volume of VLLW repository.

Table 3.7. Solid waste to VLLW repository, m^3

Filling of VLLW repository	2010	2011	2012	2013	2014	2015	2016	Total (2010-2016)
From activities, performed during decommissioning	0	0	0	3167	0	1071	0	4238
Operational waste, retrieved from SWRF (B2) and waste from projects B9-X	0	0	0	800	0	2800	0	3600
In total	**0**	**0**	**0**	**3967**	**0**	**3871**	**0**	**7838**

3.2.4.4 Solid Waste for Treatment in SWTSF

Currently solid radioactive waste, generated in the INPP and/or accepted for storage, is divided into three groups based on its radiological characteristics and old classification system: G1 (low level waste), G2 (intermediate level waste), G3 (high level waste). Comparison between old and new solid radioactive waste classification systems is presented in Section 3.2.1

Spent sealed sources may be found in non-combustible waste storage sections of groups G1, G2 and G3 of existing storage facilities. Since 2000 spent sealed sources have been collected and stored separately from other waste.

It is planned [23, 24], that before the planned final INPP shutdown (before 2010) 22300 m^3 of G1 waste and 5000 m^3 of G2 waste will be accumulated. The planned amount of untreated G3 waste will be approximately 1000 m^3.

SWMSF is designed so that its average efficiency will be:

- G1 waste – 11.2 m^3/d;

- G2 waste – 2.8 m^3/d;
- G3 waste – 0.9 m^3/d.

Average efficiency is estimated assuming that operation time (operation time of waste retrieval and treatment equipment, not considering maintenance) is 245 days per year, working in one shift. After commissioning of SWMSF, all G1 and G2 waste (accumulated before 2010) will be managed in 10 years, and G3 waste will be managed in 5 years, operating at average efficiency.

Besides, during INPP decommissioning after 1 January 2010, solid waste will also be generated, which will need to be treated in SWTSF. Amounts of solid waste for treatment in SWTSF, generated due to all activities during the defuelling phase of unit 2 decommissioning, are presented in Table 3.8.

Table 3.8. Solid waste for treatment in SWTSF, tons

Flows of generated waste	2010	2011	2012	2013	2014	2015	2016	Total (2010-2016)
Unit 2 decommissioning project for the defuelling phase – U2DP0	205	194	103	64	58	58	42	724
Unit 1 decommissioning project for the defuelling phase – U1DP0	79	67	58	58	58	58	0	378
Operation of cementation equipment and interim storage facility building	742	742	742	742	742	742	742	5194
Operation of interim SNF storage facility – B1	0	2.8	3.9	3.9	3.9	3.9	3.9	22.3
Operation of solid waste management and storage facility – B2/3/4	0	210	400	440	446	446	446	2388
Operation of VLLW repository storage facility – B19	0.6	1.4	1.4	1.4	1.4	1.4	1.4	9
Operation of VLLW repository – B19	0	0	0	1.2	1.2	1.2	1.2	4.8
In total	**1027**	**1217**	**1308**	**1311**	**1311**	**1311**	**1237**	**8720**

Since the planned start of operation of the near surface repository is only 2016, all generated conditioned waste, meant for near surface disposal, generated during the defuelling of unit 2 decommissioning, will have to be kept for interim storage in B3/4 long-lived and short-lived waste storage facilities.

SWTF (B3) final production to short-lived waste storage facility is presented in Table 3.9.

Table 3.9. SWTF (B3) final production to short-lived waste storage facility, m^3

B3 final production	2010	2011	2012	2013	2014	2015	2016	Total (2010-2016)
From activities,	0	178	162	162	162	162	124	950

performed during decommissioning								
Operational waste, retrieved from SWRF (B2) and waste from projects B9-X	0	150	250	250	250	250	250	1400
In total	**0**	**328**	**412**	**412**	**412**	**412**	**374**	**2350**

It may be seen from data presented in Table 3.9 that the most part of conditioned short-lived low and intermediate level waste will consist of solid waste, retrieved from SWRF, generated during the INPP operation before 2010 (1400 m^3 in total, or approximately 60 %), and only 950 m^3, or approximately 40 %, will be waste from other activities, performed during decommissioning. In total 2350 m^3 of waste will be generated, and operating volume of the first module of short-lived waste storage facility is 2500 m^3, therefore no other planned modules will be needed before 2016.

No long-lived waste will be generated during the defuelling phase of unit 2 decommissioning, it is planned that it will not be generated also during the execution of projects B9-X. But in 2011–2016 a considerable part of long-lived waste of groups D and E that were generated during INPP operation will be retrieved, put into containers and put for safe interim storage in the new long-lived waste storage facility in complex B3/4, waiting for the decision regarding the most suitable conditioning method, as defined in the Radioactive Waste Management Strategy [15]. At the end of the discussed period, approximately 1100 m^3 of waste of groups D and E will be kept for interim storage (Table 3.10), it will take up approximately 55 % of operating volume of long-lived waste storage facility.

Table 3.10. SWTF (B3) final production to LILW-LL storage facility (B4), m^3

B3 final production	2010	2011	2012	2013	2014	2015	2016	Total (2010-2016)
From activities, performed during decommissioning	0	0	0	0	0	0	0	0
Operational waste, retrieved from SWRF (B2)	0	185	185	185	185	185	175	1100
In total	**0**	**185**	**185**	**185**	**185**	**185**	**175**	**1100**

3.2.4.5 Cemented Waste to Existing Storage Facility

Amounts of cemented waste, generated during the defuelling phase of unit 2 decommissioning, are presented in Table 3.11.

Table 3.11. Cemented waste to existing storage facility, m^3

Flows of generated waste	2010	2011	2012	2013	2014	2015	2016	Total (2010-2016)
Unit 2 decommissioning project for the defuelling phase – U2DP0	32.2	30.5	6.5	0.5	0	0	0	69.7

Unit 1 decommissioning project for the defuelling phase – U1DP0	2	0.8	0	0	0	0	0	2.8
Operation of cementation equipment and interim storage facility building	0	0	0	0	0	0	0	0
Operation of interim SNF storage facility – B1	0	0	0	0	0	0	0	0
Operation of solid waste management and storage facility – B2/3/4	0	0	0	0	0	0	0	0
Operation of VLLW repository storage facility – B19	0	0	0	0	0	0	0	0
Operation of VLLW repository – B19	0	0	0	0	0	0	0	0
Cementation of spent resins, perlite and sediments accumulated in storages during the INPP operation and cementation of waste from B9-X projects	2477	2480	2504	2510	2511	2511	2511	17504
In total	**2511**	**2511**	**2511**	**2511**	**2511**	**2511**	**2511**	**17577**

It may be seen from data presented in Table Table 3.11 that during the period of the planned economical activity approximately 17,577 m^3 of cemented waste may be generated in total, it would amount to approximately 50 % of the volume of the cemented waste storage facility. Due to activities, performed during the defuelling phase of decommissioning of units 2 and 1, very small amounts of cemented waste will be generated – 86.2 m^3 in total, or a bit more than 15 containers. Therefore the cementation equipment, working at the designed capacity (2511 m^3 or 450 containers per year) will be able to cement the bigger part of spent resins, perlite and sediment mixture, still left in storages before 1 January 2010, accumulated during INPP operation.

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4 POSSIBLE IMPACT ON VARIOUS ENVIRONMENTAL COMPONENTS DUE TO THE PROPOSED ECONOMIC ACTIVITY AND ENVIRONMENTAL IMPACT MITIGATION MEASURES

4.1 Water

4.1.1 Information about the site

4.1.1.1 Hydrological conditions

Lake Druksiai is the largest lake in Lithuania and has its eastern margin in Belarus. The total volume of water is about 369×10^6 m^3 (water level altitude of 141.6 m). The total area of the lake, including nine islands, is 49 km^2 (6.7 km^2 in Belarus, 42.3 km^2 in Lithuania). The greatest depth of the lake is 33.3 m and the average is 7.6 m. The length of the lake is 14.3 km, the maximum width 5.3 km and the perimeter 60.5 km. Some characteristics of the lake are given in Table 4.1.1 [1-3].

Table 4.1.1 Main data of hydrologic regime of water cooling reservoir of the INPP

No	Characteristics of Lake Druksiai	Value
1.	The catchment area of Lake Druksiai, km^2	564
2.	Water area of lake at normal affluent level, km^2	49
3.	Multiyear flow rate of water from lake, m^3/s	3.19
4.	Multiyear discharge from lake, m^3/year	100.5×10^6
5.	Multiyear quantity of atmospheric precipitation, mm/year	638
6.	Multiyear value of evaporation from water surface, mm/year	600
7.	Normal affluent level of lake, m	141.6
8.	Minimum permissible lake level, m	140.7
9.	Maximal lake level, m	142.3
10.	Regulating volume of lake, m^3	43×10^6
11.	Permissible drop of lake level, m	0.90

The INPP region is drained into watersheds of the rivers Nemunas (Sventoji) and Daugava. The small territory in the north-eastern part of the region belongs to the upper course of the Stelmuze stream (Stelmuze–Luksta–Ilukste–Dviete–Daugava). The greater northern part of the region belongs to the Laukesa watershed (Nikajus–Laukesa–Lauce–Daugava). The greatest part of the region belongs to the Dysna watershed, which may be divided into two parts: the upper course of the Dysna and the Druksa watershed with Lake Druksiai (Druksiai lake – the present effluent Prorva – from the Drisveta or Druksa watershed – Dysna) (Table 4.1.2) [4, 5].

Table 4.1.2 The main river watersheds of the INPP region

River	Main watershed	The length of river till the INPP region, km	The distance from the mouth, km	Watershed area, km^2	Average height of spring flood, mm
Sventoji	Nemunas	23.0	241.6	218	90
Dysna	Daugava	19.1	154.3	445.2	90
Druksa	Daugava	0.5	44.5	620.9	90
Laukesa	Daugava	2.3	29.1	274.9	95
Stelmuze	Daugava	3.8	7.8	48.3	100

There are a lot of lakes in the INPP region. Their total area of water surface is 48.4 km^2 (without Lake Druksiai). The net density of rivers is 0.3 km/km^2. There are 11 tributaries to Lake Druksiai and one river that flows from it (the Prorva). The main rivers, which are connected to Lake Druksiai are the Ricianka (area of catchment: 156.6 km^2), the Smalva (area of catchment: 88.3 km^2) and the Gulbine (area of catchment: 156.6 km^2) [1-4].

The catchment basin of Lake Druksiai (Figure 4.1.1) is small (only 564 km^2). The greatest length of the catchment basin (from south-west to north-east) is 40 km; maximum width is 30 km and average 15 km. The lake is characterized by relatively slow water exchange rate. The main outflow is the River Prorva (99 % of all surface outflows) in the south part of the lake. Then, following the hydrographic net lake Druksiai → Prorva → Druksa → Dysna → Daugava → Gulf of Riga (at the Baltic Sea) which makes about 550 km, before the outflows of Lake Druksiai enters the Baltic Sea [4, 5].

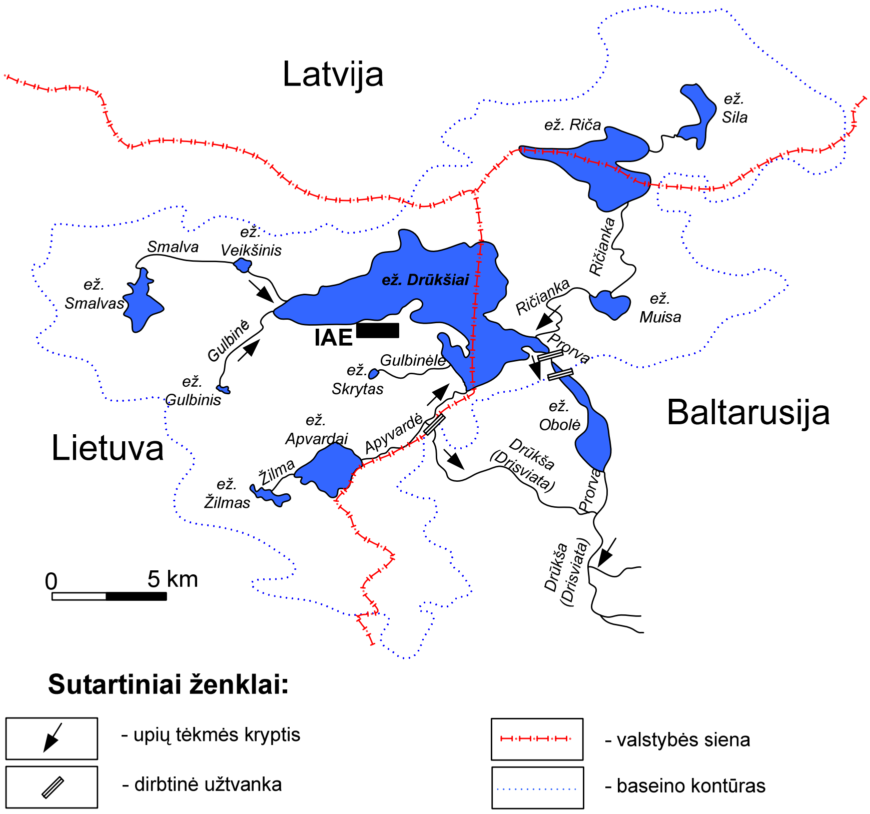

Figure 4.1.1 Scheme of Lake Druksiai catchment basin

The region is dominated by clay, loamy and sandy loam soils, which are responsible for varying water filtration conditions in different parts of the region. The percentage of the forestland of the region also varies widely, the highest being characteristic of Lake Druksiai basin. The average annual precipitation ranges from 590 to 700 mm. Two thirds of this value belongs to warm season. The snow cover accumulates 70–80 mm of precipitation. The summary evaporation from the land is about 500 mm [4].

4.1.1.2 Hydro-geological conditions

The INPP area is located in the recharge area of the eastern part of the Baltic artesian basin. The hydro-geological cross-section data indicates presence of hydrodynamical zones of the active, slower and slow water exchange. The active water exchange zone is separated from the slower water exchange zone by the 86–98 m thick regional Narva aquitard, located at the depth of 165–230 m. It is composed of loam, clay, domerite and clayey dolomite. The lower part of the aquitard contains an 8–10 m thick layer of gypsum-containing breccia. The slower water exchange zone is separated from slow water exchange zone by 170–200 m thick regional Silurian–Ordovican aquitard, located at the depth of 220–297 m [6].

The thickness of the Quaternary aquifer system is 60–260 m (mostly – 85–105 m). This aquifer system includes seven aquifers: the upper shallow unconfined groundwater aquifer and six confined groundwater aquifers located in Baltijos–Grudos, Grudos–Medininku, Medininku–Zemaitijos, Zemaitijos–Dainavos, Dainavos–Dzukijos and Dzukijos intertill fluvioglacial deposits [6].

The shallow aquifer is located in moor deposits (peat), aquaglacial deposits (sand, gravel, cobbles and pebbles), and the fissured upper part of the eroded silt of the glacial till, and the lenses of sand and gravel within the glacial till, here the aquifer is sometimes confined [6].

The aquifers in the intertill deposits are composed of sand, gravel, and in some palaeo-valleys – cobble and pebble deposits. The thicknesses of different aquifers vary from 0.3–2 m to 20–40 m, and in palaeo-valleys – 100 m and higher [6].

The confined aquifers in the intertill deposits are separated from each other by the low permeability till aquitards of sandy silt and silt, with lenses of sand and gravel. The thickness of different aquitards varies from 0.5 to 50–70 m, mostly – from 10–15 to 25–30 m [6].

The Sventoji–Upninkai aquifer system is located under the Quaternary aquifer system in the interlayering deposits of fine and very fine grained sand, weak cemented sandstone, silt and clay. The aquifer system is 80–110 m thick, and conditionally it is protected from surface contamination because the thickness of the separating layer above this facility is more than 25 m, and 50–75 % of its section consists of clay or loam [5], [7]. Water from the Šventoji–Upninkai complex is used for the provision of the city of Visaginas and the INPP. The watering-place of the city of Visaginas is operated by “Visagino energija”; the boreholes of the watering-place are approximately 4 km to the southwest of the INPP. The sanitary protection zone of this watering-place consists of three belts – strict regime protection, microbial contamination restriction, and chemical contamination restriction belts. The watering-place of the city of Visaginas and its SPZ belts are presented in Pic. 4.1.2. Existing and planned nuclear energy objects of the Ignalina NPP (reactor units, radioactive waste management and storage facilities, spent nuclear fuel storages, etc.) are beyond the limits of the SPZ of the watering-place of the city of Visaginas, therefore the proposed economic activity, which will be performed inside Unit 2 of the Ignalina NPP, will not breach the contamination limitations determined for the SPZ belts of the watering-place. The 3b sector of the 3rd belt (the belt of chemical contamination restriction) of the SPZ of the watering-place encompasses the dump of the city of Visaginas, a railroad strip with access roads, parts of a previous construction enterprise and auto-transport bases, an industrial heating boiler house, but, based on assessments, presented in [7], even hypothetical contamination of these objects during 50 years will not reach the watering-place, therefore their activity is not regulated by HN 44:2006 “Identification and maintenance of sanitary protection zones of watering-places”.

According to the field investigations [8], [9] the groundwater at the INPP site was found mainly to be at 1.0–4.0 m below the soil surface. Locally the groundwater was found at depths of 0–19 m below the soil surface. The typical feature is that the aquifer can consist of several hydraulically connected layers. The main flow is directed to the north and northeast towards Lake Druksiai.

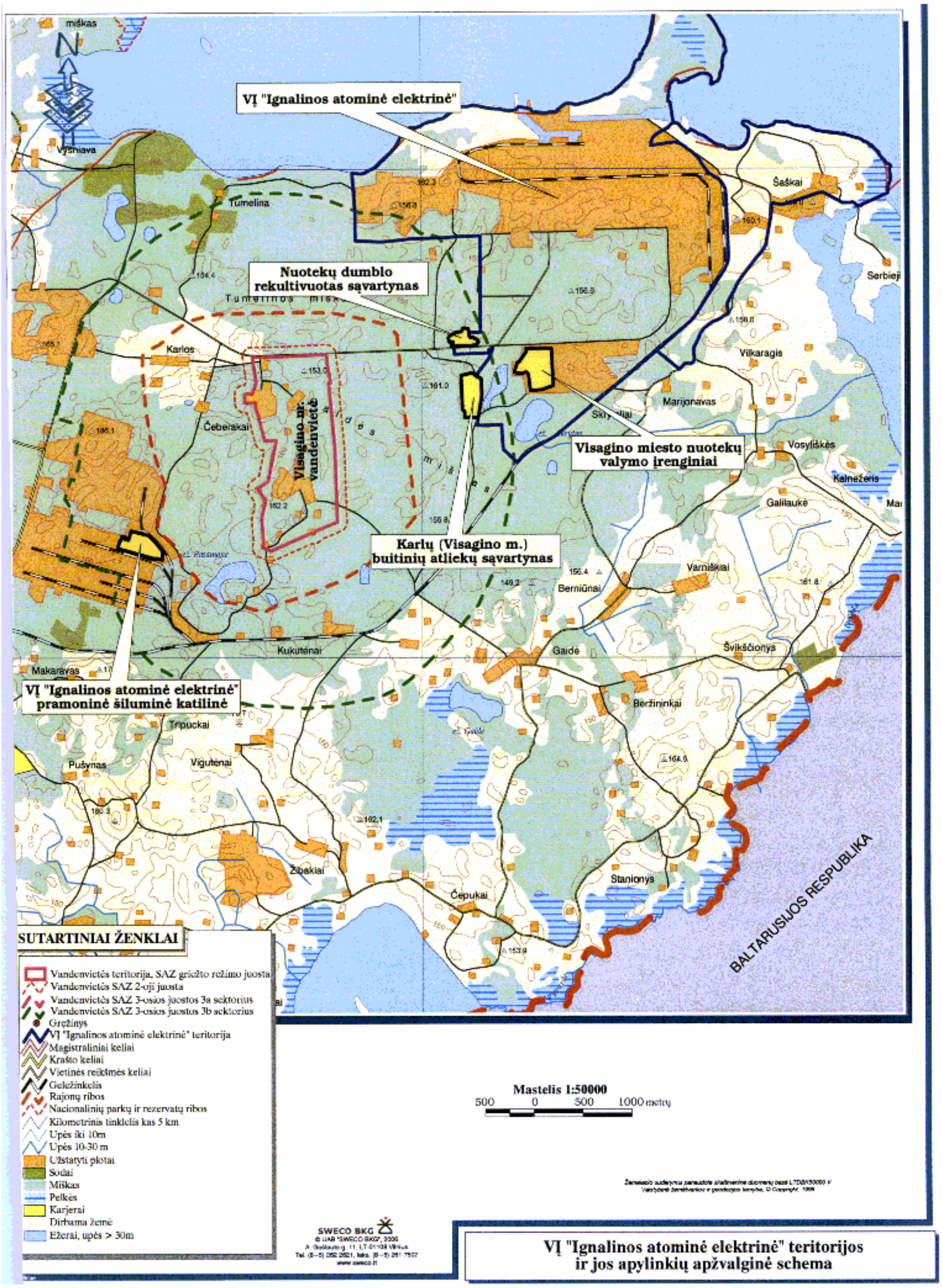

Figure 4.1.2. Visaginas town waterworks and lines of waterworks SPZ [8]

4.1.2 Planned Water Demand

The INPP uses artesian (potable) water and water from Lake Druksiai.

Artesian water is used for daily purposes (e.g. for drinking, showers, toilets) and for manufacture of treated technological water. Artesian water is provided by VĮ "Visagino energija". Artesian water is treated in local cleaning equipment. Its quality is constantly controlled, and it is suitable for daily purposes. Artesian water is also used in technological processes, where high quality water is needed. Artesian water, used for technological needs, is additionally treated in the INPP by demineralization. Artesian water is also used for the needs of the new heat only and thermal boilers.

The water of Lake Druksiai is used for purposes that do not require good water quality. Lake water is used for cooling INPP technological equipment (e.g. for cooling turbine condensers of reactor blocks, for technological needs of the liquid radioactive waste treatment facility, etc.), for the needs of the existing industrial heating boiler room, as fire extinguishing water, etc.

INPP water intake and use as well as the biggest permissible water amounts for use in separate activities are regulated by conditions, identified in the Permit of Integrated Pollution Prevention and Control [10]. The pollution permit shall be renewed before 2010.

The planned water demand when performing the proposed economic activity is presented in Chapter 1.6. When the both INPP reactors will be shut down, the water consumption for technological equipment cooling from Lake Druksiai will decrease. It is also not foreseen that during performance of the planned economic activity the water consumption by the other INPP water consumers could increase in such a way, which could exceed the INPP permissible water use [10]. Water will be supplied using existing equipment and technologies. Existing equipment is sufficient in order to ensure the necessary water supply. Implementation of new water suction boring holes or other water collection channels is not foreseen.

4.1.3 Management of Discharges

Management of non-radioactive discharges is described in Chapter 3.1 "Non-radioactive Waste". Only non-radioactive discharges may be discharged into the existing INPP household waste water system. The INPP household waste water system conforms to requirements of the normative document [11]. Household waste water is transferred for further management to VĮ "Visagino energija". After treatment in waste water treatment equipment INPP waste water is released into Lake Druksiai. Waste water treatment plant, operated by VĮ "Visagino energijai", is planned to be modernized in order to conform to waste water management requirements of Lithuania and the EU. Modernisation is planned to be finished by 2010.

Water used for cooling of technological equipment is discharged into Lake Druksiai without any additional treatment. Non-radioactive technological discharges are neutralised (to pH = 5-9), and later they are discharged into lake Druksiai.

Management of liquid radioactive waste is described in Chapter 3.2 "Radioactive Waste". Liquid radioactive waste, generated during the execution of the proposed economic activity, will be treated in the existing INPP liquid radioactive waste treatment facility (building 150).

Discharges from the INPP industrial site (rainwater, building drainage water, etc.) are collected with the surface discharge drainage system of the INPP industrial site and released into Lake Druksiai. The surface discharge drainage system of the INPP industrial site conforms to requirements of the normative document [12].

4.1.4 Non-radiological Impact

4.1.4.1 Sources of Non-radioactive Contamination of Environmental Water

Under normal operation conditions of INPP the potential sources of non-radioactive contamination of environmental water are:

- Discharges into Lake Druksiai of water used for cooling of technological equipment;
- Technological discharges (discharges from treatment of demineralised water, discharges from equipment maintenance, etc.);
- Household waste water;
- Surface discharges from the INPP industrial site.

It must be noted that in latter years the INPP does not release technological discharges into the environment. All discharges, generated in the controlled zone, are treated in the INPP existing liquid radioactive waste treatment facility. Treated water is returned and reused for technological needs.

After final shutdown of reactors and during INPP decommissioning, the existing water demand and discharges will change:

- The demand for technological equipment cooling water will decrease (e.g., condensers of reactor turbines will not have to be cooled anymore). Intake of water from Lake Druksiai and return of heated water will significantly decrease.
- With gradual shutting down of circuits which are not needed anymore for INPP operation (draining water from them, isolating and decontaminating them), the demand for demineralised water and demineralised water treatment discharges will decrease gradually;
- The amount of water needed for maintenance of equipment, that are still operational in the INPP, and for laboratories will not change in general. The generation of discharges, related with maintenance of no longer operational systems, will decrease;
- During performance of separate INPP equipment dismantling projects, water demand may increase, depending on technologies, used for dismantling works. Operation of new SNF and radioactive waste management and storage facilities will determine their own water demand. Water demand for new equipment and impact on environmental water is assessed in separate impact assessment reports for new equipment [13], [14] or activities [15].
- Water usage for daily needs will gradually decrease together with the decrease of the number of personnel working in the INPP. Generation of household waste water will also decrease accordingly.

During the proposed economic activity water will be drained from the main circulation circuit and related circuits; circuit in-line decontamination works will be performed, see Chapter 2. After appropriate treatment in LWTF, water, as non-radioactive technological effluents, will be discharged into Lake Druksiai, using existing dischargers.

In other respects the proposed economic activity (i.e. performed works, their performance technology, etc., see Chapter 2) will be analogous to activities, performed in the INPP before, during conditions of normal operation. Production non-radioactive discharges will be generated due to operation of systems, left after the final shutdown of unit 2 reactor, including periodical testing and maintenance. Other activity that determine production discharges will be management of SNF and radioactive waste. Meeting personnel sanitary and radiation safety demands, sanitary waste water will be generated. Existing conditions of contamination discharge (dischargers, contamination nature) will not change.

4.1.4.2 Forecast of Non-radioactive Contamination of Environmental Water

The biggest annual amount of treated liquid waste does not exceed 35 000 m^3 (see Section 3.2.3.1 and Figure 3.4). After appropriate treatment in the existing INPP liquid radioactive waste treatment facility, water, as non-radioactive technological effluents, will be discharged into Lake Druksiai. Amount of discharged water constitutes less than 0.01% of the total lake water amount and will not have any significant impact on lake hydrology. Quality of discharged water and discharge conditions will have to conform to requirements, set in the Permit for Integrated Pollution Prevention and Control.

Other activities, performed during the proposed economic activity (operation, supervision, maintenance of INPP existing systems, see Chapter 2) will be analogous to activities, performed in the INPP under conditions of normal operation. Unneeded systems' isolation works will also not require any equipment or technological operations, which would differ in essence from the ones, used in the INPP up till now (e.g. performance of maintenance works of existing equipment). The proposed economic activity will be performed by existing INPP personnel; increase in personnel numbers is not planned. Thus, in the same way as under normal INPP operational conditions, controlled and small-scale discharge of production and sanitary waste water into the environment is possible. It is possible to forecast, based on INPP existing discharge monitoring results, that the proposed economic activity will not determine significant discharges into environmental water that would worsen or significantly change the existing situation in the INPP environment.

4.1.4.3 Non-radioactive Contamination Impact Mitigation Measures for Environmental Water

Exclusive non-radioactive contamination impact mitigation measures for environmental water, related with this proposed economic activity, are not planned. Discharge of non-radioactive contaminants from the INPP to the water is limited based on conditions, set in the Permit for Integrated Pollution Prevention and Control [10]. The pollution permit shall be renewed before 2010. Certain designed solutions of proposed economic activity, specified during preparation the technical design for the proposed economic activity, will be considered during renewal of the pollution permit.

4.1.5 Radiological Impact

4.1.5.1 Sources of Radioactive Contamination of Environmental Water

During performance of the proposed economic activity radioactive discharges into the environmental water will be generated due to:

- Operation of systems, left in operation after the final shutdown of unit 2 reactor, including periodical tests and maintenance;
- Modification and isolation of systems, operational and non-operational after the final shutdown of unit 2 reactor;
- SNF defuelling from unit 2 reactor to fuel storage pools;
- SNF defuelling from unit 2 fuel storage pools to dry storage containers;
- Specific works like water drainage from separate circuits, including the main circulation circuit and related circuits (MCC+PCS), also in-line decontamination of circuits and SNF fuelling/defuelling machine.

- Primary works of radioactive waste defuelling and treatment:
  - Managing spent ion-exchange resins, perlite and sediment,
  - Managing various liquid radioactive waste,
  - Managing various solid radioactive waste;
- Storage, transportation and final treatment of radioactive waste.

Implementation of the proposed economic activity is planned for years 2010-2016. Detailed description of works and technology, works performance sequence and planned timetable are presented in Chapters 1 and 2. Radioactive discharges will be from unit 2 and INPP existing liquid radioactive waste management facility. Radionuclides will be discharged into Lake Druksiai together with INPP service water.

4.1.5.2 Forecast for Radioactive Contamination of Environmental Water and Radiological Impact

4.1.5.2.1 Forecasted Radioactive Discharges into the Environmental Water

During preparation of the INPP decommissioning project for stages of Unit 1 reactor final shutdown and SNF defuelling [16], detailed assessments of likely radioactive contamination of Unit 1 equipment, technological operations of decommissioning and radioactive discharges to the environmental water were performed. These discharge assessments were used during performance of environmental impact assessment of the defuelling phase of unit 1 decommissioning project and during preparation of the EIA report [17].

Analogous project of unit 2 final shutdown and SNF defuelling stage is under preparation still, and radioactive contamination, technological operations of decommissioning and radioactive discharges have not be assessed yet. Therefore, radioactive discharges to the environmental water, forecasted during the proposed economic activity, were assessed based on assessments, made for unit 1, i.e. it was accepted that:

- Radioactive contamination of unit 2 equipment and systems during final reactor shutdown will be analogous to contamination, assessed for final reactor shutdown of unit 1;
- As foreseen in the final INPP decommissioning plan, analogous decommissioning operations will be performed in Unit 2, applying analogous technologies, as performed or planned to perform in Unit 1;
- Differences in discharges from Unit 2 and Unit 1 may form only due to more intensive decommissioning works' timetable in Unit 2. Most decommissioning operations are planned to be performed in unit 2 earlier after reactor final shutdown.

Thus annual discharges [16], [17], assessed for final shutdown of Unit 1 reactor and SNF defuelling stage, were recalculated with regard to the timetable of planned works of final shutdown of Unit 2 reactor and SNF defuelling stage:

$$N_{j2,T} = N_{j2,0} \times \exp\left(-\lambda_j \times T_2\right),$$

Where:

$N_{j2,T}$ – annual discharge of radionuclide j to the environmental water, determined by decommissioning actions, performed in Unit 2 , during year T_2 after the final shutdown of Unit 2 reactor;

λ_j – constant of radioactive decay of radionuclide j.

Initial activity of separate decommissioning actions (i.e. activity, recalculated for the date of the shutdown of the final reactor), calculated in the following way:

$$N_{j2,0} = N_{j1,0} = N_{j1,T} \Big/ \exp(-\lambda_j \times T_1),$$

Where:

$N_{j1,T}$ – annual discharge of radionuclide j to the environmental water, determined by decommissioning actions, performed in reactor unit 1, during year T_1 after the final shutdown of reactor of unit 1.

Radioactive discharges into the environmental water, generated by proposed economic activity, are summarized in Figure 4.1.2 below. Radionuclide content of annual discharges is detailed in Table 4.1.3.

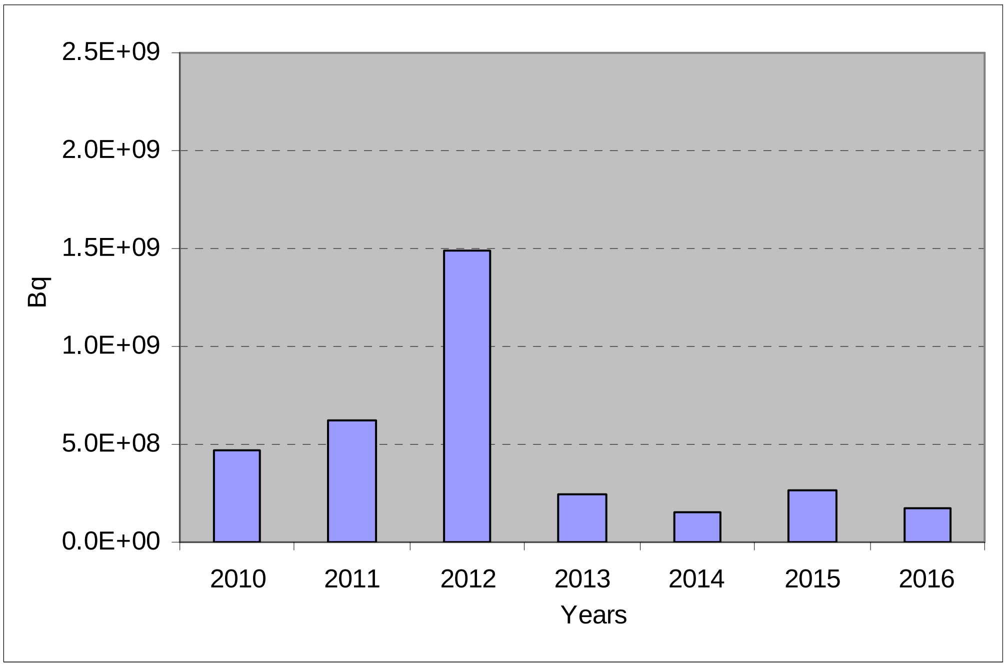

Figure 4.1.3 Planned annual radioactive discharges (Bq) to the environmental water due to implementation of proposed economic activity

Table 4.1.3 Planned annual radionuclide discharges (Bq) to the environmental water due to implementation of proposed economic activity

Radionuclides	Years						
	2010	2011	2012	2013	2014	2015	2016
Co-60	3.28E+07	6.44E+07	2.99E+08	3.03E+07	3.04E+07	4.48E+07	2.94E+07
C-14	1.78E+05	4.05E+05	2.33E+06	2.52E+05	2.90E+05	4.91E+05	3.68E+05
Mn-54	2.83E+07	2.81E+07	5.22E+07	3.38E+06	1.71E+06	1.29E+06	4.31E+05
Fe-55	1.36E+08	2.35E+08	8.87E+08	8.62E+07	7.62E+07	9.88E+07	5.73E+07
Co-58	1.50E+06	9.70E+04	6.41E+03	4.81E+01	1.56E+00	7.53E-02	1.58E-03
Ni-59	3.74E+04	8.36E+04	4.84E+05	5.31E+04	6.06E+04	9.95E+04	7.46E+04
Ni-63	8.91E+06	1.98E+07	1.13E+08	1.21E+07	1.37E+07	2.27E+07	1.69E+07
Nb-94	7.10E+04	1.59E+05	9.24E+05	1.01E+05	1.15E+05	1.89E+05	1.42E+05
Cs-137	1.31E+08	1.53E+08	7.67E+07	7.69E+07	2.45E+07	7.74E+07	5.67E+07
Sr-90	7.90E+05	9.36E+05	5.34E+05	4.60E+05	1.62E+05	4.63E+05	3.39E+05
Tc-99	5.40E+04	6.56E+04	3.84E+04	3.39E+04	1.22E+04	3.57E+04	2.68E+04

Radionuclides	Years						
	2010	2011	2012	2013	2014	2015	2016
I-129	4.82E+02	5.76E+02	2.96E+02	3.03E+02	9.87E+01	3.20E+02	2.40E+02
Cs-134	1.34E+08	1.14E+08	4.17E+07	3.06E+07	7.10E+06	1.64E+07	8.80E+06
Pu-241	1.15E+06	3.83E+06	1.24E+07	4.44E+05	2.48E+06	4.07E+05	2.91E+05
U-235	2.06E-01	7.16E-01	2.44E+00	9.14E-02	5.32E-01	9.24E-02	6.93E-02
U-238	6.28E+00	2.19E+01	7.46E+01	2.78E+00	1.63E+01	2.80E+00	2.10E+00
Pu-238	1.28E+04	4.42E+04	1.48E+05	5.55E+03	3.20E+04	5.52E+03	4.10E+03
Pu-239	3.46E+03	1.21E+04	4.11E+04	1.53E+03	8.97E+03	1.54E+03	1.16E+03
Pu-240	8.26E+03	2.86E+04	9.75E+04	3.67E+03	2.13E+04	3.71E+03	2.78E+03
Am-241	2.25E+04	8.89E+04	3.28E+05	1.27E+04	7.88E+04	1.40E+04	1.05E+04
Cm-244	3.46E+03	1.16E+04	3.80E+04	1.37E+03	7.69E+03	1.28E+03	9.27E+02
Total:	**4.74E+08**	**6.19E+08**	**1.49E+09**	**2.41E+08**	**1.57E+08**	**2.63E+08**	**1.71E+08**

Currently radioactive discharges to the environmental water from the INPP site are limited by requirements, set in the Permission for the Emission of Radioactive Material into Environment [18]. The document presents annual permissible discharge values for radionuclides that may be discharged into the environment, and information about planned future INPP annual radioactive discharges is presented. In total 13 radionuclides are identified in the requirements for discharges to the environmental water.

Annual limit values of radioactive discharges are set so that the annual effective dose determined by discharges would not exceed 0.1 mSv. This conforms to half of the set dose constraint value [19]. Daily and monthly discharges shall not exceed 1 % and 25 % of annual limit values respectively.

Annual limit values of radioactive discharges into the environmental water and INPP planned annual discharges are summarized in Table 4.1.4. Currently INPP planned annual discharges are insignificant and compose approximately 6.6 % of the permissible limit value.

Table 4.1.4 Summary of licensed conditions of radioactive discharges to the water from the INPP site

Radioactive discharges	Limit, Bq per year	Planned discharges from the INPP	
		Bq per year	% from limit
Cs-137	2.08E+10	1.37E+09	6.6%
Cs-134	2.56E+08	1.69E+07	6.6%
Mn-54	4.37E+09	2.88E+08	6.6%
Co-58	6.35E+08	4.18E+07	6.6%
Co-60	3.70E+10	2.44E+09	6.6%
Fe-59	8.73E+08	5.75E+07	6.6%
Cr-51	1.32E+09	8.72E+07	6.6%
Zr-95	6.70E+08	4.42E+07	6.6%
Nb-95	9.76E+08	6.43E+07	6.6%
I-131	8.64E+09	5.70E+08	6.6%
Sr-89	5.29E+08	3.49E+07	6.6%

Sr-90	7.94E+08	5.23E+07	6.6%
H-3	8.73E+12	5.76E+11	6.6%
Total	**8.81E+12**	**5.81E+11**	**6.6%**

The current permit to discharge radioactive substances into the environment is valid until the end of 2010 and will have to be renewed during performance of the proposed economic activity. Also the current permit does not contain limit activities for all radionuclides, planned to be discharged during the proposed economic activity. The list of discharged radionuclides and corresponding values of limit discharges will have to be updated in the renewed permit.

4.1.5.2.2 Radiological Impact of Forecasted Radioactive Discharges into the Environmental Water

Radioactive substances, discharged into the environmental water, may determine contamination of environmental components and exposure of inhabitants and other live organisms. According to requirements of the normative document [20], two main principles must be considered in the radiological environmental impact assessment:

- When assessing radiological environmental impact of a nuclear object, there is a principle that if security measures ensure sufficient inhabitant safety, they are sufficient also for safeguarding the environment and natural resources (paragraph 5);
- Doze assessment is performed gradually: firstly the simplest especially conservative model is applied that does not assess radionuclide dispersion in the environment. If results, received when applying the conservative model, are not satisfactory, general models are applied, and universally approved indices of radionuclide dispersion, human lifestyle and nutrition are used as basis. The most exact results are received when applying models, characteristic of the location, when real radionuclide dispersion and exposure pathways and peculiarities of lifestyle and nutrition of real critical groups of inhabitants are taken into consideration, and real indices, characteristic of the location, of radionuclide dispersion in the atmosphere, hydrosphere and lithosphere (Annex 1, paragraph 3) are used as basis.

Environmental impact of radionuclides, discharged from INPP equipment to the environmental water (i.e. Lake Druksiai together with service water) may be assessed applying provisions of Annex 3 of the normative document [20]. According to these provisions, exposure of members of the critical group of inhabitants of the INPP environment, determined by radioactive discharges into the environmental water may be calculated using dose conversion factors. These dose conversion factors, determined for certain radionuclides, assess the relation between long-term discharge of a separate radionuclide into the environment and annual effective dose of exposure of a member of a critical inhabitant group. Two critical inhabitant groups were analyzed when determining dose conversion factors of discharges into the water: fishermen and gardeners. Radionuclide dispersion in the water ecosystem was designed with regard to radionuclide dilution, sedimentation, bioaccumulation and accumulation in littoral soil. When assessing dose of critical group members, the following factors were taken into consideration:

- In case of fishermen – external exposure, determined by radionuclides in the lake water and littoral soil, and internal exposure due to feeding on fish;
- In case of gardeners – external exposure due to watered soil surface and internal exposure due to feeding on food products, grown in the watered ground and due to inhalation of soil particles, raised to the air.

Annual effective dose of critical group members E due to radioactive discharges to the water is calculated in the following way:

$$E = \sum_j Q_j \times DCF_j ,$$

Where:

Q_j – annual activity of radionuclide j, discharged into the water, Bq;

DCF_j – dose conversion factor for activity unit of radionuclide j, discharged into the environmental water, Sv/Bq [20];

Dose conversion factors are not given for radionuclides Fe-55, Ni-59, Ni-63, Nb-94, Tc-99, U-235 and U-238 in the normative document [20]. In the analogous project of stages of the final shutdown of unit 1 reactor and SNF defuelling (U1DP0), dose conversion factors for missing radionuclides were derived from known [20] dose conversion factors and ICRP-72 [21] determined dose coefficients for radionuclide insertion after its ingestion. Conversion factor derivation methodology and calculated dose conversion factors for missing radionuclides are discussed in detail in document [17]. Conversion factors, derived in the INPP decommissioning project U1DP0, are used also in this environmental impact assessment. Dose conversion factors for discharges into the water, used in calculations, are presented in Table 4.1.5.

Table 4.1.5 Dose conversion factors of radionuclides, discharged into the environmental water from the Ignalina NPP

Radionuclide	**Dose conversion factor, Sv/Bq**	**Reference *)**
Co-60	1.20E-15	LAND 42-2007
C-14	3.10E-15	LAND 42-2007
Mn-54	8.20E-17	LAND 42-2007
Fe-55	1.20E-16	U1DP0
Co-58	2.60E-17	LAND 42-2007
Ni-59	2.20E-17	U1DP0
Ni-63	5.30E-17	U1DP0
Nb-94	6.00E-16	U1DP0
Cs-137	2.40E-15	LAND 42-2007
Sr-90	1.90E-15	LAND 42-2007
Tc-99	1.20E-16	U1DP0
I-129	3.60E-15	LAND 42-2007
Cs-134	7.40E-15	LAND 42-2007
Pu-241	1.40E-16	LAND 42-2007
U-235	9.78E-17	U1DP0
U-238	9.36E-17	U1DP0
Pu-238	8.50E-17	LAND 42-2007
Pu-239	5.20E-16	LAND 42-2007
Pu-240	5.30E-16	LAND 42-2007
Am-241	1.10E-15	LAND 42-2007
Cm-244	4.70E-16	LAND 42-2007

*) In the table: “LAND 42-2007” – dose conversion factor values from the normative document [20], “U1DP0” – dose conversion factor values, determined in the environmental impact assessment report of the

defueling phase of the INPP unit 1 decommissioning project [18]. Dose conversion factors for U-235 and U-238 are calculated according to methodology provided in [18].

Annual exposure (annual effective doses) of a member of the critical inhabitant group of the INPP environment, determined by radioactive discharges into the environmental water due to proposed economic activity, is summarized in Figure 4.1.3. Contribution of separate radionuclides to the annual exposure is detailed in Table 4.1.6.

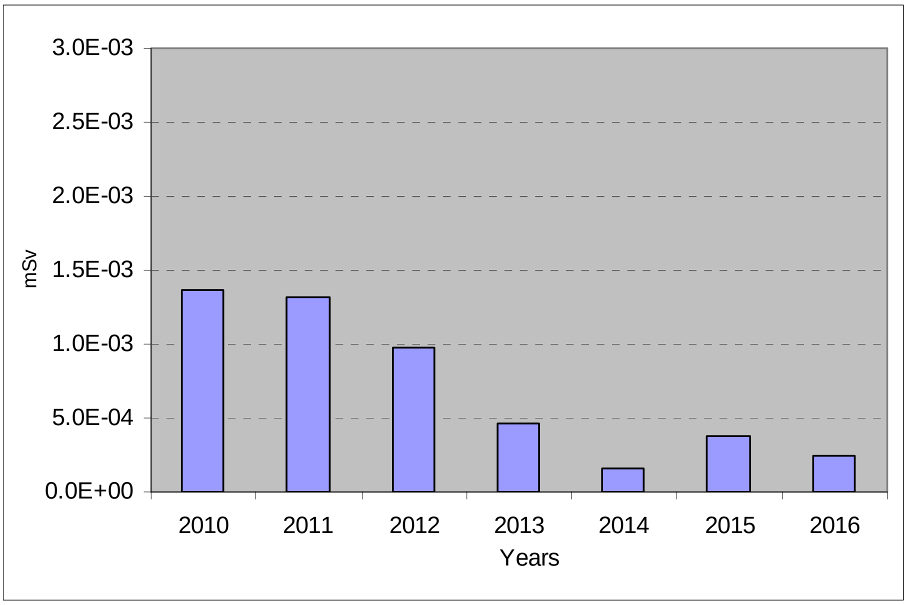

Figure 4.1.4 Annual effective dose (mSv) due to planned radioactive discharges to the environmental water of the proposed economic activity

Table 4.1.6 Annual effective dose to critical group members determined by separate radionuclides (mSv) due to planned radioactive discharges to the environmental water of the proposed economic activity

Radionuclides	Years						
	2010	2011	2012	2013	2014	2015	2016
Co-60	3.93E-05	7.72E-05	3.59E-04	3.64E-05	3.65E-05	5.37E-05	3.53E-05
C-14	5.51E-07	1.26E-06	7.22E-06	7.81E-07	8.99E-07	1.52E-06	1.14E-06
Mn-54	2.32E-06	2.31E-06	4.28E-06	2.77E-07	1.40E-07	1.06E-07	3.53E-08
Fe-55	1.63E-05	2.82E-05	1.06E-04	1.03E-05	9.14E-06	1.19E-05	6.88E-06
Co-58	3.89E-08	2.52E-09	1.67E-10	1.25E-12	4.05E-14	1.96E-15	4.11E-17
Ni-59	8.23E-10	1.84E-09	1.06E-08	1.17E-09	1.33E-09	2.19E-09	1.64E-09
Ni-63	4.72E-07	1.05E-06	5.97E-06	6.40E-07	7.26E-07	1.20E-06	8.97E-07
Nb-94	4.26E-08	9.54E-08	5.54E-07	6.06E-08	6.90E-08	1.13E-07	8.51E-08
Cs-137	3.14E-04	3.67E-04	1.84E-04	1.84E-04	5.88E-05	1.86E-04	1.36E-04
Sr-90	1.50E-06	1.78E-06	1.01E-06	8.75E-07	3.07E-07	8.79E-07	6.44E-07
Tc-99	6.48E-09	7.87E-09	4.61E-09	4.07E-09	1.46E-09	4.28E-09	3.21E-09
I-129	1.74E-09	2.07E-09	1.07E-09	1.09E-09	3.55E-10	1.15E-09	8.64E-10
Cs-134	9.91E-04	8.44E-04	3.09E-04	2.26E-04	5.25E-05	1.22E-04	6.51E-05
Pu-241	1.62E-07	5.36E-07	1.74E-06	6.21E-08	3.47E-07	5.70E-08	4.08E-08
U-235	2.02E-14	7.00E-14	2.39E-13	8.94E-15	5.20E-14	9.03E-15	6.77E-15

Radionuclides	Years						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
U-238	5.88E-13	2.05E-12	6.98E-12	2.60E-13	1.53E-12	2.62E-13	1.97E-13
Pu-238	1.09E-09	3.75E-09	1.26E-08	4.71E-10	2.72E-09	4.69E-10	3.49E-10
Pu-239	1.80E-09	6.28E-09	2.14E-08	7.96E-10	4.66E-09	8.01E-10	6.01E-10
Pu-240	4.38E-09	1.52E-08	5.17E-08	1.95E-09	1.13E-08	1.97E-09	1.47E-09
Am-241	2.47E-08	9.78E-08	3.61E-07	1.40E-08	8.66E-08	1.54E-08	1.16E-08
Cm-244	1.63E-09	5.45E-09	1.79E-08	6.44E-10	3.61E-09	6.04E-10	4.36E-10
Total:	**1.37E-03**	**1.32E-03**	**9.80E-04**	**4.60E-04**	**1.60E-04**	**3.77E-04**	**2.46E-04**

As it may be seen from the presented assessments, the biggest exposure, determined by radioactive discharges to the water of the proposed economic activity, should be in the beginning of project execution, in 2010–2011. The maximum annual effective dose consists of approximately 1.4 µSv. Discharges of radioactive caesium (Cs-137, Cs-134) determine the biggest contribution to the exposure dose. In later years, in 2012–2016, doses will decrease and will not exceed 1 µSv.

The impact of four radionuclides (Fe-55, Co-60, Cs-134 and Cs-137) dominates in the annual radiation dose due to discharges into the environmental water of the proposed economic activity, see Figure 4.1.4. Contribution of other radionuclides in the annual radiation dose is insignificant and constitutes approximately 1–2%.

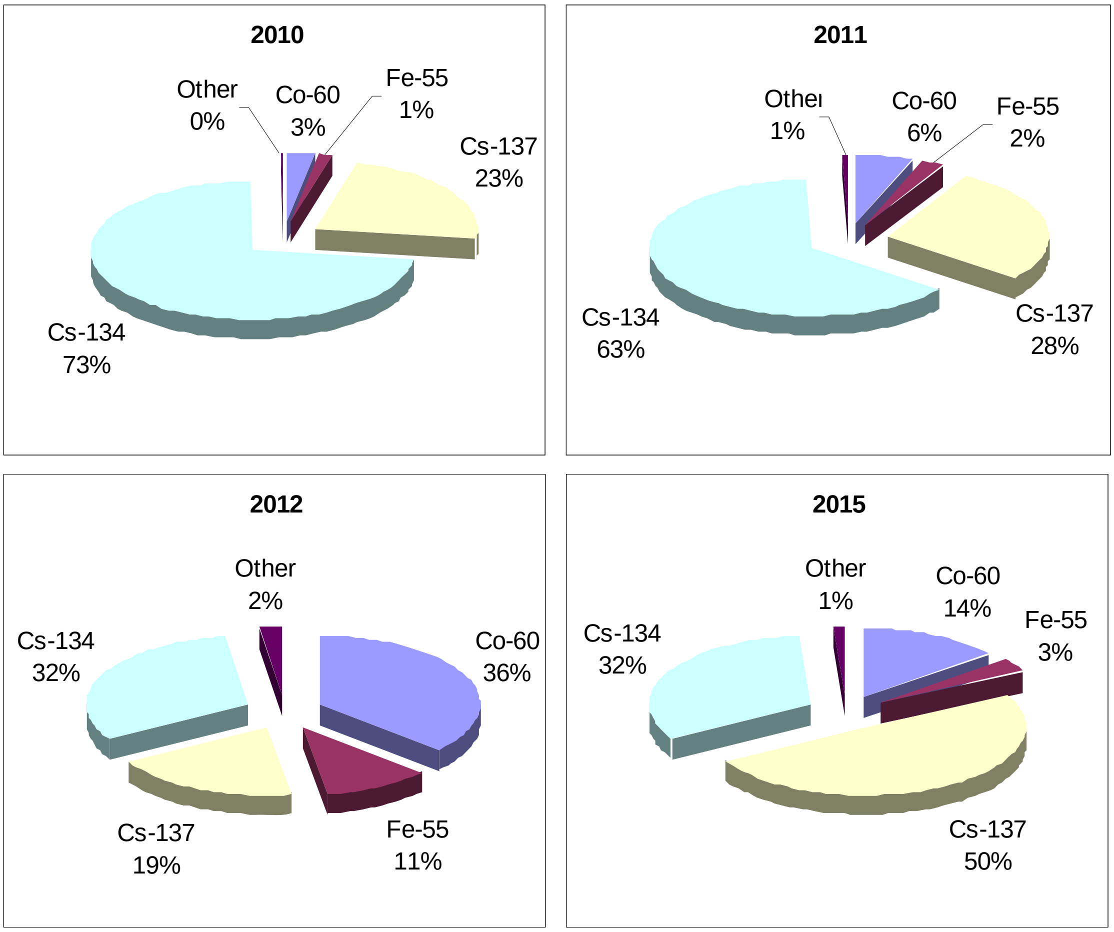

Figure 4.1.5 Contribution of separate radionuclides in the annual effective dose due to planned radioactive discharges into the environmental water of the proposed economic activity

4.1.5.3 Impact Mitigation Measures for Radioactive Contamination of the Environmental Water

Exclusive non-radioactive contamination impact mitigation measures for environmental water, related with the proposed economic activity, are not planned. Impact of radioactive contamination of the environmental water, determined by implementation of the proposed economic activity, is small. Annual effective dose of a member of a critical inhabitant group of the INPP environment, determined by radioactive discharges to the environmental water, will not exceed 1.4 μSv. Radioactive discharges to the water from the INPP site are limited by the Permission for the Emission of Radioactive Material into Environment [18]. The permit is valid until 31 December 2010. During permit renewal, it will be possible to take into account actual design solutions of the proposed economic activity, updated during the preparation of the technical design of the proposed economic activity.

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4.2 Environment Air

4.2.1 Information about the site

The region concerned is located in the continental East Europe climate area. One of the main features of the climate in the region is the fact that no air masses are formed over this area. Cyclones are mostly connected with the polar front and determine continuous movement of air masses. The cyclones formed over the medium latitudes of the Atlantic Ocean move from the west towards the east through Western Europe and the INPP region is often located at the intersection of the paths of the cyclones bringing humid maritime air. The variation of maritime and continental air masses is frequent, therefore the climate of the region can be considered as a transient climate from the maritime climate of Western Europe to the continental climate of Eurasia.

In comparison with other Lithuanian areas, the INPP region is characterized by bigger variations of air temperature over the year, colder and longer winters with abundant snow cover, and warmer, but shorter summers. Average precipitation is also higher [1].

Monthly and annual averages of precipitation for the INPP region are given in the Table 4.2.1.

Table 4.2.1 Monthly and annual averages of precipitation (mm) for the INPP region [2 - 4]

Meteorological station and observation period	Month (s)												Total for months		
	January	February	March	April	May	June	July	August	September	October	November	December	Jan.-Dec.	Nov.-Mar.	Apr.-Oct.
Dukstas, 1961–1990	32	25	28	43	58	69	75	66	64	50	42	40	592	167	425
Utena, 1961–1990	39	31	37	47	53	69	73	75	66	50	57	53	650	217	433
Zarasai, 1961–1990	45	36	39	42	59	72	75	66	66	55	60	56	671	236	435
INPP, 1988–1999	41	41	46	33	55	84	60	64	70	66	58	57	676	244	432
INPP, 2000–2008	46	40	42	37	65	72	63	77	37	67	54	38	639	221	418

Average annual amount of precipitation around INPP region is 658 mm. About 65 % of all precipitation takes place during the warm period of the year (April–October), and about 35 % during the cold period (November–March).

Western and southern winds dominate. The strongest winds are from west and south-east. The average annual wind speed is about 3.5 m/s, and maximal (gust) speeds can reach 28 m/s. No-wind conditions are observed on average of 6 % of the time and last no more than one day (24 hours) in the summer, and no more than two days in the winter [1].

The wind rose at INPP region is based on local wind measurements [3, 4] and is presented in Figure 4.2.1.

Winds with speeds below 7 m/s dominate – recorded events constitute more than 90 % of the total number of observations. Recorded events with wind speeds above 10 m/s are not frequent – less than 10 events per year.

Calculated average wind pressure is 0.18 kPa and pulsation component of wind load is 0.12 kPa. With the reliability coefficient 1.4, calculated value of uniform wind load is 0.42 kPa and extreme wind load (with frequency 1 per 10 000 years) is 1.05 kPa with the reliability overloading coefficient 2.5 [1].

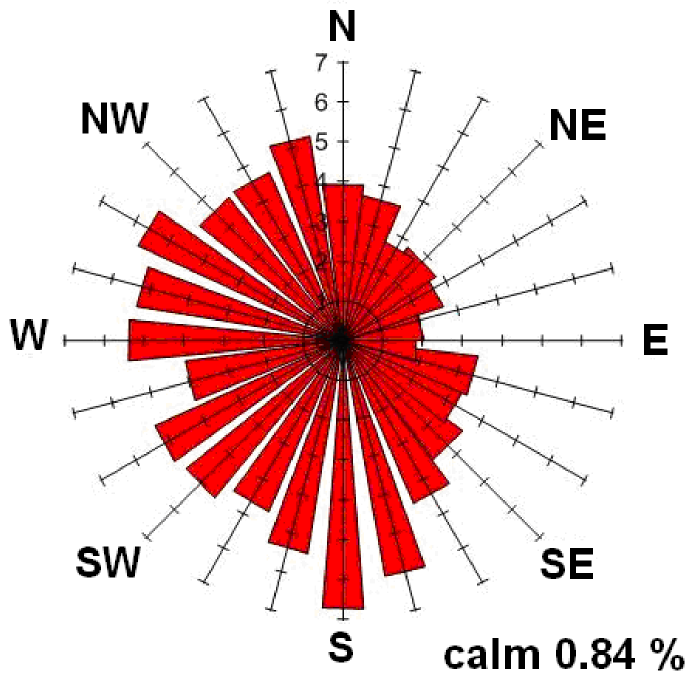

Figure 4.2.1 Wind rose at the INPP region

Monthly average temperatures in the INPP region are given in the Table 4.2.2.

Table 4.2.2 Monthly average temperatures (°C) for the INPP region [4, 7]

Meteorological station and observation period	Month												Average per year
	January	February	March	April	May	June	July	August	September	October	November	December	
Dukstas, 1961–1990	-6.8	-5.9	-1.9	5.2	12.1	15.5	16.8	15.9	11.2	6.2	0.9	-3.8	5.5
Utena, 1961–1990	-6.0	-5.2	-1.2	5.5	12.2	15.6	16.8	15.9	11.4	6.6	1.4	-3.2	5.8
INPP, 1988–1999	-2.5	-2.2	0.3	6.6	12.4	16.5	17.9	16.5	11.3	6.0	-0.1	-3.1	6.6
INPP, 2000–2008	-3.1	-5.0	0.2	7.2	12.4	15.7	18.8	17.4	12.2	7.0	1.8	-1.9	6.9

Average calculated air temperatures of the coldest five-day period are –27 °C. Absolute maximum of recorded temperature is 36 °C and absolute minimum is –40 °C.

4.2.2 Non-Radiological Impact

4.2.2.1 Non-Radioactive Contamination Sources of Environment Air

Release of non-radioactive contamination from INPP site into atmosphere air is limited according to conditions, set in the permission for Integrated Prevention and Control [6]. Information about actual releases of contaminants into environment air in 2006 and permitted releases of contaminants in 2007–2009 is presented in this document. Quantities of permitted releases of contaminants and conditions of releases are established, based on SE "Ignalina NPP" Environment Impact Assessment Report for environment air [7]. Contamination permission has to be renewed till 2010.

Quantities of the most important INPP released contaminants, permitted to be released, are presented in [6] Table 4.2.3.

Table 4.2.3. Quantities of carbon monoxide (CO), nitrogen oxide (NO_X), solid particles and sulfur dioxide (SO_2), permitted to be released into atmosphere by INPP

Contaminant	Contaminant source group	Contaminant code	Permissible contamination 2007-2009, kg/year
CO	A	177	99 652
	B	5917	31
	C	6069	33
NO_X	A	250	41 394
	B	5872	10
	C	6044	39
Solid particles	A	6493	74
	B	6486	243
	C	4281	1 671
SO_2	A	1753	822
	B	5897	161

According to the requirements of regulation [8], contaminants, depending on the source of contaminations, are classified into thee groups A, B and C.

Contaminants, escaped during production of heat and power, are included in Group A. Such contamination sources at the INPP site are 12 standby diesel generators and a new steam boiler.

Contaminants, escaped during production processes while burning fuel, are included in Group B (e.g. burning furnace and etc.). The source of contaminants of this group at the INPP site is a furnace, located in the building of centralized repair workshops.

Contaminants, escaped during chemical reactions, are included in Group C. This group includes contaminants, escaped from all the rest stationary contamination sources, present at INPP site, 24 units in total. Majority of these sources are located in centralized repair workshops and equipment base buildings, reactor units 1 and 2, technological nitrogen and oxygen building.

When implementing proposed economic activity, no sources of new non-radioactive releases into environment air will be created. Proposed economic activity (i.e. implemented works, their performance technology and etc. see Chapter 2) mostly will be equivalent to the activity, up till now implemented at INPP under normal operation conditions. Releases into environment air will generate due to operation of auxiliary equipment (e.g. possible releases from existing at INPP centralized repair workshops and etc.) or due to operation of devices, associated with safety assurance for shut down reactors and SF (e.g. testing of periodical standby diesel generators and etc.). Existing contamination conditions will not change.

4.2.2.2 Estimation of Environment Air Non-Radioactive Contamination

Operation, maintenance and repair of the existing INPP systems, performed during proposed economic activity, will be equivalent to activity, performed until now at INPP under normal operation conditions. Activities for isolation of unnecessary systems will also not require equipment or technological processes that would significantly differ from the ones used by INPP until now (e.g. performing works for maintenance and repair of the existing equipment). According to the monitoring results of existing releases from INPP, it is possible to forecast that proposed economic activity will not cause significant releases to environment air, which could impair or significantly change the existing situation in the surroundings of INPP.

Air contamination and its quality in the surroundings of INPP will be determined by other devices, functioning of which upon shutdown of both INPP reactors, becomes necessary. Main sources of non-radioactive releases into air will become new steam boiler [9] and new heat boiler [10]. It is estimated to keep the existing heat boiler in reserve, and use it only in exceptional cases, when the heat, produced by a new boiler, will not satisfy the existing needs. Small releases will be caused by new radioactive waste incineration facility [11]. Also, in certain periods, releases may occur during performance of dismantling of INPP facilities, which are performed following certain INPP decommissioning projects, e.g. B9-0 [12] and etc. Impact of these sources to environment air is assessed in impact assessments of certain new facilities or activities.

4.2.2.3 Environment Air Non-Radioactive Contamination Impact Mitigation Measures

No special and specifically related to this proposed economic activity impact mitigation measures for non-radioactive air contamination are foreseen. Amount of non-radioactive pollution releases from INPP site into atmosphere is limited according to criteria defined in national and European Union legislation [5], and according to conditions established in the permission for Integrated contamination prevention and control [6]. Permission for contamination has to be renewed till 2010. When renewing the permission, it will be necessary to take into consideration specific design solutions for proposed economic activity, specified during preparation of design for the proposed economic activity.

4.2.3 Radiological Impact

4.2.3.1 Sources of Radioactive Contamination of Environment Air

Implementing proposed economic activity, radioactive releases into environment air will be generated due to:

- Operation of systems, remaining after Unit 2 reactor final shutdown, including periodic testing, maintenance and repairs;
- Modification and isolation of systems, operated and no longer operated after Unit 2 reactor final shutdown;
- SF transfer from Unit 2 reactor into fuel storage pools;
- SF loading from Unit 2 reactor storage pools into dry storage casks;
- Specific activities, such as water drainage from some circuits, including main circulation circuit and associated circuit (MCC+ PCS), also from decontamination by of washing and SF defueling machine;
- Radioactive waste retrieval and primary treatment activities while:
  - Handling spent ion-exchange resins, perlite and sediments,

  - Handling miscellaneous types of liquid radioactive waste,
  - Handling miscellaneous types of solid radioactive waste;
- Radioactive waste storage, transfer and final treatment.

Implementation of proposed economic activity is planned for years 2010–2016. More detailed description of activities and technology, work implementation priorities and estimated schedule for implementation are presented in Chapter 1 and 2. Radioactive releases will occur from Unit 2 reactor and radioactive waste management facilities, located at INPP site. Radionuclides will be released via ventilation pipes of units and ventilation pipes of radioactive waste processing facilities.

4.2.3.2 Estimation of Radioactive Contamination of Environment Air and Radiological Impact

4.2.3.2.1 Estimated radioactive releases into environment air

Preparing project of INPP decommissioning for Unit 1 reactor final shutdown and SF defueling stages [13], detailed assessments of probable radioactive contamination of Unit 1 reactor facilities, technological operations for decommissioning and radioactive releases into environment air were performed. These assessments of releases were also used during performance of Environment Impact Assessment and when preparing EIA Report for Unit 1 decommissioning project for defueling phase [14].

Analogical project for Unit 2 reactor final shutdown and SF defueling phase is only being prepared, and there are no evaluations of radioactive contamination, technological operation for decommissioning and radioactive releases. Therefore, radioactive releases into environment air, estimated for proposed economic activity, were assessed following evaluations, performed for Unit 1 reactor, i.e. it was assumed that:

- Radioactive contamination of facilities and systems of Unit 2 after reactor shutdown will be equivalent to contamination, assessed for Unit 1 reactor shutdown;
- As estimated in final INPP decommissioning plan, equivalent decommissioning operations by applying equivalent technologies will be performed for Unit 2, as have been performed or are planned to perform for Unit 1;
- Differences between releases from Unit 2 and Unit 1 may occur only due to more intensive schedule of decommissioning works at Unit 2 reactor. It is estimated that majority of decommissioning operations at Unit 2 reactor will be performed earlier after final shutdown of the reactor.

Thus, annual releases, assessed for Unit 1 reactor final shutdown and SF defueling phase [13], [14], were recalculated according to schedule of estimated works for Unit 2 reactor final shutdown and SF defueling phase:

$$N_{j2,T} = N_{j2.0} \times \exp\left(-\lambda_j \times T_2\right),$$

where:

$N_{j2,T}$ – annual release of radionuclide j due to decommissioning activities implemented at Unit 2 in year T_2 after Unit 2 reactor final shutdown;

λ_j – radioactive fission of radionuclide j.

Initial activity of individual decommissioning actions (i.e. activity is re-calculated for the date of reactor final shutdown) is calculated:

$$N_{j2,0} = N_{j1.0} = {N_{j1,T}}\Big/{\exp(-\lambda_j \times T_1)},$$

where:

$N_{j1,T}$– annual release of radionuclide j due to decommissioning activities implemented at Unit 1 in year T_1 after Unit 1 reactor final shutdown.

Estimated radioactive releases into atmosphere air due to implementation of proposed economic activity are summarized in Table 4.2.2 below. Annual content of radionuclide releases is detailed in Table 4.2.4.

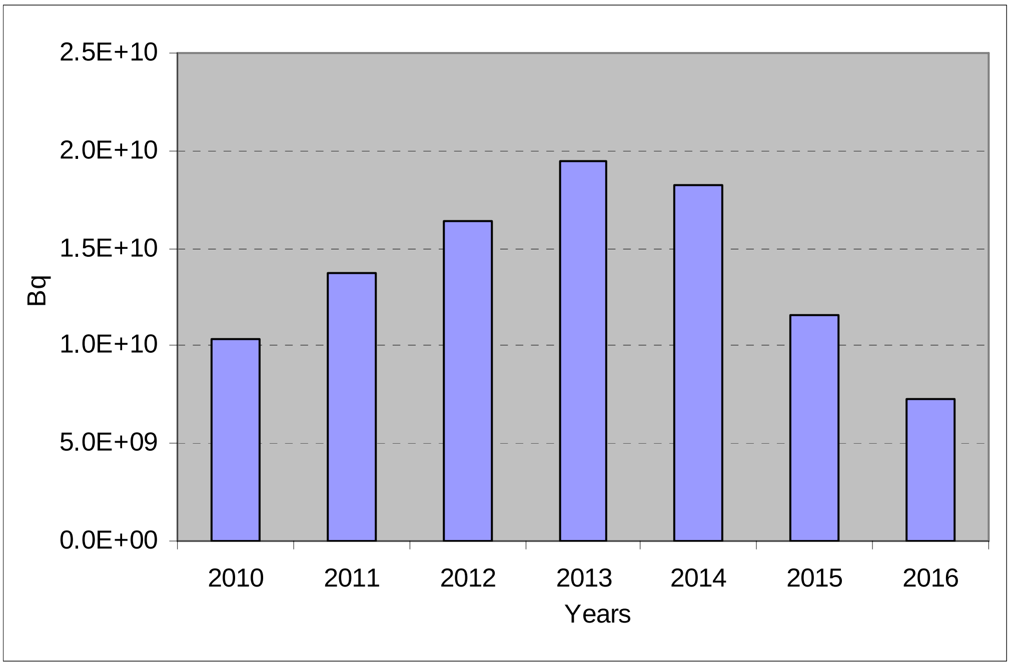

Table 4.2.2. Estimated annual radioactive releases (Bq) into atmosphere air due to implementation of proposed economic activity

Table 4.2.4. Estimated annual radionuclide releases (Bq) into atmosphere air due to proposed economic activity

Radionuclides	Years						
	2010	2011	2012	2013	2014	2015	2016
Co-60	1.03E+09	1.81E+09	2.82E+09	3.59E+09	3.59E+09	2.46E+09	1.62E+09
C-14	5.59E+06	1.14E+07	1.80E+07	2.60E+07	2.99E+07	2.42E+07	1.82E+07
Mn-54	8.88E+08	7.91E+08	1.86E+08	9.38E+07	4.77E+07	2.75E+07	9.15E+06
Fe-55	4.27E+09	6.59E+09	1.10E+10	1.25E+10	1.10E+10	6.42E+09	3.72E+09
Co-58	4.73E+07	2.73E+06	4.08E+04	1.34E+03	4.34E+01	1.61E+00	3.38E-02
Ni-59	1.17E+06	2.35E+06	1.36E+07	2.10E+07	2.39E+07	1.60E+07	1.20E+07
Ni-63	2.80E+08	5.55E+08	1.67E+09	2.51E+09	2.84E+09	2.01E+09	1.50E+09
Nb-94	2.23E+06	4.46E+06	2.59E+07	4.00E+07	4.55E+07	3.05E+07	2.29E+07
Cs-137	1.88E+09	2.24E+09	4.28E+08	4.36E+08	4.36E+08	4.60E+08	3.37E+08
Sr-90	1.13E+07	1.37E+07	2.61E+06	2.65E+06	2.64E+06	2.78E+06	2.04E+06
Tc-99	7.75E+05	9.63E+05	1.88E+05	1.95E+05	1.99E+05	2.15E+05	1.61E+05
I-129	6.91E+03	8.42E+03	1.65E+03	1.72E+03	1.76E+03	1.90E+03	1.43E+03
Cs-134	1.92E+09	1.67E+09	2.33E+08	1.73E+08	1.27E+08	9.76E+07	5.23E+07
Pu-241	1.89E+07	6.64E+07	9.82E+06	8.54E+06	8.33E+06	7.72E+06	5.52E+06

Radionuclides	Years						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
U-235	3.36E+00	1.24E+01	1.93E+00	1.76E+00	1.80E+00	1.75E+00	1.31E+00
U-238	1.02E+02	3.80E+02	5.90E+01	5.38E+01	5.51E+01	5.36E+01	4.02E+01
Pu-238	2.08E+05	7.65E+05	1.18E+05	1.07E+05	1.09E+05	1.05E+05	7.79E+04
Pu-239	5.63E+04	2.10E+05	3.25E+04	2.96E+04	3.03E+04	2.95E+04	2.21E+04
Pu-240	1.35E+05	4.98E+05	7.73E+04	7.05E+04	7.21E+04	7.02E+04	5.27E+04
Am-241	3.69E+05	1.53E+06	2.59E+05	2.49E+05	2.66E+05	2.70E+05	2.02E+05
Cm-244	5.65E+04	2.01E+05	3.01E+04	2.65E+04	2.60E+04	2.44E+04	1.76E+04
Total:	**1.04E+10**	**1.38E+10**	**1.64E+10**	**1.94E+10**	**1.82E+10**	**1.16E+10**	**7.29E+09**

Presently, radioactive releases to the environment air from INPP site are limited by requirements, determined in permission for radioactive material releases into the environment [15]. Annual limit values for radionuclide releases, which may be released into the environment are identified in the document, and information about estimated future annual radioactive releases from INPP is presented. Requirements for releases into atmosphere air are determined for the total of 39 radionuclides.

Annual limit values of radionuclide releases are determined in such a way that annual effective dose due to releases would not exceed 0.1 mSv. This corresponds to a half of the determined dose constraint value [16]. Annual limit values are determined for releases via main reactor unit ventilation stacks (height of releases 150 m). If factual releases take place in lower heights, before comparing releases of radioactive material with the licensed conditions, they have to be re-calculated [17]. 24 hour releases should not exceed 1 %, and monthly releases should not exceed 25 % of annual limit values.

Summary of licensed conditions for radioactive releases into atmosphere is presented in Table 4.2.5. Currently estimated annual releases from INPP are not great and make about 6.8 % from permitted limit value.

Table 4.2.5. Summary licensed conditions for radioactive releases into atmosphere from INPP site

Radioactive releases	Limit value Bq/year	Estimated releases from INPP	
		Bq/year	**% from limit value**
Noble gas	1.39E+16	9.64E+14	6.9
Aerosols	9.40E+11	9.56E+09	1.0
H-3	2.39E+14	2.43E+12	1.0
C-14	2.27E+11	1.27E+11	55.9
I-131*	9.87E+11	1.00E+11	10.1
Total	**1.41E+16**	**9.66E+14**	**6.8**

* Total value for all molecules, organic and aerosol fractions.

The existing permission for releases of radioactive materials into the environment is valid till the end of 2010 and will have to be renewed during implementation of proposed economic activity. Also, in the existing permission, not all limit values for radionuclides estimated to be released during proposed economic activity are determined. In the renewed permission, list of released radionuclides and limit values for releases will have to be specified.

4.2.3.2.2 Radiological Impact of Estimated Radioactive Releases into Environment Air

Radioactive materials, released into atmosphere and diffused there, may cause contamination of environment components and exposure of population and other living organisms. In compliance with the requirements of regulation [17], two main principles will have to be followed in the radiological environment impact assessment:

- Analyzing radiological impact of the nuclear plant to environment, the principle that if safety measures provide sufficient safety to population, they are also sufficient to provide safety for the environment and natural recourses, is followed (Clause 5);
- Dose assessment is performed gradually: first of all, the simplest, very conservative model is applied, which does not assess dispersion of radionuclides in the environment. If the results obtained by applying conservative model are not sufficient, general models are applied and universally approved radionuclide dispersion, population living and nutrition factors are taken as a basis. The most precise results are obtained by applying location-specific models, based upon real radionuclide dispersion and exposure routs and real living and nutrition characteristics of members of critical group of population and based upon real location-specific factors of radionuclide dispersion in atmosphere, hydrosphere and lithosphere (Appendix 1 Clause 3).

Environment impact by radionuclides, released at INPP facilities into the environment air (via ventilation stacks of units and ventilation stacks in buildings of radioactive waste treatment facilities), may be assessed applying Appendix 3 regulations of regulation [17]. According to these regulations, exposure of members of critical group of population due to radioactive releases from INPP may be calculated using dose factors. These dose factors, determined for a specific radionuclide, assess the relation of long-term releases of a separate radionuclide into the environment and annual effective exposure doses of members of critical group of population. Determining dose factors of releases into atmosphere, a half empirical Gauss model and data of average temperature, wind direction and velocity, cloudiness, precipitation and ground surface characteristics were applied to assess radionuclide dispersion in the environment air. Analyzing dose to members of critical group (farmers), external exposure due to existing in air radionuclides and fallouts of radionuclides on the ground, and ascension of these particles into air, and inner exposure due to respiration of air contaminated by radionuclides and consumption of food products contaminated by radionuclides were taken into consideration.

Annual effective exposure dose of members of critical group of population E due to radioactive releases into the environment air is estimated as follows:

$$E = \sum_j Q_j \times DCF_j \times K_{VS},$$

where:

Q_j – annual activity of radionuclide j released into atmosphere, Bq;

DCF_j – dose factor of radionuclide j released into atmosphere for activity unit, Sv/Bq [17];

K_{VS} – height factor of releases, if height of releases differs from height of the main ventilation stack of the reactor unit. As in the same project for Unit 1 reactor final shutdown and SF defueling phases (U1DP0) [14], height factor of releases is selected conservatively. It is assumed that 95% of releases will occur via 75 m height stack (i.e. height of the currently existing stack of liquid waste treatment installations), and 5% of releases will occur at 10 m height. Thus K_{VS} value equals 5.1.

For radionuclides Fe-55, Ni-59, Ni-63, Nb-94, Tc-99, U-235, U-238, Pu-238, Pu-241 and Am-241 dose factor are not presented in the regulation [17]. In the same project for Unit 1 reactor final shutdown and SF defueling stages (U1DP0), dose factors for missing radionuclides were derived from the known [17] dose factors and ICRP-72 [18] dose factors, determined for insertion of radionuclide upon ingestion. Conversion factor derivation methodology and calculated dose conversion factors for missing radionuclides are discussed in detail in document [14]. Conversion factors, derived in the INPP decommissioning project U1DP0, are used also in this environmental impact assessment. Dose factors used for calculations of releases into air are presented in Table 4.2.6.

Table 4.2.6. Dose factors of radionuclides, released into environment air from Ignalina NPP

Radionuclides	Dose factor, Sv/Bq	Reference *)
Co-60	5.70E-17	LAND 42-2007
C-14	4.40E-19	LAND 42-2007
Mn-54	3.20E-18	LAND 42-2007
Fe-55	5.50E-18	U1DP0
Co-58	1.10E-18	LAND 42-2007
Ni-59	1.10E-18	U1DP0
Ni-63	2.50E-18	U1DP0
Nb-94	2.90E-17	U1DP0
Cs-137	1.20E-16	LAND 42-2007
Sr-90	7.00E-17	LAND 42-2007
Tc-99	5.90E-18	U1DP0
I-129	1.20E-15	LAND 42-2007
Cs-134	8.30E-17	LAND 42-2007
Pu-241	4.40E-17	U1DP0
U-235	7.14E-17	U1DP0
U-238	6.84E-17	U1DP0
Pu-238	3.50E-16	U1DP0
Pu-239	3.80E-16	LAND 42-2007
Pu-240	3.80E-16	LAND 42-2007
Am-241	3.00E-16	U1DP0
Cm-244	1.80E-16	U1DP0

*) In Table: “LAND 42-2007” – dose factor values are taken from the regulation [17], “U1DP0” – INPP Unit 1 decommissioning project for defueling phase, from dose factor values determined in Environment Impact Assessment Report [15]. Dose conversion factors for U-235 and U-238 are calculated according to methodology provided in [15].

Annual exposure dose (annual effective doses) of a member of critical group of population in the INPP region due to radioactive releases from proposed economic activity is summarized in Figure 4.2.3. Detailed contribution of separate radionuclides to annual exposure is presented in Table 4.2.7.

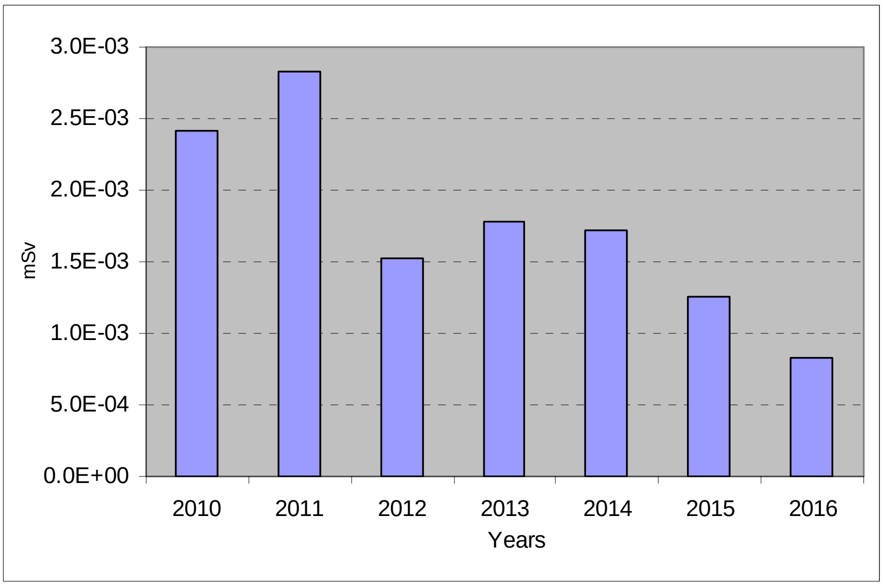

Figure 4.2.3. Annual effective dose (mSv) due to radioactive releases into environment air foreseen as a result of proposed economic activity

Table 4.2.7. Annual effective dose (mSv) to critical group members caused by separate radionuclides due to radioactive releases into environment air foreseen as a result of proposed economic activity

Radionuclides	Years						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Co-60	2.99E-04	5.25E-04	8.21E-04	1.04E-03	1.04E-03	7.15E-04	4.70E-04
C-14	1.25E-08	2.55E-08	4.04E-08	5.84E-08	6.71E-08	5.43E-08	4.07E-08
Mn-54	1.45E-05	1.29E-05	3.04E-06	1.53E-06	7.78E-07	4.48E-07	1.49E-07
Fe-55	1.20E-04	1.85E-04	3.08E-04	3.52E-04	3.10E-04	1.80E-04	1.04E-04
Co-58	2.65E-07	1.53E-08	2.29E-10	7.52E-12	2.43E-13	9.02E-15	1.89E-16
Ni-59	6.59E-09	1.32E-08	7.63E-08	1.18E-07	1.34E-07	8.98E-08	6.73E-08
Ni-63	3.56E-06	7.08E-06	2.13E-05	3.20E-05	3.62E-05	2.56E-05	1.91E-05
Nb-94	3.30E-07	6.60E-07	3.83E-06	5.92E-06	6.73E-06	4.51E-06	3.38E-06
Cs-137	1.15E-03	1.37E-03	2.62E-04	2.67E-04	2.67E-04	2.81E-04	2.06E-04
Sr-90	4.05E-06	4.91E-06	9.32E-07	9.47E-07	9.44E-07	9.92E-07	7.27E-07
Tc-99	2.33E-08	2.90E-08	5.66E-09	5.87E-09	5.99E-09	6.47E-09	4.85E-09
I-129	4.23E-08	5.15E-08	1.01E-08	1.05E-08	1.08E-08	1.16E-08	8.72E-09
Cs-134	8.12E-04	7.06E-04	9.87E-05	7.34E-05	5.36E-05	4.13E-05	2.21E-05
Pu-241	4.23E-06	1.49E-05	2.20E-06	1.92E-06	1.87E-06	1.73E-06	1.24E-06
U-235	1.22E-12	4.53E-12	7.03E-13	6.41E-13	6.56E-13	6.38E-13	4.78E-13
U-238	3.57E-11	1.33E-10	2.06E-11	1.88E-11	1.92E-11	1.87E-11	1.40E-11
Pu-238	3.72E-07	1.37E-06	2.10E-07	1.90E-07	1.94E-07	1.87E-07	1.39E-07
Pu-239	1.09E-07	4.06E-07	6.30E-08	5.74E-08	5.87E-08	5.72E-08	4.29E-08
Pu-240	2.61E-07	9.65E-07	1.50E-07	1.37E-07	1.40E-07	1.36E-07	1.02E-07
Am-241	5.64E-07	2.35E-06	3.96E-07	3.81E-07	4.07E-07	4.13E-07	3.09E-07
Cm-244	5.19E-08	1.85E-07	2.77E-08	2.43E-08	2.39E-08	2.24E-08	1.62E-08
Total:	**2.41E-03**	**2.83E-03**	**1.52E-03**	**1.78E-03**	**1.72E-03**	**1.25E-03**	**8.28E-04**

As seen from the presented assessments, the highest exposure due to releases into environment air foreseen as a result of proposed economic activity should be in the beginning of the project implementation, in 2010–2011. Maximal effective dose is about 2.8 μSv. The greatest contribution to exposure dose is caused by releases of radioactive cesium (Cs-137, Cs-134). In later years, 2012–2016, doses are decrease and range from 1.8–1 μSv. Dose is determined by releases of radioactive Co-60.

In the annual exposure dose of releases into environment air due to proposed economic activity the impact of four radionuclides predominates: Fe-55, Co-60, Cs-134 and Cs-137, see Figure 4.2.4. Contribution of the remaining radionuclides into annual exposure dose is insignificant and is about 1–3%.

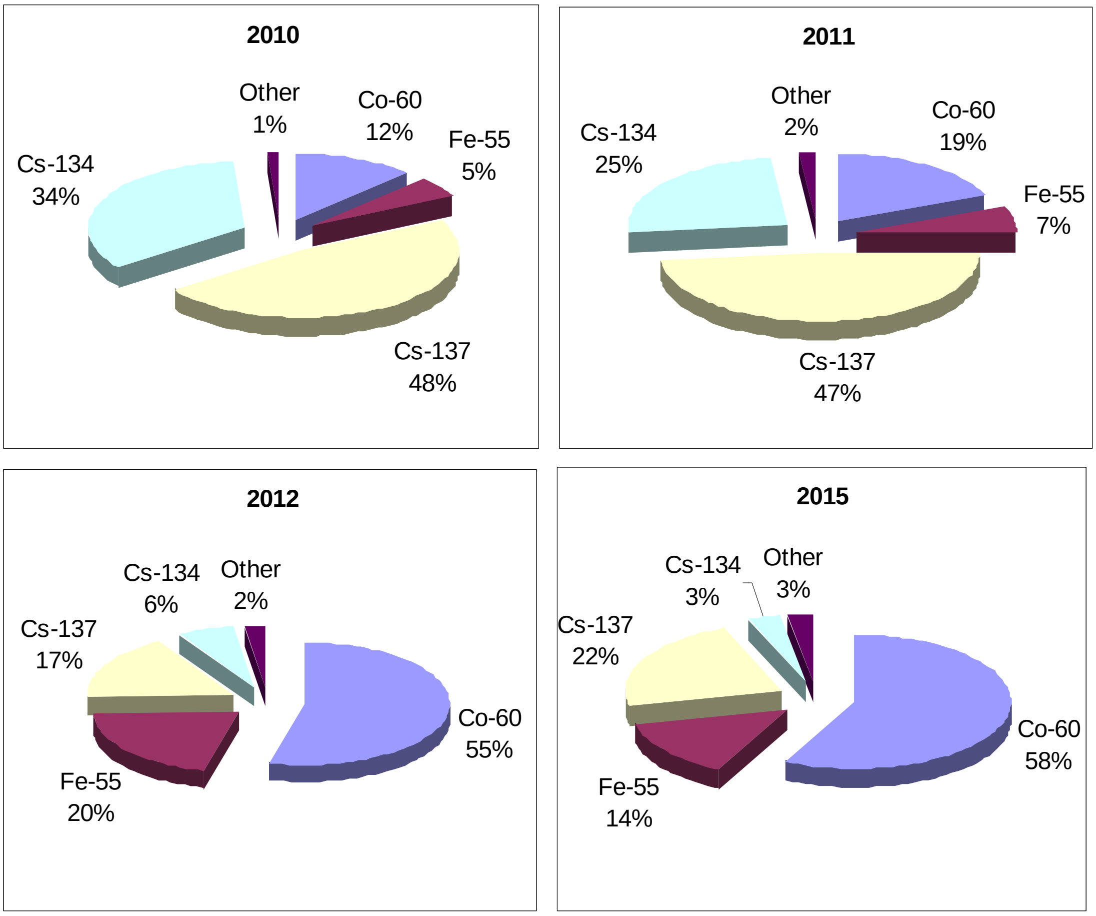

Figure 4.2.4. Contribution of separate radionuclides into annual effective dose due to radioactive releases into environment air foreseen as a result of proposed economic activity

4.2.3.3 Environment Air Radioactive Contamination Impact Mitigation Measures

No specific and particularly associated with this proposed economic activity impact mitigation measures against releases of radioactive contamination into environment air are foreseen. Radioactive air contamination impact, due to implementation of proposed economic activity, is small. Annual effective doze for a member of critical group of population due to radioactive releases into environment air in INPP surroundings will not exceed 2.9 μSv. Radioactive releases into air from INPP site are limited by permission for Radioactive material release into environment [16]. The permission is valid till December 31, 2010. Renewing of the permission will allow considering specific design solutions for proposed economic activity, specified during preparation of technical design for the proposed economic activity.

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4.3 Soil

4.3.1 Information about the site

The area of the INPP site has been changed in the past because of construction and industrial activity, thus natural soil in this area is almost totally absent. The INPP site is almost entirely covered by artificial ground which consists of clay loam with pebble and gravel, sand at places with organic remains. Layer thickness is about 2 m [1, 2].

According to the INPP monitoring program, samples of the soil in the INPP region are continuously monitored. The information on detected radionuclides and their activity is presented in the Table 4.3.1 [3].

Table 4.3.1 Specific activity of the radionuclides in the soil of INPP region

Year	**Specific activity in the soil, Bq/kg**								**Total (except Ra, Th, K)**	
	Cs-137	**Cs-134**	**Mn-54**	**Co-60**	**Sr-90***	**Ra-226**	**Th-228**	**K-40**	**Bq/kg**	**Bq/m^2**
1999	7.89	1.28	0.17	0	<20.0	21.9	33.1	807	9.35	170
2000	5.10	1.50	0.10	0	<20.0	31.4	30.2	618	6.70	339
2001	4.89	1.36	0.08	0	<20.0	42.6	31.9	606	6.34	320
2002	7.02	1.65	0	0	<20.0	45.9	45.2	850	7.36	154
2003	3.70	1.03	0	0	<1.53	22.9	29.3	596	6.26	131
2004	4.98	0.43	0.08	0	2.08	34.2	26.8	549	7.47	158
2005	3.38	0	0	0	1.49	13.8	18.6	462	4.87	31.3
2006	3.38	0	0	0.05	0	22.0	25.6	613	3.43	74.8
2007	2.77	0	0	0	0	19.6	21.5	631	2.77	76.7
2008	3.59	0	0	0	3.27	12.1	16.5	399	6.86	262

* – since 2003 detection methodology of Sr-90 has been improved.

4.3.2 Potential impact

The proposed economic activity will be implemented within the INPP industrial site and will include activities performed inside the Unit 2, radioactive and non-radioactive waste transfer using internal roads of the INPP industrial site and waste management in the appropriate INPP waste management facilities. INPP licensed equipment and INPP work organization and performance procedures in force (coordinated with and approved by the competent authorities, if necessary) will be applied during performance of these works. Proposed economic activity under normal operation conditions does not foresee any actions, which could have an impact on the INPP site ground or ground beyond the border of the INPP site.

4.3.3 Impact mitigation measures

No impact mitigation measures are foreseen for the soil. The proposed economic activity will not impact the soil.

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4.4 UNDERGROUND (GEOLOGY)

4.4.1 Information about the site

The INPP area is located in the western margin of the East European Platform. It is located in the junction zone of two major regional tectonic structures: the Mazur-Belarus Rise and the Latvian Saddle that makes the structural pattern of the area rather complicated. The contemporary relief of the crystalline basement reflects movements over a period of 670 million years. Several tectonic structures (blocks) of the lower order are distinguished in the surface of the Precambrian crystalline basement: the North Zarasai Structural terrace, the Anisimoviciu Graben, the East Druksiai Uplift, the Druksiai Depression (Graben) and the South Druksiai Uplift. The North Zarasai Structural terrace, the Anisimoviciu Graben and the East Druksiai Uplift are related to the Latvian Saddle. The South Druksiai Uplift belongs to the Mazur-Belarus Rise and the Druksiai Depression (Graben) is located within the junction zone of the two aforementioned regional structures [1].

The crystalline basement is buried to a depth of about 720 m from the current ground level. It is comprised of the Lower Proterozoic rocks predominantly of biotite and amphibole composition: gneisses, granite, migmatite, etc. The thickness of the sedimentary cover in the region of the INPP varies in the range of 703–757 m. Pre-Quaternary succession is represented by the Upper Proterozoic Vendian complex, overlain by sediments of the Paleozoic systems. The Vendian deposits are represented by a succession of gravelstone, feldspar-quartz sandstone of different grain size, siltstone and shale. The Paleozoic section comprises the successions of the Lower and Middle Cambrian, the Ordovician, the Lower Silurian and the Middle and Upper Devonian sediments (Figure 4.4.1 and Figure 4.4.2).

The Lower Cambrian is represented by quartz sandstone with inconsiderable admixture of the glauconite, siltstone and shale. The sandstone is of different grain size with the fine-grained and especially fine-grained sandstone predominating. The Middle Cambrian comprises the fine-grained sandstone. The Ordovician is composed of interbedded marlstone and limestone. The Lower Silurian is composed of dolomitic marlstone and dolomite. The Middle Devonian – of gypsum breccia, dolomitic marlstone and dolomite as well as interbeds of the fine-grained and very fine-grained sand and sandstone, siltstone and claystone; the Upper Devonian – of fine-grained and very fine-grained sand and sandstone, interbeds of the siltstone and claystone. The Vendian deposits vary in thickness from 135 to 159 m; the total thickness of the Lower and Middle Cambrian succession reaches 93–114 m, the thickness of the Ordovician varies in a range of 144–153, the Silurian – 28–75 m and the total thickness of the Devonian sediments reaches 250 m [1].

Sub-Quaternary relief of the area is highly dissected by paleoincisions. The thickness of the Quaternary cover varies from 62 up to 260 m.

The Quaternary deposits are of Pleistocene and Holocene age. The area is made up of glacial deposits (till) of the Middle Pleistocene Dzukija, Dainava, Zemaitija and Medininkai Formations, and of the Upper Pleistocene Upper Nemunas Formation (Gruda and Baltija). The intertill glaciofluvial (sand, gravel, cobble, pebble) and glaciolacustrine (fine-grained sand, silt, clay) sediments are detected in the area. The thickness of the intertill deposits varies from 10–15 m up to 25–30 m (Figure 4.4.3). The intersticial deposits are composed of very fine-grained and fine-grained sand, silt and peat (Figure 4.4.5 and Figure 4.4.6). The Holocene deposits are represented by alluvial, lacustrine and bogs sediments. Alluvial sediments are variously grained sands with 1–1.2 m thick organic layers. The lacustrine sediments (fine-grained sand, clay, silt) reach a thickness of 3 m. The thickness of the peat is 5–7 m [1].

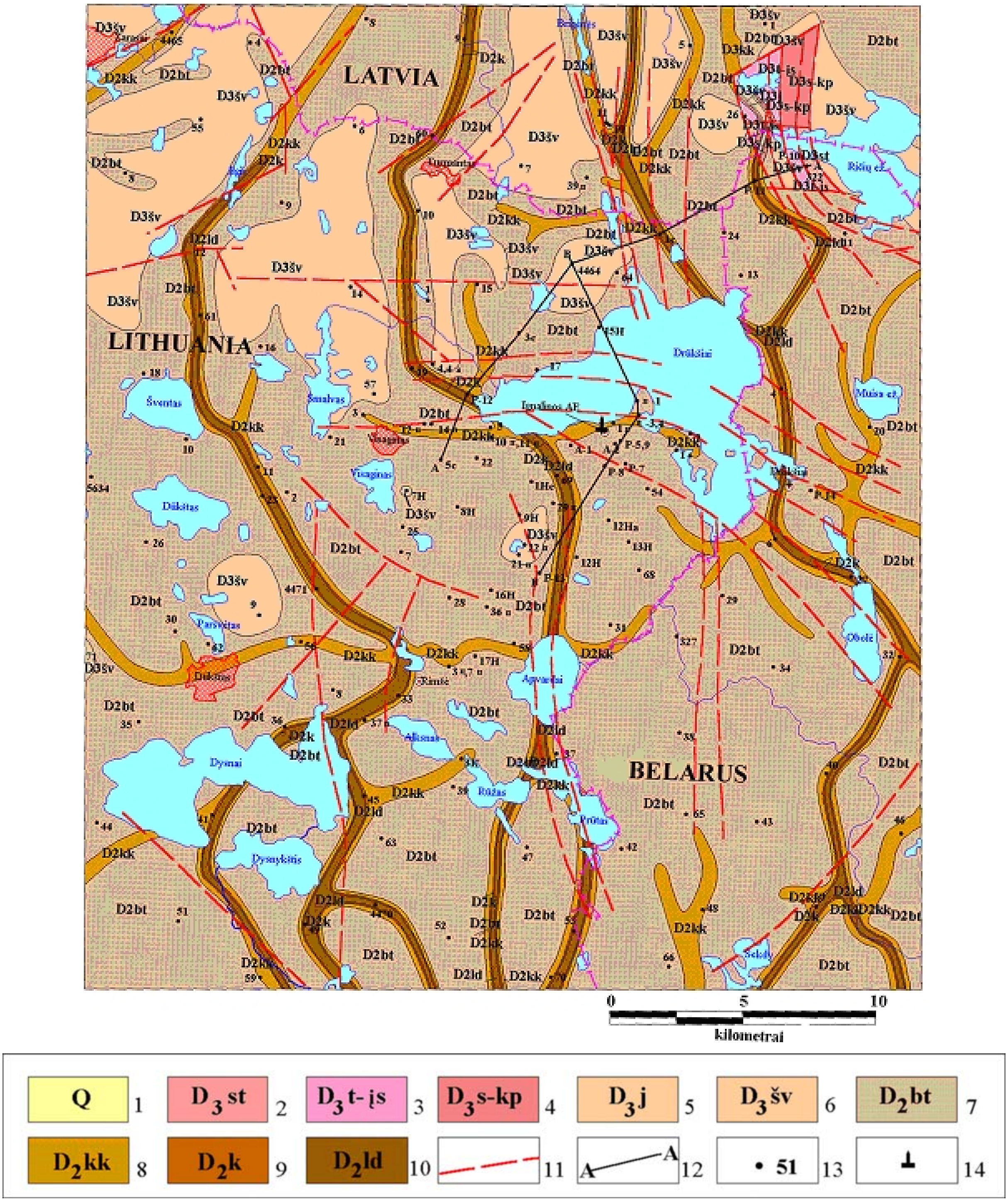
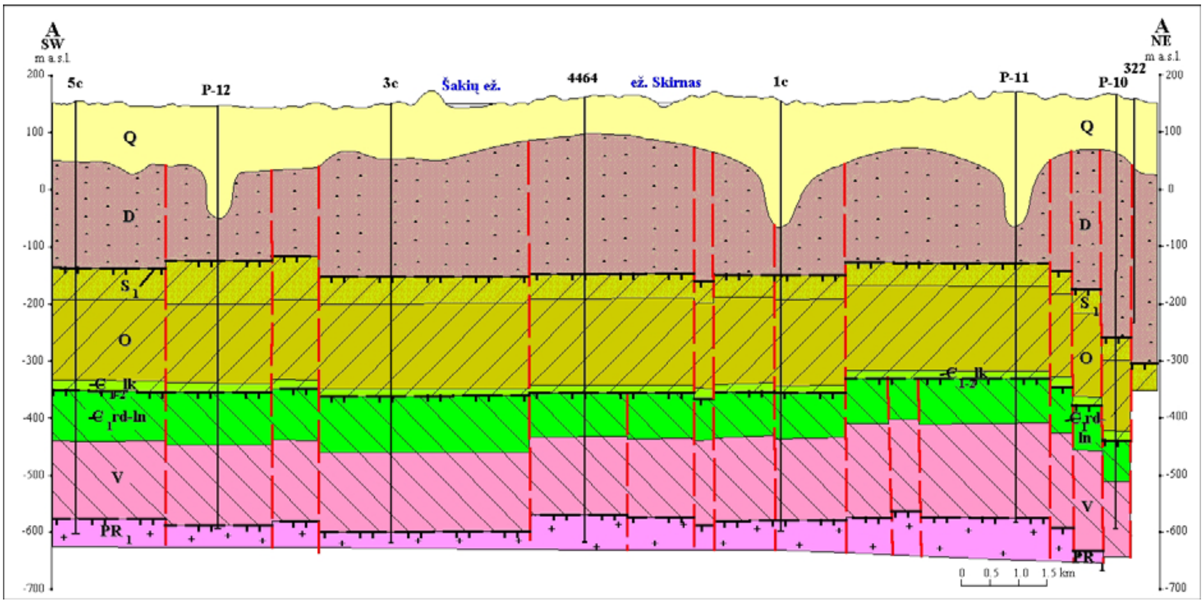


Figure 4.4.1 Pre-Quaternary geological map of the INPP region [1]:

1 – Quaternary deposits (on the sections); Upper Devonian formations: 2 – Stipinai; 3 – Tatula–Istra; 4 – Suosa–Kupiskis; 5 – Jara; 6 – Sventoji; Middle Devonian formations: 7 – Butkunai; 8 – Kukliai; 9 – Kernave; 10 – Ledai; 11 – Fault; 12 –Line of geological-tectonical cross-section; 13 – Borehole; 14 – INPP



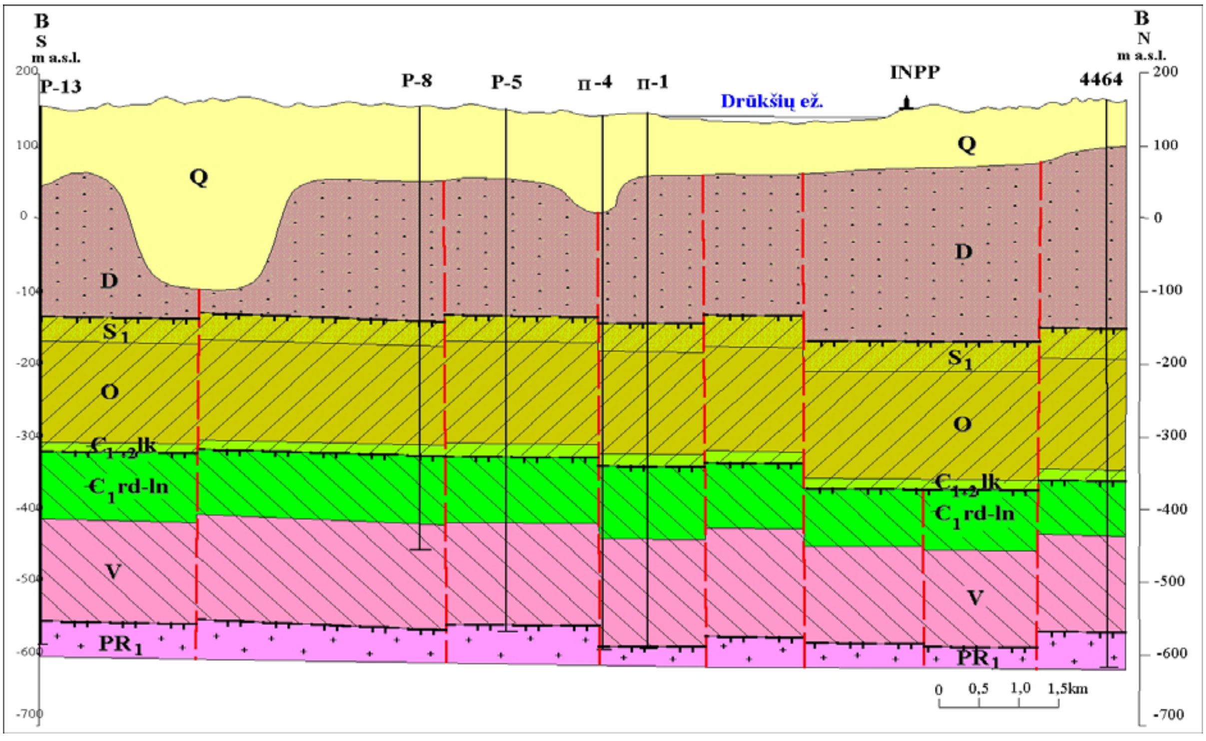


Figure 4.4.2 Geological-tectonic cross-sections (location see in Figure 4.4.3) of the INPP region [1]:

1 – Quaternary: till, sand, silt and clay; 2 – Middle and Upper Devonian: sand, sandstone, siltstone, clay, domerite, dolomite, breccia; 3 – Lower Silurian: domerite, dolomite; 4 – Ordovician: limestone, marl; 5 – Lower and Middle Cambrian Aisciai Series Lakajai Formation: sandstone; Lower Cambrian Rudamina–Lontova Formations: argillite, siltstone, sandstone; 7 – Vendian: sandstone, gravelite, siltstone, argillite; 8 – Lower Proterozoic: granite, gneiss, amphibolite, mylonite; Structural complexes: 9 – Hercynian; 10 – Caledonian; 11 – Baikalian; 12 – Crystalline basement; 13 – Border between systems; 14 – Border between complexes; 15 – Fault; 16 – Borehole

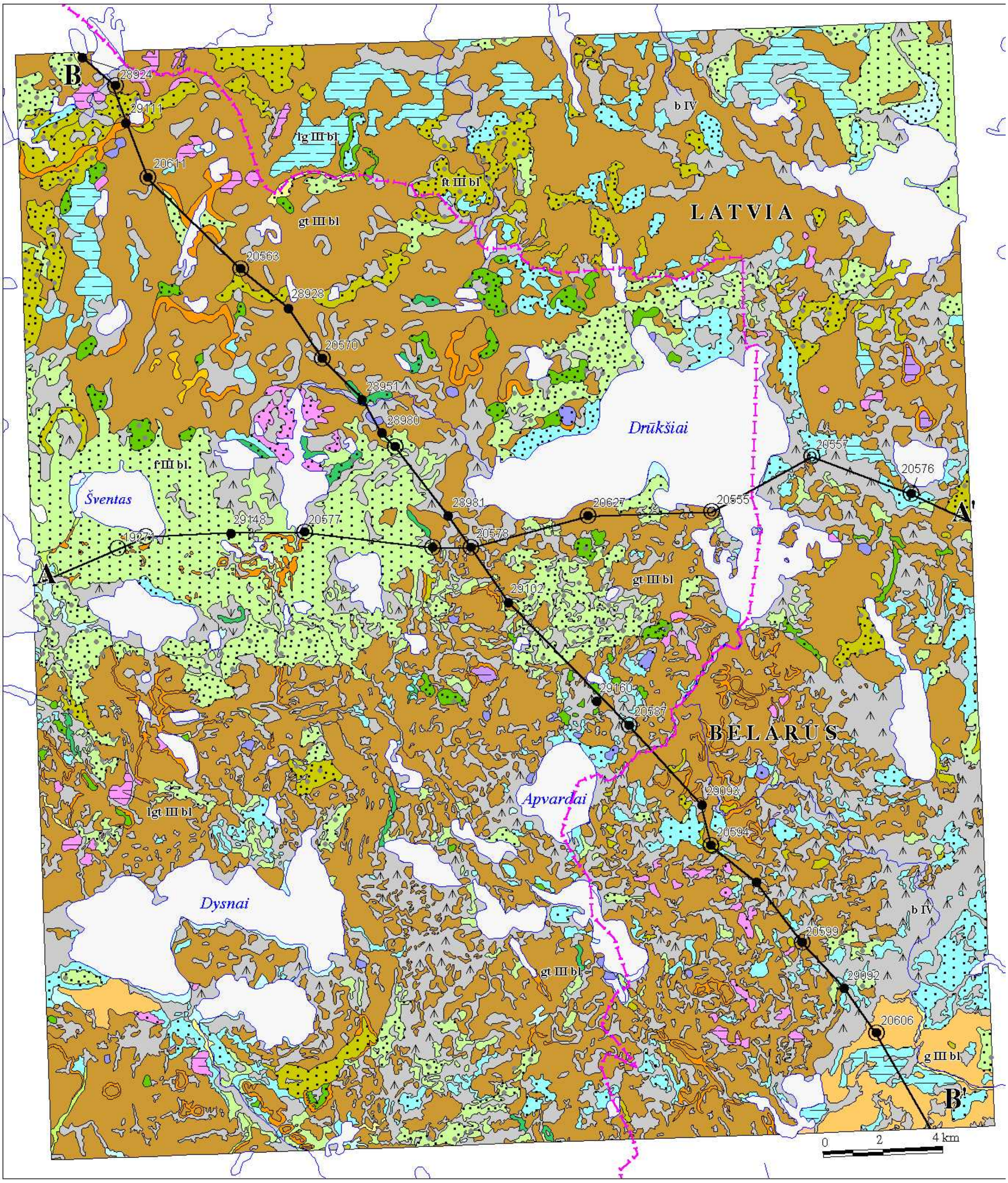


Figure 4.4.3 Quaternary geological map of the INPP area (original scale 1:50 000, author: R. Guobyte [1]); legend see in Figure 4.4.4

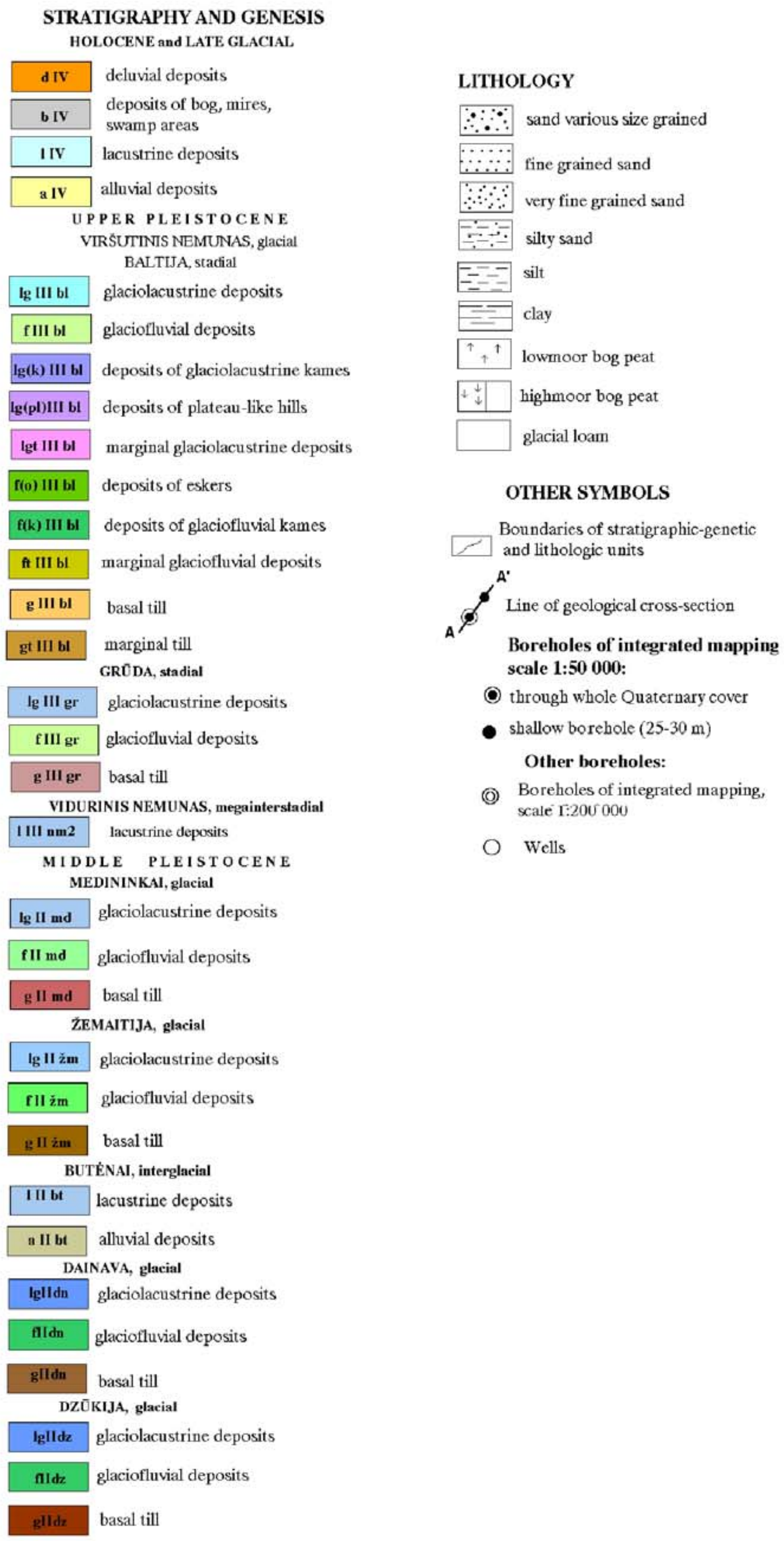


Figure 4.4.4 Legend for Quaternary geological map and geological cross-sections of the INPP region

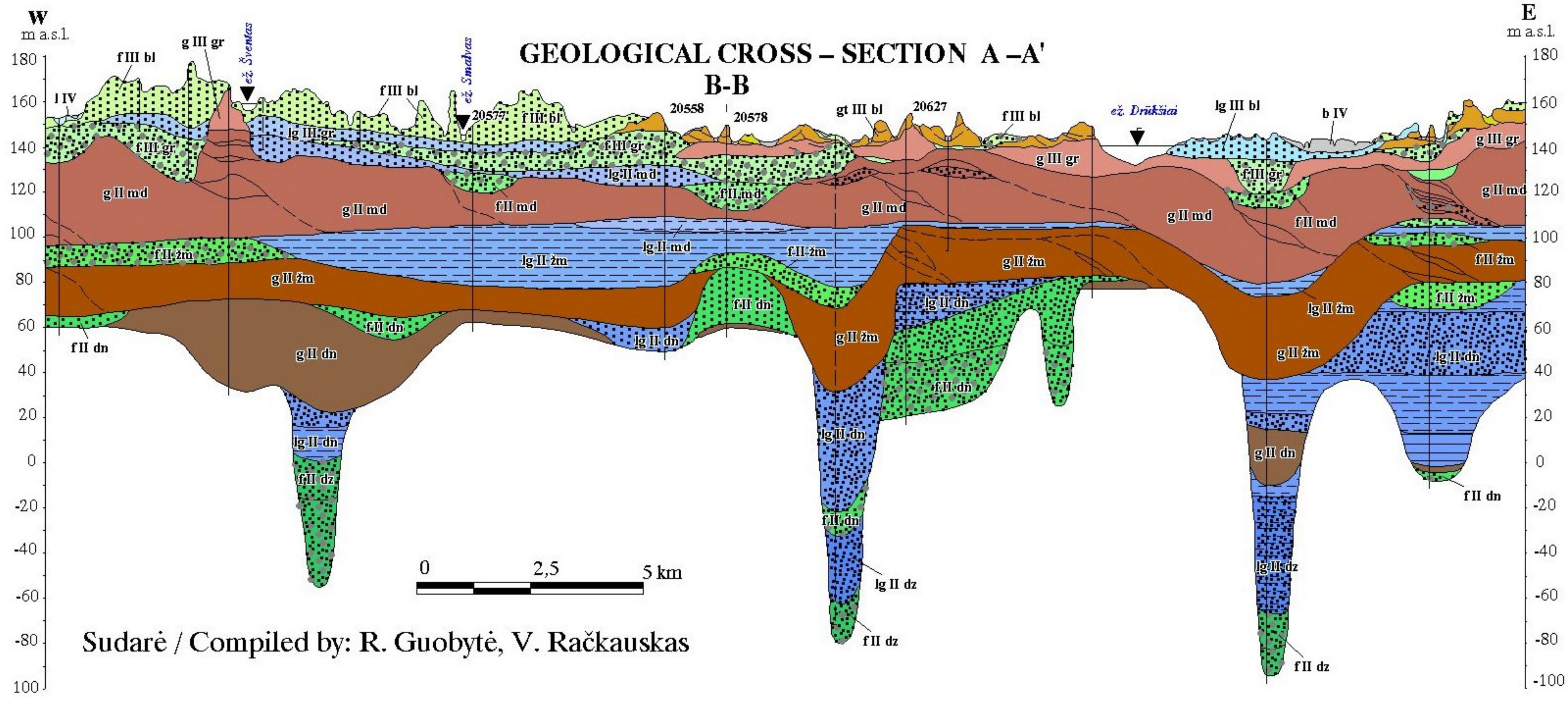


Figure 4.4.5 Quaternary geological cross-section A-A of the INPP area (original scale 1:50 000, authors: R. Guobyte, V. Rackauskas [1]); legend see in Figure 4.4.4

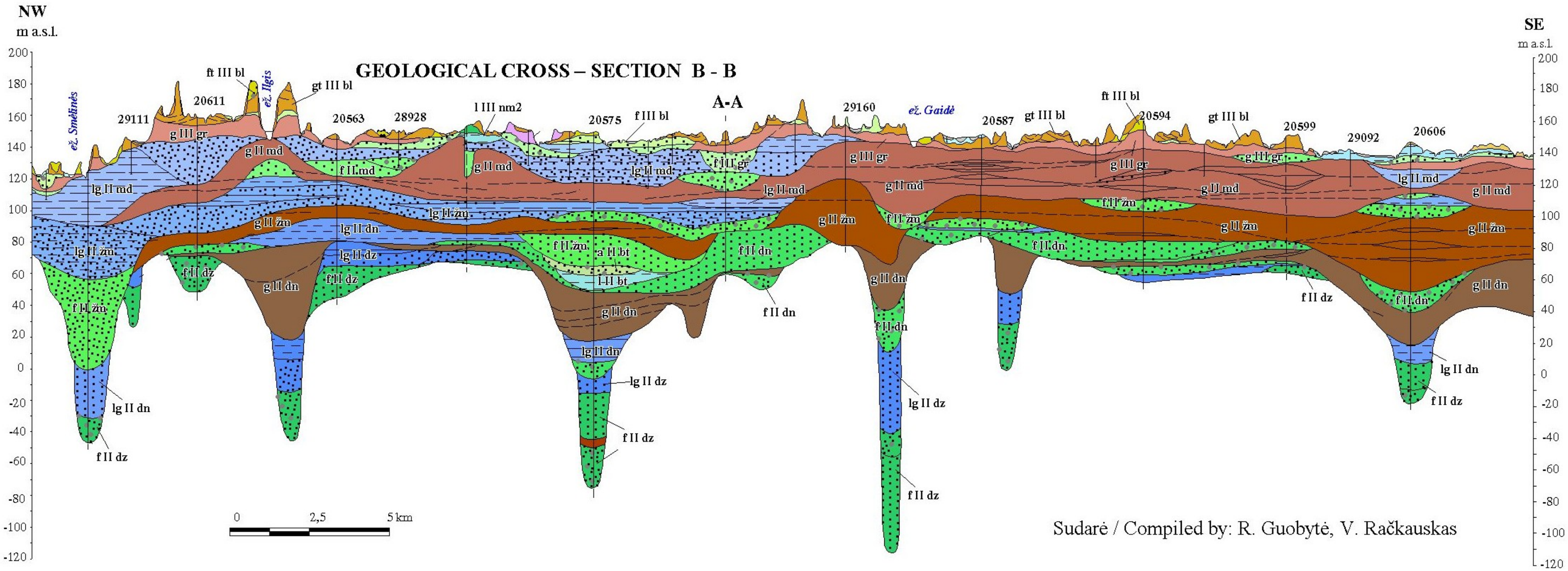


Figure 4.4.6 Quaternary geological cross-section B-B of the INPP area (original scale 1:50 000, authors: R. Guobyte, V. Rackauskas [1]); legend see in Figure 4.4.4

4.4.2 Potential impact

The proposed economic activity will be implemented within the INPP industrial site and will include activities performed inside the Unit 2, radioactive and non-radioactive waste transfer using internal roads of the INPP industrial site and waste management in the appropriate INPP waste management facilities. INPP licensed equipment and INPP work organization and performance procedures in force (coordinated with and approved by the competent authorities, if necessary) will be applied during performance of these works. Proposed economic activity under normal operation conditions does not foresee any actions, which could have an impact on the underground.

4.4.3 Impact mitigation measures

No impact mitigation measures are foreseen for the underground. The proposed economic activity will not impact the underground.

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4.5 BIODIVERSITY

4.5.1 Information about the Site

Protected species, as designated by Lithuanian or European Law, are not encountered within the boundaries of the INPP industrial site.

Specific activity of radionuclides in selected flora, vegetables and foodstuff in the INPP region in 2008 and resulting population exposure due to consumption of foodstuff are summarized in Table 4.5.1 [1]. Annual effective dose due to consumption of foodstuff containing radionuclides in year 2008 was about 4.86 μSv. The dose forms only a small fraction from dose constraint (0.2 mSv or 200 μSv) which limits admissible population exposure due to operation of nuclear facilities [2].

Table 4.5.1 Specific activity of radionuclides in selected flora, vegetables and foodstuff in the INPP region in 2008

Object	Annual consumption, kg	Specific activity, Bq/kg					Annual dose due to food chain (except K-40), 10^{-8} Sv
		Cs-137	Mn-54	Co-60	Sr-90	K-40	
Grass	–	0.03	0	0	0.89	601	–
Milk	259	0	0	0	0.05	45.7	36.3
Potatoes	93	<0.3	<0.3	<0.4	<0.1	164	0
Cabbage	83	<0.9	<0.7	<0.8	0.73	99.8	170
Moss	–	17.4	0	0	3.41	165	–
Mushroom	3	46.0	0	0	0.01	72.6	179
Corn (barley)	122	<0.1	<0.1	<0.2	0.12	53.6	41.0
Fish	19.5	1.26	0	0	0.51	92.9	59.8

4.5.2 NATURA 2000 Network and other Protected Areas

European 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 Community 79/409/EEC [3] and 92/43/EEC [4]. The main objective of the NATURA 2000 network is to ensure the survival of species and habitats that are threatened or rare throughout Europe.

Basing on the Council Directive 79/409/EEC of the 2nd of April 1979 on the Conservation of Wild Birds (further – Birds Directive) the Special Protection Areas (SPAs) are to be designated. When implementing the Council Directive 92/43/EEC of the 21st of 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.

Prior to establishment of SACs, based on scientific research, potential SACs (or Sites of Community Importance, SCIs) are to be selected and the list is to be presented to the European Commission (EC). After the potential SAC is approved by EC, the member state has to commence its establishment.

Potential SAC (SCI) territories are areas meeting the established criteria for selection of Special Areas for Conservation and indicated in the list, approved by the Order of the Minister of the Lithuanian Ministry of Environment [5]. According to the EU Directive the member states shall introduce measures in order to ensure that the quality of the natural habitats and the habitats of species in the NATURA 2000 network does not deteriorate and that no factors arise which might disturb the species for which the areas have been designated.

According to the requirements of the Lithuanian Law on Protected Areas [6], primarily a national protected area is to be established with the purpose to grant them the status of Special Protection Area or/and Special Areas for Conservation. The European Commission has already approved the list of potential SAC territories in Lithuania.

The basis for legal establishment of all mentioned SCIs is the Order of the Minister of the Ministry of Environment [5] of Republic of Lithuanian.

The nearest to INPP SACs of the "NATURA 2000" network are generalized in Table 4.5.2 and are shown in Figure 4.5.1.

Table 4.5.2 The nearest to INPP Special Areas for Conservation (SACs) of the "NATURA 2000" network

The name of location	Area, ha	SAC code in NATURA 2000 network database and comments on SAC boundaries	Valuable species in the area	Preliminary area of the habitation, ha
Lake Druksiai	3611	LTZAR0029 Preliminary border is established according to the plan. The border is nearly the same as for Lake Druksiai SPA.	Spined Loach (*Cobitis taenia*)	
			European otter (*Lutra lutra*)	
River Smalvele and adjacent limy fens	547	LTZAR0026 The border is the same as for Smalva national hydrographical reserve	Fire-bellied toad (*Bombina bombina*)	
			European otter (*Lutra lutra*)	
Lakes and wetlands Smalva and Smalvykstis	2225	LTZAR0025 The border is the same as for Smalva national landscape reserve	3140, Lakes with benthic vegetation of *Chara*	354.6
			3160, Dystrophic lakes	45.0
			7140, Transition mires and quaking bogs	265.9
			7210, Calcareous fens with *Cladium mariscus* and *Carex davaliana*	88.7
			7230, Alkaline fens	88.7
			9010, Western taiga	265.9
			9080, Fennoscandian deciduous swamp woods	88.7
			91D0, Bog woodland	88.7
			Fen orchid (*Liparis loeselii*)	
			Hamatocaulis vernicosus	
Grazute regional	26101	LTZAR0024 The border is the same as for	3130, Light mineralized lakes with helofits	105

The name of location	Area, ha	SAC code in NATURA 2000 network database and comments on SAC boundaries	Valuable species in the area	Preliminary area of the habitation, ha
park		Grazute regional park, with the exception of the zones for recreational, agriculture and residential purposes	3140, Hard oligo-mesothrophic waters with benthic vegetation of Chara formations	18.4
			3150, Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation	2.0
			6120, Xeric sand calcareous grasslands	5.0
			6210, Semi-natural dry grasslands	1568.0
			7120, Degraded raised bogs, (still capable of natural regeneration)	26.0
			7140, Transition mires and quaking bogs	69.6
			7160, Fennoscandian mineral-rich springs and spring fens	2.0
			9010, Western taiga	810.0
			9020, Fennoscandian hemiboreal natural old broad-leaved deciduous forests	99.0
			9060, Coniferous wood on the fluvioglacial ozes	45.0
			9080, Fennoscandian deciduous swamp woods	201.0
			91D0, Bog woodland	2012.0
			Large copper (*Lycaena dispar*)	
			Thesium ebracteatum	
			Fire-bellied toad (*Bombina bombina*)	
			Crested newt (*Triturus cristatus*)	
			European otter (*Lutra lutra*)	
			Eastern pasque-flower (*Pulsatilla patens*)	
Pusnis wetland	779	LTIGN0001 The border is the same as for Pusnis national telmological reserve	6230, Mat-grass swards with plenty of species	8.0
			6430, Hydrophilous tall herb fringe communities	39.0
			7140, Transition mires and quaking bogs	234.0

Protected territories in Lithuania comprising Special Protection Areas are approved by the Government [7] of Republic of Lithuania. The nearest to INPP Special Protection Areas of the

“NATURA 2000” network are listed in Table 4.5.3 and are shown in Figure 4.5.1. Information on what protected bird species of European importance are found in each SPA is also indicated in Table 4.5.3. Forbidden activities in the Special Protection Areas are summarized in Table 4.5.4.

Table 4.5.3 The nearest to INPP Special Protection Areas (SPAs). of the “NATURA 2000” network

Protected area (or its part) in Lithuania	SPA code in NATURA 2000 network database and boundaries	Bird species of European importance	Comments on SPA boundaries
Part of the protected zone for Lake Druksiai	LTZARB003 Lake Druksiai	Great Bittern (*Botaurus stellaris*)	SPAtakes a part of the protected territory. The border is defined according to the plan.
Parts of protected zone for Lakes Dysnai and Dysnyksciai	LTIGNB004 The limy fens complex of Dysnai and Dysnykstis lake area	Corn crake (*Crex crex*)	SPAtakes a part of the protected territory. The border is defined according to the plan.
Part of Grazute regional park	LTZARB004 North eastern part of Grazute regional park	Black-throated Diver (*Gavia arctica*), Pygmy owl (*Glaucidium passerinum*)	SPAtakes a part of the protected territory. The border is defined according to the plan.
Smalva hydrographic reserve	LTZARB002 The complex of Smalva limy fens	Black Tern (*Chlidonias niger*)	The border of the SPAis the same as for Smalva hydrographic reserve

Table 4.5.4 Forbidden activities in the Special Protection Areas (SPAs) to the INPP site

Area of SPA, ”NATURA 2000” code	Bird species of European importance	Forbidden activities [8]
Lake Druksiai, LTZARB003	Great Bittern (*Botaurus stellaris*)	Reap reeds (in certain areas); Visiting places of above water vegetation overgrowth from ice melting till July 1 (in certain areas); Boating and yachting (in certain areas); Camping, excepting in specially predefined recreational areas, from ice melting till July 1 (in certain areas); Hunting of water and wetland birds excepting cases of regulation of cormorant population in pisciculture waters; Change the land usage main purpose excepting cases of changing to more conservative purpose; Change the hydrological regime if it leads to decrease of habitability area or quality; Plant forest.
The limy fens complex of Dysnai and	Corn Crake (*Crex crex*)	Change the land usage main purpose excepting cases of changing to more conservative purpose; Convert meadows and pastures into plough-land;

Dysnykstis lake area, LTIGNB004		Change the hydrological regime if it leads to decrease of habitability area or quality; Plant forest.
The complex of Smalva limy fens, LTZARB002	Black tern (*Chlidonias niger*)	Boating and yachting from May to July; Change the hydrological regime if it leads to decrease of habitability area or quality; Perform water body bed renovation works if it leads to decrease of habitability area or quality.
North eastern part of Grazute regional park, LTZARB004	Black-throated Diver (*Gavia arctica*)	Visiting from ice melting till July 1 (in certain areas); Erect constructions which are not related to purpose of protected territory and expand infrastructure (in certain areas).
	Pygmy owl (*Glaucidium passerinum*)	Perform general deforesting (in certain areas); Perform deforesting and timbering works from February till May (in certain areas); In case of general deforesting not less than 20 (per hectare) seminal of main group and trees (arranged in biogroups) necessary to maintain biodiversity shall be left (in certain areas).

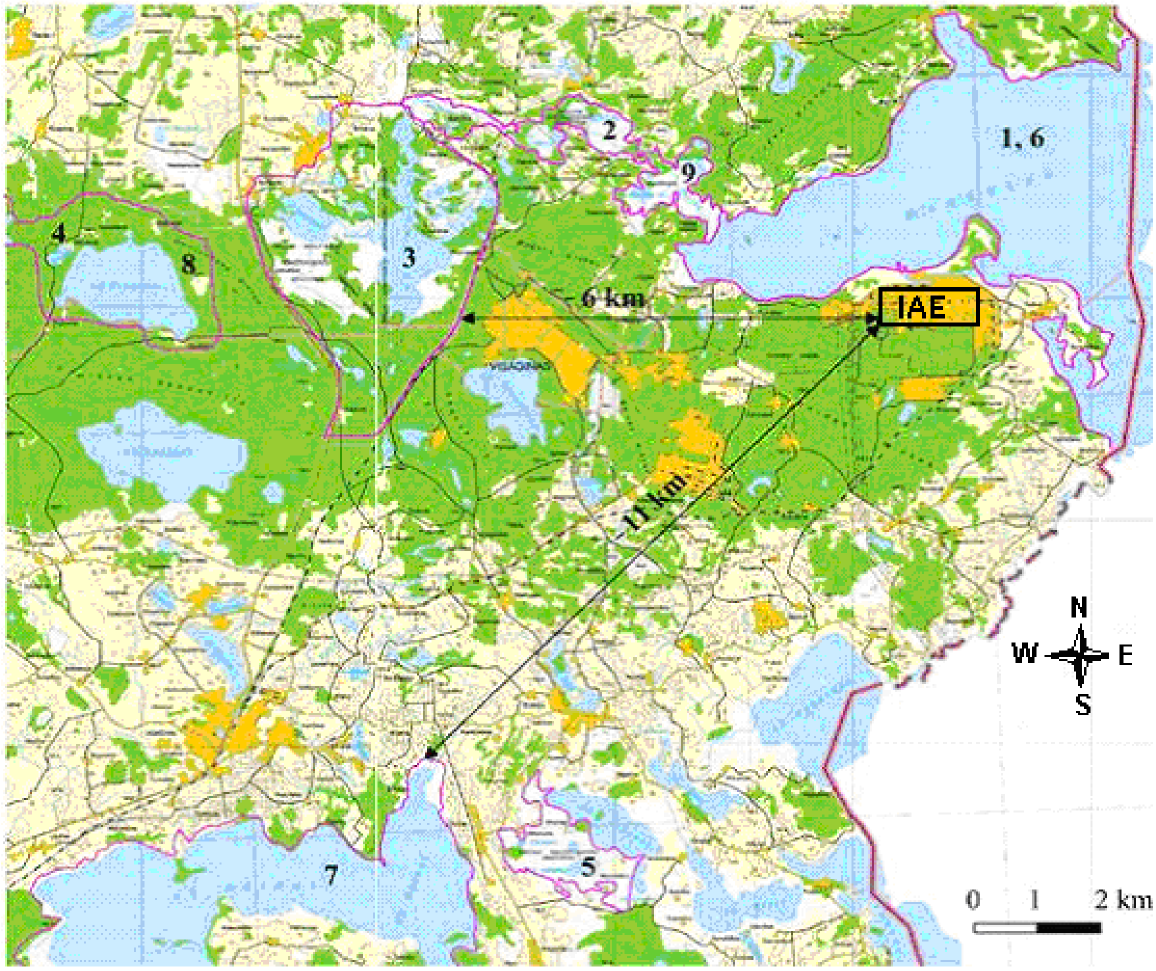

Figure 4.5.1 The nearest to the INPP site "NATURA 2000" network areas (perimeters are indicated in red).

Special Areas for Conservation (SACs): 1 – Lake Druksiai; 2 – River Smalvele and adjacent limy fens; 3 – Lakes and wetlands Smalva and Smalvykstis; 4 – Grazute Regional Park; 5 – Pusnis wetland. Special Protection Areas (SPAs): 6 – Lake Druksiai; 7 – the limy fens complex of Dysnai and Dysnykstis lake area; 8 – North eastern part of Grazute Regional Park; 9 – the complex of Smalva limy fens

4.5.3 Potential impact

The proposed economic activity will be held within the INPP industrial site, where theprotected species, as designated by Lithuanian or European Law, are not encountered.

The proposed economic activity will have no relevant interaction with biodiversity outside the INPP industrial site. The proposed economic activity does not plan building demolition or equipment dismantling works. No changes are foreseen regarding to the existing environment impact sources. As in the case of normal INPP operation, the proposed economic activity will include waste transfer within INPP industrial site and waste management in the INPP waste management facilities, cf. chapter 2. However, the resulting impact on environment will not be significant or will not change significantly, cf. chapters 4.1, 4.2 and 4.3. The proposed economic activity will not have an effect on the deterioration of natural habitats, the habitats of species and birds as well as disturbance of the species for which the SACs and SPAs have been designated. There will be no project implications for the SACs and SPAs in the vicinity of INPP in view of their conservation objectives.

The long term monitoring results show that functional and structural changes in the main INPP environment biodiversity component - Lake Druksiai and it related fauna and flora are stipulated by the heat emission from the INPP and chemical pollution. The main chemical pollution sources are household waste water effluents from the INPP and Visaginas city. Household effluents are released into the Lake Druksiai after treatment in a household waste water treatment facility (previous Lake Skripkai) which is common for both INPP and Visaginas city.

A comprehensive description of the long term impact on Lake Druksiai due to heat emission taking into account whole operation of INPP is provided in the report [9]. Potential changes resulting from final shut down of the power units, when cooling of INPP reactors will not be further necessary, are also assessed. It is noted, that reduction of the heat release may give certain positive effects (e.g. for stenothermal fish species) while it should not be expected that eutrophication status of the lake will come back to the pre-operational of INPP. Chemical pollution of the lake will remain. Significant reduction of effluents from INPP during decommissioning activities, when equipment dismantling and waste management are performed intensively, is not expected. Quality of effluents will be the same as during operation of INPP. Impact due to release of the household waste water from the Visaginas city will prevail. Therefore quality of cleaning of household effluents will be one of the main factor reducing impact on the Lake Druksiai and it's biodiversity.

4.5.4 Impact mitigation measures

No impact mitigation measures are foreseen for the biodiversity. The proposed economic activity will not impact the biodiversity. The potential impact and impact mitigation measures due to planned releases into Lake Druksiai are discussed in chapter 4.1.

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4.6 LANDSCAPE

4.6.1 Information about the site

Landscape of the INPP industrial site is characterized as complex of installations and buildings that is typical to the industry of electric production. The most visible parts on the site are buildings of the power units and their ventilation stacks of 150 m height. The existing buildings of radioactive waste management and storage facilities can be marked on the western part of the site.

Landscape around the power plant is mainly composed of forests and wetlands. Lake Druksiai is a major natural landscape element with associated activities (fishing, recreational use). The recreation areas which are outside the existing INPP sanitary protection zone and are situated along the Lake Druksiai with their specific natural and visual qualities have a great value for the quality of life. The valuable landscape areas (like Grazute Regional Park and Smalva hydrographic reserve, cf. chapter 4.5) are located at about 10 kilometers from the INPP site.

Residential areas consist of small villages with traditional houses. They are located outside the 3 km radius INPP sanitary protected zone.

4.6.2 Potential impact

The proposed economic activity does not plan to perform demolition or modification works of INPP buildings and structures. The proposed economic activity will not change the existing landscape of the INPP site. Also, no works are planned which could change landscape outside the borders of the INPP site. The proposed economic activity will not impact the landscape, changes in the existing landscape are not foreseen.

It should be pointed out that implementation of the proposed economic activity is related to implementation of other INPP decommissioning projects. These decommissioning activities will construct a new facilities in the environment of INPP, i.e. facility for interim storage of spent nuclear fuel (ISFSF), facilities for solid radioactive waste management and storage (SWMSF), repository for short-lived very low level waste, repository for short-lived low and intermediate level waste etc. Impact on landscape due to these new facilities is analyzed in separate environment impact assessment reports [1, 2, 3].

4.6.3 Impact mitigation measures

No impact mitigation measures are foreseen for the landscape. The proposed economic activity will not impact the landscape.

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4.7 SOCIAL AND ECONOMIC ENVIRONMENT

4.7.1 Information about the site

4.7.1.1 Population and demography

According to data [1] of the Department of Statistics to the Government of the Republic of Lithuania for 2007 the total population of the INPP region, which includes the municipality of Visaginas (58 km^2), Ignalina district (1 447 km^2) and the Zarasai district (1 334 km^2) was 70.2 thousand (in Visaginas 28.6 thousand people and in Ignalina and Zarasai districts 20.6 and 21.0 thousand people, respectively). INPP region comprises 4.3% of Lithuania territory, however the population number is about 2.1% of the total Lithuania population. So, population density in the INPP region is quite low.

The population of the INPP region has been decreasing during the last decade, like in the whole country. It may be noted that the relative decrease of the region's population is almost two times bigger than the corresponding rate in Lithuania. From the beginning of 1998 to the end of 2007 the total population of the region has decreased approximately by 12% (from 79.1 to 69.3 thousand inhabitants). Annual decrease of the region's population constitutes approximately 1.2-1.4%.

The decrease in population in the region is partly determined by population migration. The balance of inner and international migration in the districts of Ignalina and Zarasai in separate years of 1998-2007 varies from –(0.7-1.0)% to +(0.3-0.7)% of the number of inhabitants in these districts. Departure from Visaginas increased in 1998-2002. During this period the balance of annual inner and international migration reached –(1.4-3.7)%. Since 2002 departure from Visaginas started decreasing, and now it varies around the annual average, characteristic of the whole region, i.e. around 2-3% of the number of inhabitants. Due to arrival that has increased in the latter years the annual balance of inner and international migration in the Visaginas district is approximately –(0.5-0.1)% and is smaller when compared with neighbouring districts of Ignalina and Zarasai. The annual balance of inner and international migration for the whole INPP region remains negative, and in the latter years (2003-2007) it was approximately 0.5-0.6% of the number of inhabitants in the region.

Natural population fluctuation in the INPP region is also negative (mortality exceeds birth rate), and in the latter years (in 2003-2007) it was approximately 0.7-0.8% of the number of the region population. The demographic senility rate, i.e. the number of the elderly (people 60 years old and older) for one hundred children of up to 15 years of age also increases in the region. This shows the general tendency of population of the INPP region becoming senile.

Important demographic indicators of the INPP region for the year 2007 are summarized in Table 4.7.1.

Table 4.7.1 Demographic indicators of INPP region in 2007 [1]

Indicator	Ignalina district	Zarasai district	Visaginas	INPP region
% of population < 15 years	14.4	15.3	12.3	13.8
% of population 15–44 years	36.4	38.8	49.5	42.4
% of population 45–64 years	25.2	24.4	30.4	27.1
% of population ≥ 65 years	24.0	21.6	7.7	16.7
% of population ≥ 75 years	10.7	10.0	2.0	7.0
Balance of inner and international	-7.2	-6.7	-1.4	-4.7

migration per 1000 pop.				
Birth rate per 1000 pop.	6.3	7.5	9.6	8.0
Death rate per 1000 pop.	22.5	20.2	8.0	15.8
Natural increase per 1000 pop.	-16.2	-12.7	1.6	-7.8
Demographic senility rate	208	176	86	153

A 3 km-radius sanitary protection zone is set around the INPP where economic activity, not related with operation of the INPP, is limited. There are no permanent inhabitants in this zone. Environmental monitoring is performed in the 10 times bigger zone of 30 km radius around the INPP ever since the beginning of the operation of the nuclear power plant. Population of the Republics of Latvia and Belarus fall into this zone, too.

Population density in the 30 km radius around the INPP is approximately 36 people per km^2. Population density is lower than the average population density in Lithuania (approximately 25 people per km^2), but it is similar to other Lithuanian country regions. Population and population distribution within a 30 km radius around the INPP is summarized in Table 4.7.2. Position of zones indicated in the table are shown in Figure 4.7.1.

Table 4.7.2 Population distribution (thousands) around the INPP site in 2007

Radius of circle	**N**	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**	**Amount of inhabitants**	
									in the ring	**cumulative within the radius**
30 km	27.9	0.6	6.3	1.0	1.2	1.7	1.7	0.7	41.1	101,0
25 km	1.0	0.7	1.8	1.8	3.3	1.1	1.0	6.2	16.9	59,9
20 km	0.3	0.2	1.0	0.9	0.9	2.1	0.7	0.5	6.6	43,0
15 km	0.4	0.6	0.7	0.7	0.7	0.9	0.2	0.7	4.9	36,4
10 km	0.3	0.4	0.5	0.3	0.7	0.3	28.6	0.2	31.3	31,5
5 km	–	–	–	–	0.1	–	–	0.1	0.2	0,2
3 km	-	-	-	-	-	-	-	-	-	-
Total in the segment	29.9	2.5	10.3	4.7	6.9	6.1	32.2	8.4	Total 101.0	

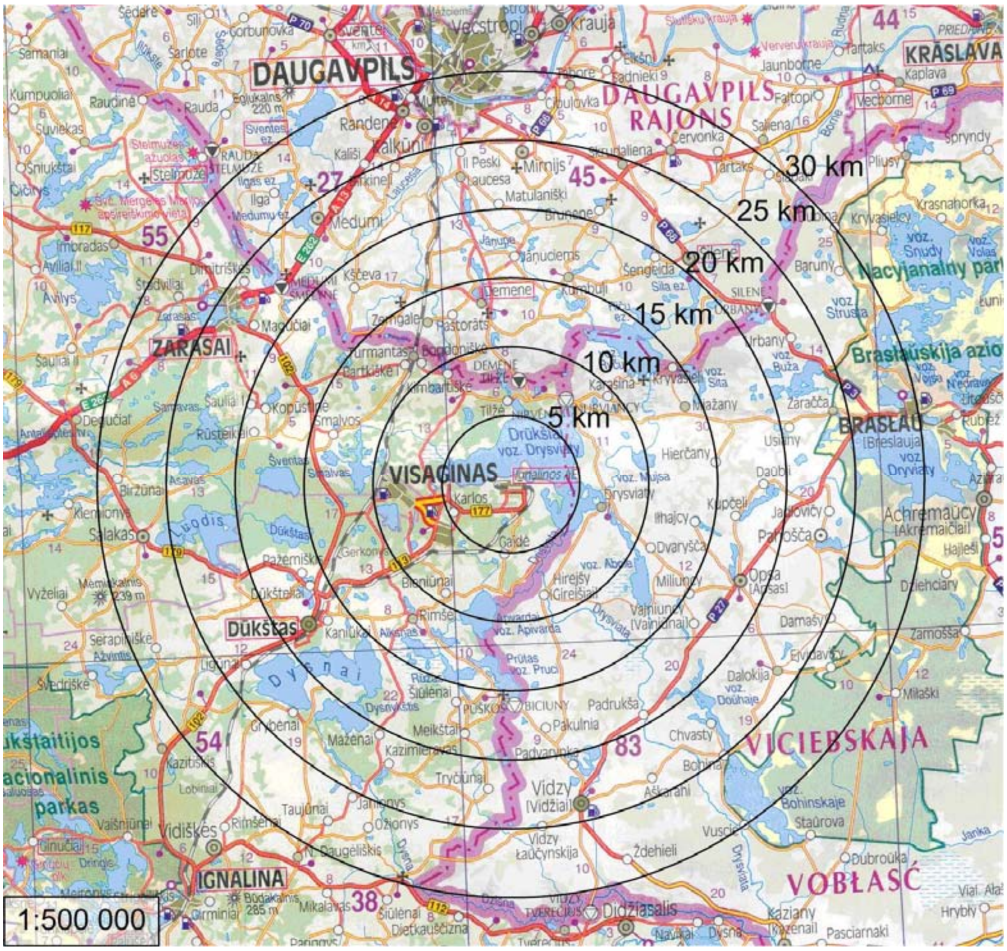

Figure 4.7.1 5 - 30 km radius circles around the INPP site

4.7.1.2 Economic activities

The number of operating economical subjects (including state institutions) in the INPP region varies around 1000, 650 of which are small and medium business enterprises. Small economical subjects with annual revenue of less than 100 thousand Litas constitute approximately 65% of all economical subjects, operating in the region. Economical subjects with annual revenue of over 1 million Litas constitute approximately 10-15% of all economical subjects, operating in the region.

According to the data [1] of the Department of Statistics to the Government of the Republic of Lithuania in 2007 employment (i.e. number of people, who do any work and receive payment for it in money, or in kind, or who have revenue or profit) in the INPP region was approximately 31.8 thousand. During the latter decade (1998-2007) employment in the region did not change in essence, and now it constitutes approximately 30 thousand inhabitants. The rate of registered unemployed and able-bodied population in the INPP region is bigger than the corresponding rate of Lithuania.

The town of Visaginas has an urban type labour force, which means a younger age structure (residents under 45 years of age is 62%), more educated people and greater variety of professional training. Ignalina and Zarasai districts have a rural type labour force, which means an older age structure, lower education and a small variety of professional training.

Direct foreign investments in the INPP region are increasing (see Table Table 4.7.3). The change of material investments is less marked (see Table Table 4.7.4). The part of direct foreign as well as material investments for one inhabitant of the INPP region still strongly lags behind the corresponding average of Lithuania.

Table 4.7.3. Direct foreign investments in the INPP region, million Lt [1]

Locality	2001	2002	2003	2004	2005	2006	2007
The municipality of Ignalina district	0.1	0.2	0.3	0.1	0.2	5.8	6.3
The municipality of Visaginas	5.1	7.4	7.1	2.4	0.5	1.5	3
The municipality of Zarasai district	1.1	1.3	1.3	1.1	1.1	2.2	1.9
INPP region	6.3	8.9	8.7	3.6	1.8	9.5	11.2

Table 4.7.4. Material investments in the INPP region, million Lt [1]

Locality	2004	2005	2006	2007*)
The municipality of Ignalina district	40.7	63.2	33.1	45.2
The municipality of Visaginas	263.5	310.9	232.0	159.2
The municipality of Zarasai district	16.8	30.3	38.5	31.4
INPP region	321.0	404.4	303.7	235.8

*) 2007 – working data

The State Enterprise Agricultural Information and Country Business Centre [2], in close cooperation with agriculture departments of municipality administrations and employees of elderships, performed agricultural land market research in the whole territory of Lithuania in September-December 2006. It is noted that prices of agricultural land in north-eastern Lithuania remain relatively high; changes in prices lately have been insignificant.

In Zarasai district in most elderships land costs 1000-1300 Lt/ha for average and worse land, and up to 1500 Lt/ha for relatively good land. But in separate elderships (Salakai, Deguciai) better land costs up to 3.000 Lt/ha, and land, suitable for recreation, costs from 5 to 30 thousand Lt/ha. Rent is up to 50-100 Lt/ha for average land and up to 200 Lt/ha for better land.

In Ignalina district, similarly to Zarasai district, land costs approximately 1000-1250 Lt/ha, but in separate elderships (Dukstas) price may reach 2.500 Lt/ha. Land, suitable for recreation, costs 5-35 thousand Lt/ha. Average rent is up to 100-150 Lt/ha for average land, and up to 200-250 Lt/ha for good land. 50-100 Lt/ha rent is taken for worse land.

4.7.1.3 Transport

The INNP region is on the very edge of Lithuania, therefore transport is an important part of the region's economic and social infrastructure. There is quite a well-developed road network in the INPP region that connects it with other regions of the country and neighbouring countries. The existing road and railway systems are shown on Figure 4.7.2. The main regional road is the road Daugpilis-Zarasai-Ignalina-Svencionys-Vilnius. This highway joins Ignalina with Zarasai and has an exit to the Kaunas–St Petersburg highway. The entrance of the main road from INPP to the highway is near the town of Dukstas. The road from INPP to Dukstas is about 20 km.

The main railroad line Vilnius–St Petersburg passes 9 km to the west of INPP. The INPP is connected to the railroad by an extension from Dukstas. The railway station Dukstas is used for cargo traffic as well as for passenger transportation.

Figure 4.7.2 Road and railway network

4.7.1.4 Development of the Socio-Economic Environment

Right from the beginning of passing the decision regarding the INPP decommissioning, means coordinated by the state are implemented in the INPP region with the aim to control and decrease the impact on the socio-economic environment of the INPP region due to the shutdown of the INPP.

During the implementation of the Programme for Decommissioning of the State Enterprise Ignalina Nuclear Power Plant Unit 1, approved by the Government of the Republic of Lithuania in 2001 [3], infrastructure was created, and legal base was expanded for the performance of Ignalina NPP decommissioning and for the decrease of socio-economic results.

In order to keep qualified personnel, to mitigate negative socio-economic impact on them, and in order to ensure safe and continuous operation of the Ignalina NPP and its decommissioning, the Law on Additional Employment and Social Guarantees for the Employees of the State Enterprise Ignalina Nuclear Power Plant of the Republic of Lithuania [4] and the Order of the Minister of Social Security and Labour that regulates its implementation [5] were passed.

Projects of INPP restructuring were prepared and implemented during the improvement of INPP management and seeking to prepare for the liberalisation of the electric power market better. With the help of these projects INPP divisions that were not directly related with the manufacture of electric power were separated from the power plant, and state enterprises “Visagino energija”, “Visagino poligrafija”, “Visagino statybininkai”, “Visagino energetikos remontas” and Visaginas Transport Centre [6] were established.

With regard to the complex and regional nature of INPP decommissioning effects, the Ignalina NPP region, encompassing the municipalities of the districts of Ignalina, Zarasai, and Visaginas city, was formed according to the resolutions of the Government of the Republic of

Lithuania [7]. Ignalina NPP Region Development Council and State Enterprise Ignalina NPP Region Development Agency for organizing the implementation of its decisions were established. The main aim of the latter institution is to mitigate the negative socio-economic impact in the Ignalina NPP region after the INPP decommissioning and to create favourable conditions for the balanced socio-economic development of this region.

Also State Enterprise Business Incubator of the Ignalina NPP Region, Visaginas Information and Consultation Centre of the Ignalina Labour Exchange, and State Institution Visaginas Social and Psychological Help Service were established.

Seeking to mitigate the negative impact of socio-economic effects on the inhabitants of the Ignalina NPP region the following documents were prepared and approved in 2004 by the Ignalina NPP Region Development Council: Ignalina NPP Region Development Plan, Small and Medium Business Development Programme of the Ignalina NPP Region, Programme and Plan of Means for Work with the Youth of the Ignalina NPP Region, Local Initiatives Support Programme of the Ignalina NPP Region.

The situation that has formed and the future development of socio-economic environment of the region as well as possible impact mitigation measures are reviewed and assessed in [8]. According to the latest data of socio-economic monitoring [9], during the assessment of impact mitigation measures for the INPP decommissioning, the bigger part of respondents, who have voiced their opinion, positively assessed the measures that were being implemented (establishment and activities of the INPP Region Development Agency, establishment and activity of a business incubator in Visaginas, implementation of the Small and Medium Business Development Programme of the Ignalina NPP Region, implementation of the Local Initiatives Support Programme of the Ignalina NPP Region, implementation of the programme of work with young people of the INPP Region).

Socio-economic environment of the INPP region is planned to be developed further. The Decommissioning Programme of the State Enterprise Ignalina Nuclear Power Plant Unit 1 and 2, approved by the Government of the Republic of Lithuania in 2005 and renewed in 2008 [10], emphasizes that, continuing the preparation for Ignalina NPP decommissioning, it is necessary to further monitor, assess and forecast the impact of the Ignalina NPP decommissioning on inhabitants and environment of the Ignalina NPP region. Seeking to mitigate the negative socio-economic impact in the Ignalina NPP region after the decommissioning of the INPP, the following actions must be performed:

- Stimulate the implementation of the projects of the Ignalina NPP region development plan, planned to be funded from the structural funds of the European Union and other sources;
- Stimulate the implementation of the projects defined in the development plan of INPP region infrastructure;
- Ensure the activity of the state institutions Ignalina NPP Region Development Agency and Visaginas Social and Psychological Service;
- Stimulate the development of small and medium business in the Ignalina NPP region;
- Create conditions for employees, stood off from the Ignalina NPP, to integrate into the labour market and to mitigate the impact of standing off – to provide them with special occupation and social guarantees;
- Stimulate highly qualified employees of the Ignalina NPP to ensure safe operation of the power plant.

Seeking to reach the goals, set in the programme [10], and solving problems for their realisation, the Government of the Republic of Lithuania commits the Ministry of Economy to prepare the Plan of Implementation Means for this programme, approved by the Order of the

Minister of Economy [11]. Responsible administrators, means implementation schedules are identified, the need of resources and possible sponsorship sources are planned in this plan of means. The plan of means is reviewed each year with regard to remarks of the responsible administrators, the need for new initiatives, and potential sponsorship sources. Approximately 160 million Litas are intended in this plan [11] for the implementation of mitigating means for social and economic consequences in the INPP region for 2008-2009, however actual financing is significantly lower. The Ministry of Energy, established quite recently, has taken over some functions that were performed by the Ministry of Economy (for example, the preparation of the programme of decommissioning of the Ignalina NPP and its implementation control; the European Union coordination of the Ignalina programme, etc.).

It should be mentioned, that social economic program, which considers all social economic problems, shall be developed by three ministries: Ministry of Social Security and Labour, Ministry of Economy and Ministry of Energy. Prepared program shall be submitted to the Government of the Republic of Lithuania for approval.

4.7.2 Potential impact

It shall be noted that this EIA report assesses the impact of the Ignalina NPP decommissioning works, which will be performed after the final shutdown of the reactor of the Energy Unit No. 2 and during the transportation of spent nuclear fuel from it. This is an environmental impact assessment of a “narrow” certain proposed activity. The impact of this “narrow” activity on the existing social and economic environment will be insignificant. The social and economic impact on the whole region (and on Lithuania) after the decommissioning of the Ignalina NPP (for example, how the prices of electricity and heating, and occupation of inhabitants will change, etc.) is forecasted and assessed by the Government of the Republic of Lithuania, and it prepares a corresponding plan of implementation means for the Ignalina NPP decommissioning programme, how to manage and decrease the social and economic impact (see Section 4.7.1.4). Also no impact of the proposed economic activity and no need to review and correct socio-economic environmental development means, implemented by the state in the INPP region, are foreseen. The proposed economic activity is one of INPP separate decommissioning projects, the necessity of which comes from the selected concept of immediate reactor dismantling [12]. The proposed economic activity will be performed by the part of existing INPP personnel; there are necessary labour and qualification resources at the INPP. Since the existing INPP personnel will be employed, this project will decrease the impact on the social and economical environment, caused by the shutdown of the INPP.

The proposed economic activity is also related to implementation of other INPP decommissioning projects. These decommissioning activities will construct a new facilities in the environment of INPP, i.e. facility for interim storage of spent nuclear fuel (ISFSF), facilities for solid radioactive waste management and storage (SWMSF), repository for short-lived very low level waste, repository for short-lived low and intermediate level waste etc. Impact on social and economical environment due to these new facilities is analyzed in separate environment impact assessment reports [13–15].

4.7.3 Impact mitigation measures

Exceptional and specific measures to mitigate the impacts on the social and environment due to this “narrow” proposed economic activity are not foreseen.

Means, which are described in Section 4.7.1.4, coordinated by the state are implemented in the INPP region with the aim to control and decrease the impact on the socio-economic environment of the INPP region due to the shutdown of the INPP. It can be concluded, that implementation of the selected immediate reactor dismantling concept with employment to the maximal possible extend INPP available labour resources is one of the main factor reducing impact on the social and environment caused by the shutdown of the INPP.

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4.8 CULTURAL HERITAGE

4.8.1 Information about the site

There are seven cultural heritage sites in the vicinity of the INPP: Petriskes settlement antiquities I, Petriskes mound, Petriskes settlement antiquities II, Grikiniskes settlement antiquities III, Grikiniskes settlement antiquities II, Grikiniskes settlement antiquities I and Stabatiskes manor place (Figure 4.8.1). Other valuable cultural heritage objects like Grazutes regional park (area 24 230 ha), Ceberaku or Pasamanes mound (cultural heritage code A1537) etc. are more distant.

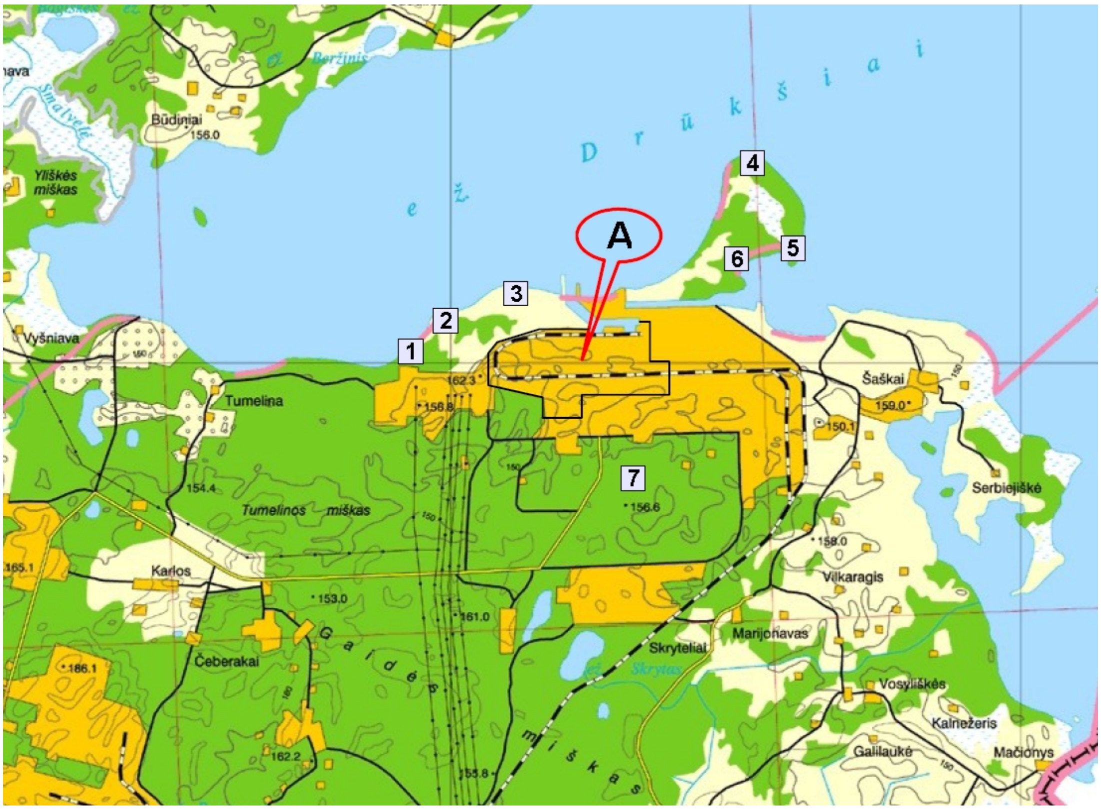

Figure 4.8.1 Cultural heritage objects in the vicinity of the INPP site: A – INPP site; 1 – Petriskes settlement antiquities I; 2- Petriskes mound; 3 – Petriskes settlement antiquities II; 4 – Grikiniskes settlement antiquities III; 5 – Grikiniskes settlement antiquities II; 6 – Grikiniskes settlement antiquities I; 7 – Stabatiskes manor place

4.8.2 Potential impact

Implementation of the proposed economic activity under normal operational conditions (cf. chapter 2), management of generated waste (cf. section 3) or emissions into the environment (cf. chapters 4.1 and 4.2) will not create any factors, which could have significant direct or indirect impact on cultural objects in the INPP environment. The proposed economic activity will not have any impact on identified immovable cultural heritage objects and zones.

4.8.3 Impact mitigation means

No impact mitigation measures are foreseen for the cultural heritage. The proposed economic activity will not have any impact on identified immovable cultural heritage objects and zones.

4.9 PUBLIC HEALTH

4.9.1 General Information

General information about population health indicators for the Ignalina NPP region (Visaginas municipality, Ignalina and Zarasai districts) is presented in Table 4.9.1 and Fig. 4.9.1.

Table 4.9.1. Population health indicators for the INPP region in 2007

Factor	Visaginas	Ignalina district	Zarasai district	Utena county	Lithuania
Registered morbidity per 100,000 adults	2162*	1245*	1710*	1698*	1902*
Registered morbidity per 100,000 children	3504*	2236*	2826*	2878*	3027*
Incidence of malignant neoplasms per 100,000 pop.	367	760	582	568	483
Prevalence of malignant neoplasms per 100,000 pop.	1195*	2080*	2097*	1952*	1999*
Incidence of mental disorders per 100,000 pop.	759	235	289	274	149
Prevalence of mental disorders per 100,000 pop.	3058	2095	6376	3591	2803
Admissions per 100,000 pop.	200	180	131	178	238

* 2005, data from Lithuanian Health Information Centre (www.lsic.lt)

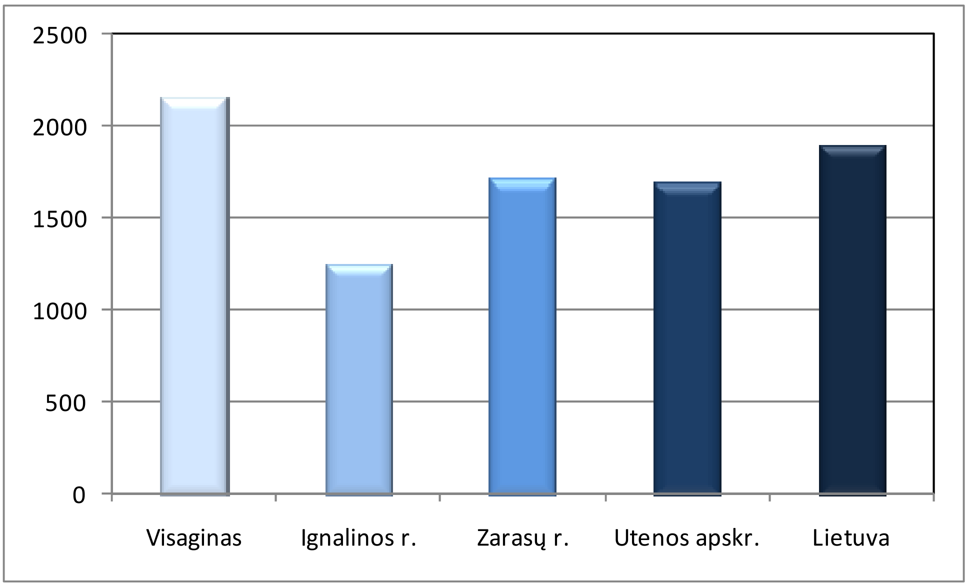

Fig. 4.9.1. Registered morbidity per 100,000 adults for Visaginas Municipality, Ignalina and Zarasai districts, Utena County and Lithuania in 2005 (Lithuanian Health Information Centre (www.lsic.lt) presents only data for 2005)

Death rate per 1000 population and percent of working age population for Visaginas municipality, Ignalina and Zarasai districts, Lithuania and Utena County in 2007 are presented in Fig. 4.9.2 and Fig. 4.9.3.

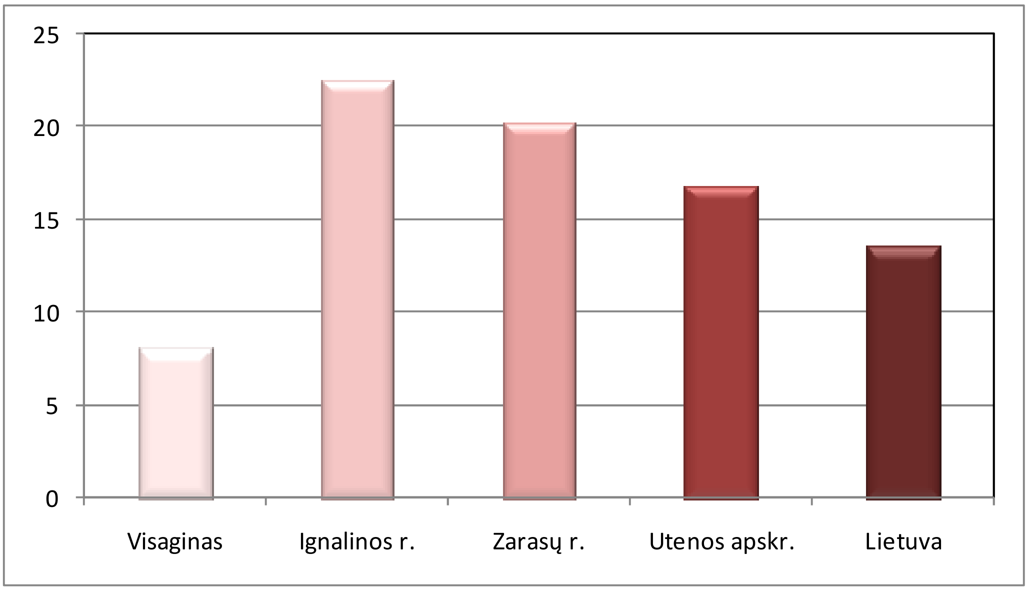

Fig. 4.9.2. Death rate per 1000 population for Visaginas Municipality, Ignalina and Zarasai districts, Utena County and Lithuania in 2007 (data from the Lithuanian Health Information Centre (www.lsic.lt))

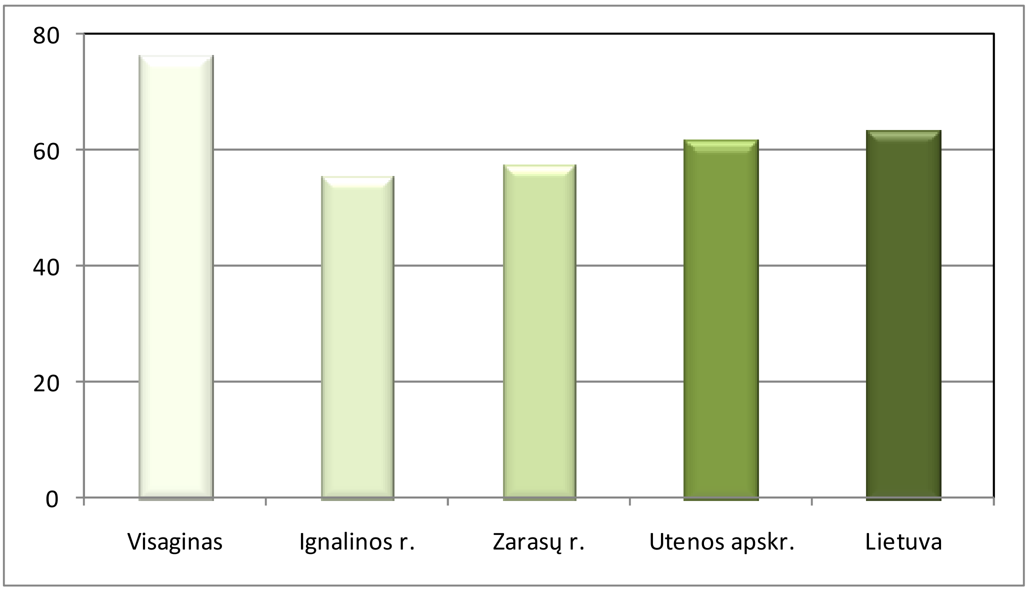

Fig. 4.9.3. Percent of working age population for Visaginas Municipality, Ignalina and Zarasai districts, Utena County and Lithuania in 2007 (data from the Lithuanian Health Information Centre (www.lsic.lt))

As can be seen from Fig. 4.9.2, the death rate per 1000 population for the town of Visaginas is the lowermost in the whole country, and the death rate per 1000 population for Ignalina and Zarasai districts is the uppermost. This is not connected in any way with the operation of the INPP; the reason is the age of population. As can be seen from Fig. 4.9.3, the percent of working age population for the town of Visaginas is the uppermost in the whole country, and the percent of working age population for Ignalina and Zarasai districts is one of the lowermost in Lithuania.

4.9.2 Non-radiological Impact

The proposed economic activity with regard to public health in essence will be analogous to the INPP operation, performed up till now. The existing situation in the INPP region and direct impact on public health will not change in essence. The performance of the proposed economic activity using the existing INPP personnel will decrease the impact on the socio-economic environment and the resulting indirect impact on public health. In the long-term perspective the implementation of the proposed economic activity managing spent nuclear fuel, existing in the INPP, and radioactive waste will decrease nuclear and radiation risk. The impact of the proposed economic activity on separate factors that influence public health is presented in detail in Chapter 4.9.4.

4.9.2.1 Non-radiological Impact Mitigation Measures

The proposed economic activity will be performed on the existing INPP industrial site. The activity will be performed by existing INPP personnel. If needed, employees will be additionally trained. Work conditions will be ensured with regard to the requirements of valid legal acts. Exceptional mitigation measures for decreasing non-radiological impact on public health, related with this proposed economic activity, are not foreseen.

4.9.3 Radiological Impact

This chapter summarizes all assessed radiological impacts, considers their total effect and demonstrates the ability of the proposed economic activity to meet compliance with radiation protection requirements in force. The chapter addresses radiological impacts that may potentially arise under normal operation conditions of the proposed economic activity. Emergency situations are discussed in chapter 8 “Risk Analysis and Assessment”.

4.9.3.1 Radiation Protection Requirements

4.9.3.1.1 Radiation Protection Requirements for Members of Personnel

The hygienic norm HN 73:2001 of the Republic of Lithuania [1] defines dose limits for workers:

- The limit for effective dose is 100 mSv in a consecutive 5-year period;
- The limit for annual effective dose is 50 mSv;
- The limit on equivalent dose for the lens of the eye is 150 mSv in a year;
- The limit on equivalent dose for the skin, limbs (hands and feet) is 500 mSv per year. This limit has to be averaged over 1 cm^2 area of skin subjected to maximal exposure.

The INPP internal procedures on radiation protection foresee additional requirements, which assure permanent control of radiation impact on personnel and implementation of the ALARA principle. The daily exposure of a member of the personnel performing works in the supervised area normally is planned to assure the effective dose not exceeding 0.2 mSv. Higher daily doses may be allowed, however working activity shall be organized in accordance with special procedures. Annual exposure of the member of personnel is controlled to be below 20 mSv. Additional restrictions on permissible daily exposure are imposed and additional radiation monitoring provisions are foreseen for members of personnel, annual exposure of whom has exceeded 20 mSv.

4.9.3.1.2 Radiation Protection Requirements for Members of General Public

The hygienic norm HN 73:2001 of the Republic of Lithuania [1] defines dose limits for members of the public:

- The limit for effective dose is 1 mSv in a year;
- In special circumstances the limit for effective dose is 5 mSv in a year provided that the average over five consecutive years does not exceed 1 mSv in a year;

- The limit on equivalent dose for the lens of the eye is 15 mSv in a year;
- The limit on equivalent dose for the skin is 50 mSv in a year. This limit has to be averaged over 1 cm^2 area of skin subjected to maximal exposure.

In optimization of radiation protection the source related individual dose is bounded by a dose constraint. The dose constraint for each source is intended to ensure that the sum of doses to critical group members from all controlled sources remains within dose limit. The dose constraint for the members of public due to operation and decommissioning of nuclear facilities is 0.2 mSv per year [2].

If radionuclides are dispersed into the environment by several pathways (e.g. by air and water paths), and members of the same or different critical groups of population are impacted, the particular pathway resulting dose shall be limited in such a way that the total sum of doses from all pathways shall not exceed the dose constraint. The impact due to direct external ionizing irradiation shall be taken into account and the total dose (due to radioactive emissions and due to direct irradiation) to the critical group member of population shall not exceed the dose constraint.

The design, operation and decommissioning of nuclear object shall be such as to assure that the annual dose to the critical group members due to operation and decommissioning of nuclear facility including short time anticipated operational transients shall not exceed the dose constraint [3].

For comparison purpose it can be indicated that average value of annual effective dose to the Lithuanian inhabitants due to natural sources of ionizing radiation is 2.2 mSv. The main natural radiation sources and their average dose values are: indoor radon - 1 mSv, cosmic radiation – 0.35 mSv, soil (external radiation) – 0.06 mSv, construction materials indoors – 0.45 mSv, natural radionuclides in human body – 0.34 mSv. The average dose of world population due to natural radiation is 2.4 mSv per year. Comparison of established annual effective dose limits, dose constraint and dose from natural sources is presented in Fig. 4.9.4. Data on natural exposure are taken from the Lithuanian Radiation Protection Centre website (http://www.rsc.lt/index.php/pageid/313#4).

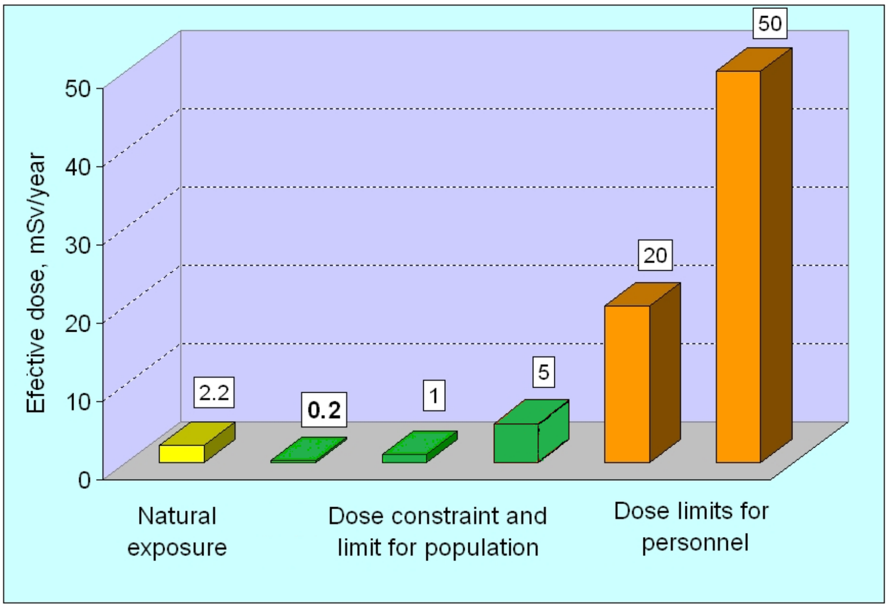

Fig. 4.9.4. Annual effective dose limits, dose constraints and exposure from natural sources in Lithuania

4.9.3.2 Radiological Impact of the Proposed Economic Activity

The proposed economic activity is planned in 2010-2016. Potential radiological impact on public health due to the implementation of the proposed economic activity may be determined by the following impact sources:

- Radioactive releases into environmental water may determine dispersion of radioactive materials beyond the limits of the INPP industrial site and public exposure;
- Radioactive releases into environmental air may determine dispersion of radioactive materials beyond the limits of the INPP industrial site and public exposure ;

Performance of INPP equipment dismantling works that would determine opening of contaminated equipment is not planned in the scope of the proposed economic activity, see Chapter 2. Therefore other potentially identifiable impacts, such as change of ionizing radiation fields (increase or decrease) in the INPP environment due to modification or isolation of non-operational systems, in-line decontamination of closed circuits, etc., are assessed as insignificant or not worsening the existing radiological situation on the INPP site.

Radiological impact due to radiological releases to environmental water is assessed in Section 4.1.5. It was estimated that annual effective dose of a member of the critical inhabitant group of the INPP environment, determined by radioactive releases to environmental water, will not exceed 1.4 µSv. Radiological impact, determined by radioactive releases to environmental air, is assessed in Section 4.2.3. It was estimated that annual effective dose of a member of the critical inhabitant group of the INPP environment, determined by radioactive releases to environmental air, would not exceed 2.9 µSv.

Total annual exposure (annual effective doses) of a member of the critical inhabitant group of the INPP environment due to radioactive releases (to environmental water and air) of the planned economic activity is summarized in Fig. 4.9.5. Contribution of separate radionuclides to annual exposure is presented in detail in Table 4.9.2.

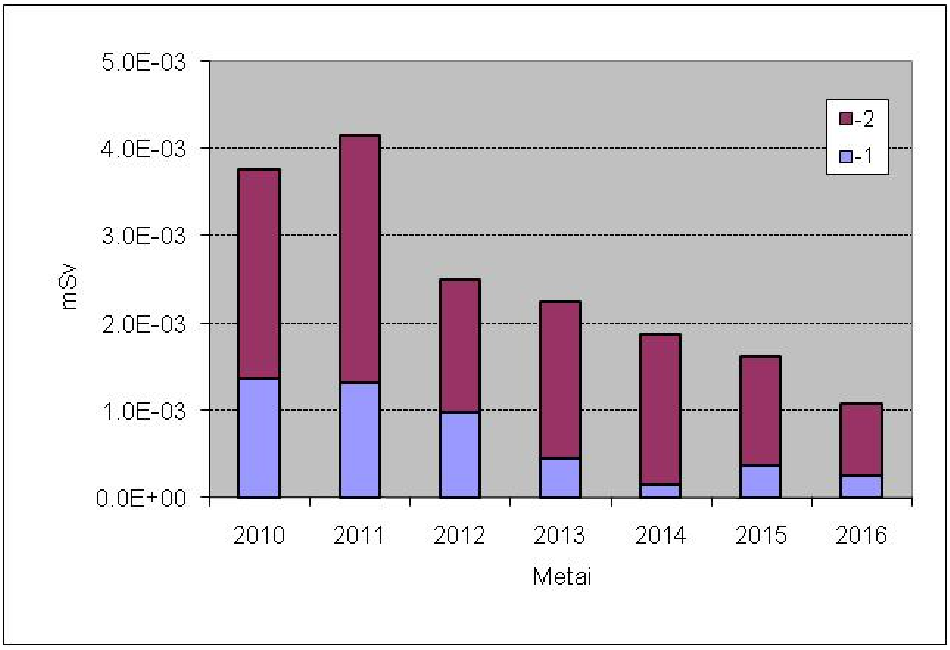

Fig. 4.9.5. Annual effective dose (mSv) due to the planned radioactive releases of the proposed economic activity: 1 – to environmental water, 2 – to environmental air

Table 4.9.2. Annual effective dose, determined by separate radionuclides (mSv) due to the planned radioactive releases (to environmental water and environmental air) of the proposed economic activity

Radionuclides	Year						
	2010	2011	2012	2013	2014	2015	2016
Co-60	3.39E-04	6.02E-04	1.18E-03	1.08E-03	1.08E-03	7.68E-04	5.05E-04
C-14	5.63E-07	1.28E-06	7.27E-06	8.40E-07	9.66E-07	1.58E-06	1.18E-06
Mn-54	1.68E-05	1.52E-05	7.32E-06	1.81E-06	9.19E-07	5.54E-07	1.85E-07
Fe-55	1.36E-04	2.13E-04	4.14E-04	3.62E-04	3.19E-04	1.92E-04	1.11E-04
Co-58	3.04E-07	1.78E-08	3.96E-10	8.77E-12	2.84E-13	1.10E-14	2.31E-16
Ni-59	7.41E-09	1.50E-08	8.69E-08	1.19E-07	1.35E-07	9.20E-08	6.90E-08
Ni-63	4.04E-06	8.13E-06	2.73E-05	3.26E-05	3.69E-05	2.68E-05	2.00E-05
Nb-94	3.73E-07	7.55E-07	4.39E-06	5.98E-06	6.80E-06	4.62E-06	3.47E-06
Cs-137	1.46E-03	1.74E-03	4.46E-04	4.51E-04	3.25E-04	4.67E-04	3.42E-04
Sr-90	5.55E-06	6.68E-06	1.95E-06	1.82E-06	1.25E-06	1.87E-06	1.37E-06
Tc-99	2.98E-08	3.68E-08	1.03E-08	9.94E-09	7.45E-09	1.08E-08	8.07E-09
I-129	4.40E-08	5.36E-08	1.12E-08	1.16E-08	1.11E-08	1.28E-08	9.59E-09
Cs-134	1.80E-03	1.55E-03	4.08E-04	3.00E-04	1.06E-04	1.63E-04	8.72E-05
Pu-241	4.39E-06	1.54E-05	3.95E-06	1.98E-06	2.22E-06	1.79E-06	1.28E-06
U-235	1.24E-12	4.60E-12	9.42E-13	6.50E-13	7.08E-13	6.47E-13	4.85E-13
U-238	3.63E-11	1.35E-10	2.76E-11	1.90E-11	2.07E-11	1.90E-11	1.42E-11
Pu-238	3.73E-07	1.37E-06	2.23E-07	1.91E-07	1.97E-07	1.87E-07	1.39E-07
Pu-239	1.11E-07	4.12E-07	8.44E-08	5.82E-08	6.34E-08	5.80E-08	4.35E-08
Pu-240	2.66E-07	9.80E-07	2.02E-07	1.39E-07	1.51E-07	1.38E-07	1.04E-07
Am-241	5.89E-07	2.44E-06	7.57E-07	3.95E-07	4.93E-07	4.28E-07	3.21E-07
Cm-244	5.35E-08	1.90E-07	4.55E-08	2.49E-08	2.75E-08	2.30E-08	1.66E-08
In total:	**3.78E-03**	**4.15E-03**	**2.50E-03**	**2.24E-03**	**1.88E-03**	**1.63E-03**	**1.07E-03**

As it may be seen from the presented assessments, the biggest exposure, determined by the radioactive releases of the proposed economic activity, should be in the beginning of the project execution, in 2010–2011. The maximum annual effective dose constitutes approximately 4.2 μSv. In later years, in 2012–2015, doses will decrease and will vary in the interval of approximately 2.5–1 μSv.

4.9.3.3 Radiological Impact of Other Nuclear Energy Objects, Existing and Planned in the INPP Sanitary Protection Zone

According to the INPP Final Decommissioning Plan [4], the INPP decommissioning process is split into several decommissioning projects (DP). Each of these DP is a process covering a particular field of activity, defining scope of works and their specific and providing input for organization of specific activity, safety analysis and environmental impact assessment. In order to ensure that environmental impact assessment is based on reliable and detailed information, what becomes available along with the progress in the particular DP, the EIA Program of INPP decommissioning [5] provides to develop EIA reports separately for each DP. Every EIA report of a subsequent DP shall take into account results of previous reports. Thus the overall environmental impact due to INPP decommissioning would be assessed and controlled on the basis of the latest information, and environmental impact mitigation measures would be adequate to the real situation.

The proposed economic activity (reactor 2 final shutdown and SNF defueling stage project) is one of separate INPP decommissioning projects, performed according to the final INPP decommissioning plan.

Together with the proposed economic activity other DP will also be performed. Similar works according to the INPP decommissioning project for reactor unit 1 final shutdown and SNF defueling stages (i.e. project U1DP0) are performed wand will be further continued in unit 1. Environmental impact may be done during the performance of other INPP decommissioning projects, according to which decontamination and dismantling works of separate equipment will be performed, see the part "Decommissioning Projects" of the table in Chapter 2 2.1.

During the performance of the INPP decommissioning, construction of new nuclear objects and modification of existing ones are planned. Construction of the new Interim Spent Nuclear Fuel Storage Facility (ISFSF), Solid Radioactive Waste Management and Storage Facility (SWMSF), very low-level radioactive waste disposal facility (Landfill repository and VLLW storage facility) and low and intermediate level radioactive waste near-surface disposal facility is planned. Future activities foresee to convert presently operated Bituminized Waste Storage Facility into a disposal facility. Liquid radioactive waste Cement Solidification Facility (i.e., for grouting of spent ion-exchange resins and filter aid deposits) was started to operate in year 2006. Solidified waste will be temporary stored in the new Temporary Storage Facility, constructed in the INPP industrial site. Later on, the waste will be disposed of in the low and intermediate level radioactive waste near-surface disposal facility. The decision has already been made concerning extension of the existing spent nuclear fuel storage facility. In year 2006 VATESI appended the license conditions and allowed to store additionally 18 CONSTOR RBMK-1500 casks in the storage facility. One more modification is planned, which would increase the storage capacity by additional 10 CONSTOR RBMK-1500 casks.

Furthermore, a possibility to construct a new nuclear power plant with total electricity production up to 3400 MW is under consideration in Lithuania. The new NPP would be built in the existing sanitary protection zone of the INPP. Operation of the first energy unit of the new NPP is planned after 2015.

Existing and planned nuclear facilities (NF), located in the Ignalina NPP sanitary protection zone of 3 km radius are shown in Fig. 4.9.6. INPP decommissioning projects and activity of radioactive waste management equipment during the implementation of the proposed economic activity are summarized in Fig. 4.9.7.

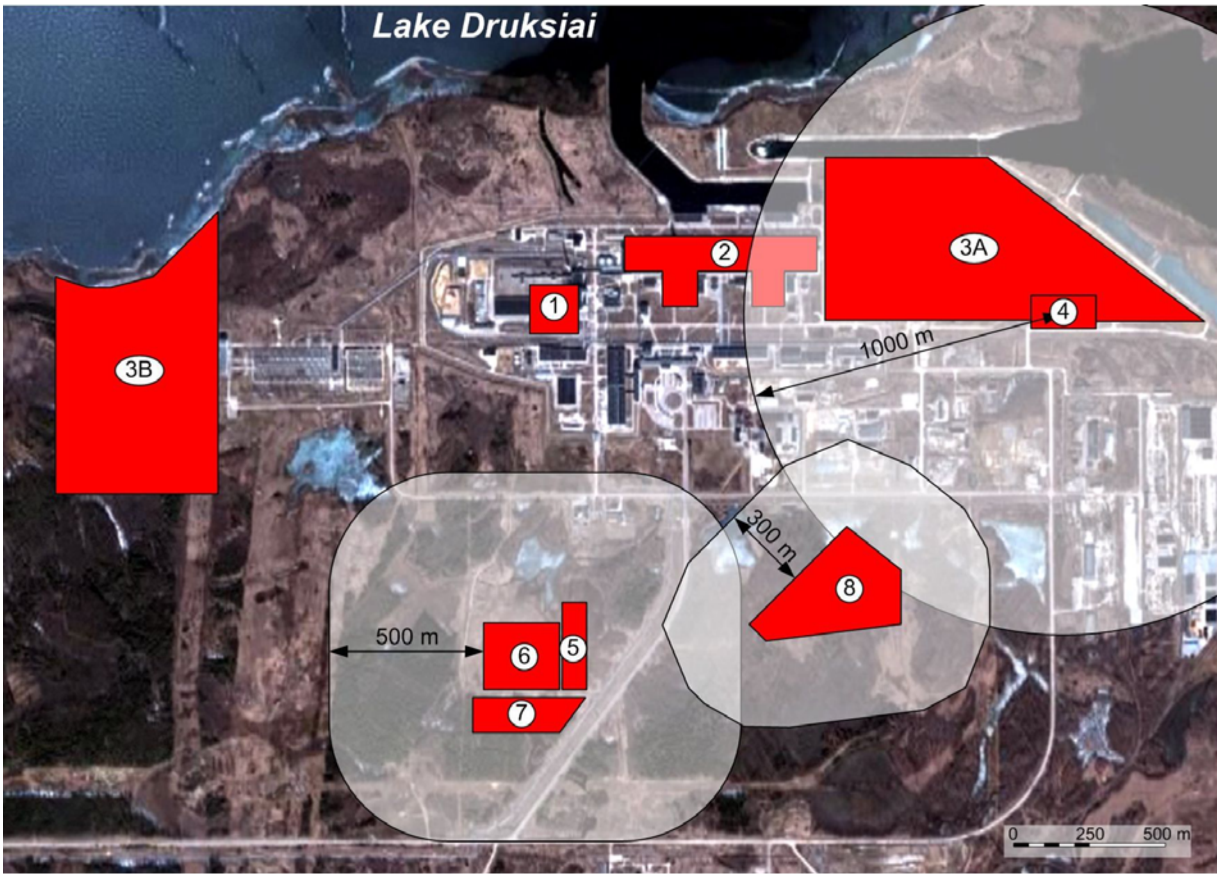

Fig. 4.9.6. Existing and planned nuclear facilities, located in the Ignalina NPP sanitary protection zone (SPZ) of 3 km radius

(1) – Existing bituminized radioactive waste storage facility and new interim storage facility for solidified radioactive waste (spent ion-exchange resins and filter aid deposits). Both storage facilities are located inside the INPP industrial site and presently do not have their separate Sanitary Protection Zones (SPZ). During INPP decommissioning it is planned to convert bituminized waste storage facility into a disposal facility. A separate SPZ will be foreseen during development of EIA documents for this disposal facility.

(2) – Reactor Units of Ignalina NPP. The INPP existing SPZ is an area of 3 km radius around the Reactor Units.

(3A), (3B) – alternative sites for the newly planned NPP. Depending on reactor type, experts propose new INPP SPZ of 1-3 km radius. The shortest distance from the planned sites to the INPP existing SPZ limit is approximately 1.5 km.

(4) – Existing Spent Nuclear Fuel (SNF) storage facility. The design of the storage facility defines a 1 km radius SPZ around this NF. SPZ of the storage facility falls within boundaries of INPP existing SPZ and presently is not allocated separately.

(5), (6) – The new interim SNF storage facility (ISFSF) and Solid radioactive Waste Treatment and Storage Facility (SWTSF). These NF will be close to each other, their SPZ will overlap, and the NF will have a common security fence. EIA Reports foresee a common SPZ of about 500 m width for both NF.

(7) – One of the proposed sites (southern) for very low-level radioactive waste disposal facility (Landfill). A 50 m width SPZ is planned in the EIA report.

(8) – Disposal vaults of the planned low and intermediate level radioactive waste near-surface disposal facility in the Stabatiskes site. EIA Report defines SPZ as area enveloping 300 m distance from the disposal vaults. The layout of the facility is preliminary and shall be detailed during development of technical design.

(9) – Very low level radioactive waste disposal storage facility. The SPZ of the storage facility falls into the limits of the INPP SPZ.

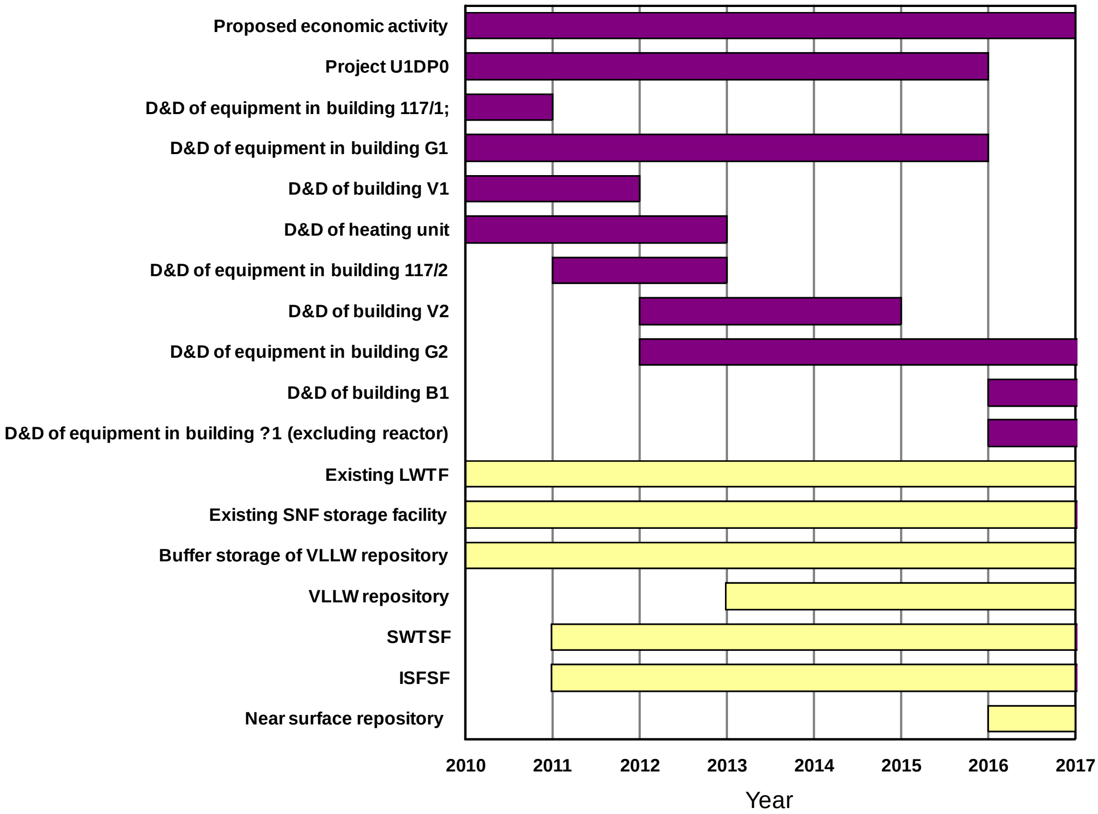

Fig. 4.9.7. INPP decommissioning projects and activity of radioactive waste management equipment during the period of the proposed economic activity

Radiological impact of nuclear facilities, existing and planned in the INPP sanitary protection zone, is discussed in sections below.

4.9.3.3.1 Radioactive Discharges to the Environment and Radiological Impact during the Execution of the Unit 1 Decommissioning Project for the SNF Defueling Phase (U1DP0)

Radioactive discharges and radiological environmental impact during the execution of the INPP decommissioning project of Unit 1 reactor final shutdown and SNF defueling stage (see Fig. 4.9.8) are assessed in the design [6] and the EIA report [7].

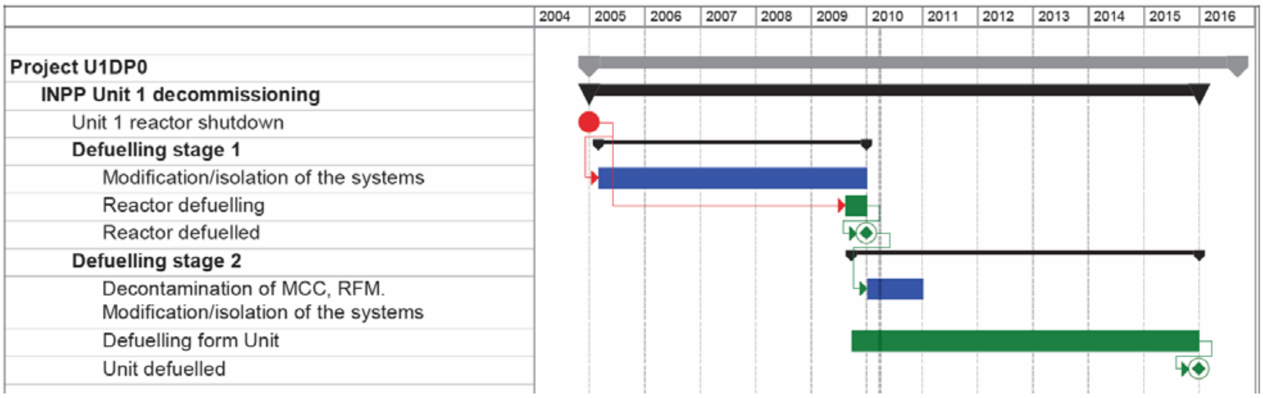

Fig. 4.9.8. Implementation stages of the Project U1DP0

Assessment were made with the premise that operation of the new ISFSF, SWMSF and VLLW repository will start in 2008, and SNF may be defueled from reactor 1 before the end of 2008. Also the first stage of modification and isolation works of existing systems would be finished (performed when SNF is in the reactor). Then decontamination works of the main reactor circuits in unit 1 could start in the beginning of 2009.

Since the implementation of the ISFSF, SWMSF and VLLW repository projects is still unfinished, activity is corrected accordingly during the implementation of project U1DP0. It is planned that SNF defueling from reactor 1 will be finished before the end of 2009, and circuit decontamination works in unit 1 will be performed in 2010, see Chapter 1. With the change of the work timetable, radioactive releases to the environment, assessed in [6, 7] and radiological impact forecast are revised. Releases generated by execution of project U1DP0 were re-calculated with regard to the corrected work timetable in the following way:

$$N_{j1,T} = N_{j1,0} \times \exp\left(-\lambda_j \times T_{1K}\right),$$

Where

T_{1K} is revised time of planned releases after the final reactor shutdown of unit 1;

λ_j is the radioactive decay constant of radionuclide j;

$N_{j1,0}$ is initial activity of separate decommissioning actions (i.e. activity, re-calculated for the final reactor shutdown date), see Sections 4.1.5.2.1 and 4.2.3.2.1.

The revised radioactive releases to the environmental air and environmental water, generated by U1DP0 activity, are summarized in Fig. 4.9.9 below. Radionuclide content of annual releases is detailed in Table 4.9.3 and Table 4.9.4.

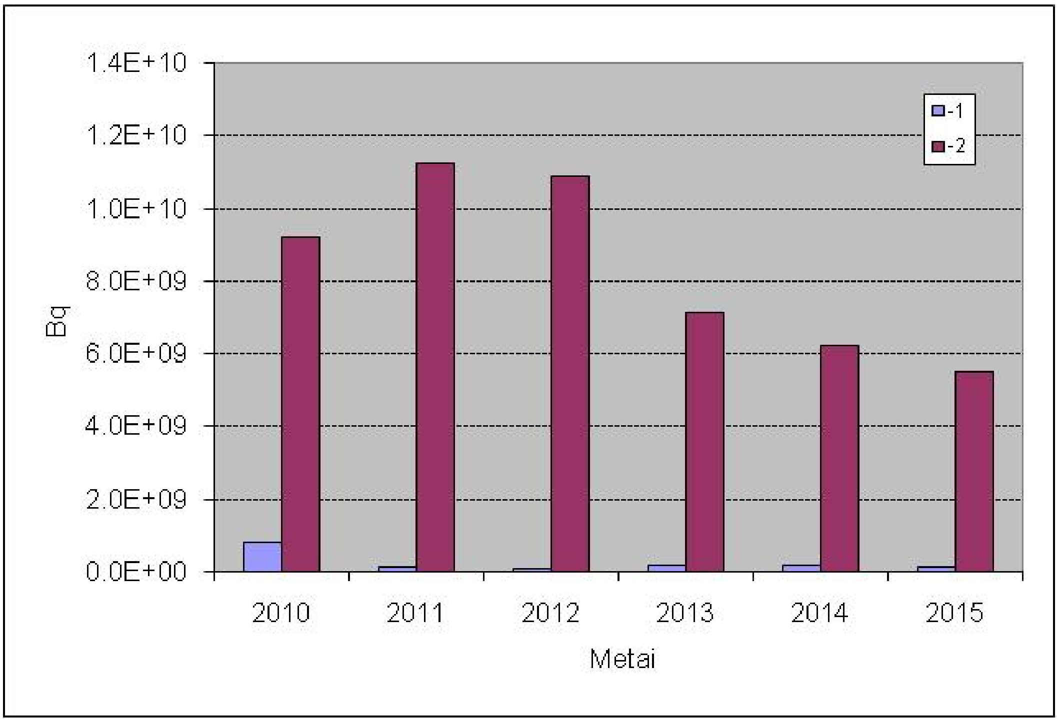

Fig. 4.9.9. Revised annual radioactive releases (Bq) to the environment during the execution of unit 1 decommissioning project for SNF defueling phase (U1DP0), 1– releases to environmental water, 2 – releases to environmental air

Table 4.9.3. Revised annual radionuclide releases (Bq) into environmental water during the execution of unit 1 decommissioning project for SNF defueling phase (U1DP0)

Radionuclides	Year					
	2010	**2011**	**2012**	**2013**	**2014**	**2015**
Co-60	2.02E+08	2.04E+07	2.05E+07	3.02E+07	2.64E+07	2.32E+07
C-14	2.33E+06	2.52E+05	2.90E+05	4.91E+05	4.91E+05	4.91E+05
Mn-54	4.58E+06	2.96E+05	1.50E+05	1.13E+05	5.03E+04	2.24E+04
Fe-55	4.11E+08	3.99E+07	3.53E+07	4.57E+07	3.54E+07	2.74E+07
Co-58	1.41E-01	1.06E-03	3.41E-05	1.65E-06	4.62E-08	1.29E-09
Ni-59	4.84E+05	5.31E+04	6.06E+04	9.95E+04	9.95E+04	9.95E+04
Ni-63	1.10E+08	1.18E+07	1.34E+07	2.22E+07	2.21E+07	2.19E+07
Nb-94	9.24E+05	1.01E+05	1.15E+05	1.89E+05	1.89E+05	1.89E+05
Cs-137	7.15E+07	7.17E+07	2.29E+07	7.22E+07	7.06E+07	6.90E+07
Sr-90	4.97E+05	4.29E+05	1.50E+05	4.31E+05	4.20E+05	4.11E+05
Tc-99	3.84E+04	3.39E+04	1.22E+04	3.57E+04	3.57E+04	3.57E+04
I-129	2.96E+02	3.03E+02	9.87E+01	3.20E+02	3.20E+02	3.20E+02
Cs-134	1.52E+07	1.11E+07	2.59E+06	5.99E+06	4.28E+06	3.05E+06
Pu-241	1.08E+07	3.84E+05	2.14E+06	3.53E+05	3.36E+05	3.20E+05
U-235	2.44E+00	9.14E-02	5.32E-01	9.24E-02	9.24E-02	9.24E-02
U-238	7.46E+01	2.78E+00	1.63E+01	2.80E+00	2.80E+00	2.80E+00
Pu-238	1.45E+05	5.42E+03	3.13E+04	5.39E+03	5.34E+03	5.30E+03
Pu-239	4.11E+04	1.53E+03	8.97E+03	1.54E+03	1.54E+03	1.54E+03
Pu-240	9.75E+04	3.67E+03	2.13E+04	3.71E+03	3.71E+03	3.71E+03
Am-241	3.26E+05	1.27E+04	7.84E+04	1.40E+04	1.40E+04	1.39E+04
Cm-244	3.39E+04	1.22E+03	6.85E+03	1.15E+03	1.10E+03	1.06E+03
In total:	**8.30E+08**	**1.57E+08**	**9.77E+07**	**1.78E+08**	**1.60E+08**	**1.46E+08**

Table 4.9.4. Revised annual radionuclide releases (Bq) into environmental air during the execution of unit 1 decommissioning project for SNF defueling phase (U1DP0)

Radionuclides	Year					
	2010	**2011**	**2012**	**2013**	**2014**	**2015**
Co-60	1.90E+09	2.42E+09	2.42E+09	1.66E+09	1.45E+09	1.27E+09
C-14	1.80E+07	2.60E+07	2.99E+07	2.42E+07	2.42E+07	2.42E+07
Mn-54	1.63E+07	8.22E+06	4.18E+06	2.41E+06	1.07E+06	4.75E+05
Fe-55	5.08E+09	5.80E+09	5.11E+09	2.97E+09	2.30E+09	1.78E+09
Co-58	8.96E-01	2.94E-02	9.52E-04	3.53E-05	9.87E-07	2.76E-08
Ni-59	1.36E+07	2.10E+07	2.39E+07	1.60E+07	1.60E+07	1.60E+07
Ni-63	1.64E+09	2.45E+09	2.78E+09	1.97E+09	1.95E+09	1.94E+09
Nb-94	2.59E+07	4.00E+07	4.55E+07	3.05E+07	3.05E+07	3.05E+07
Cs-137	4.00E+08	4.06E+08	4.06E+08	4.29E+08	4.19E+08	4.10E+08
Sr-90	2.43E+06	2.47E+06	2.46E+06	2.59E+06	2.53E+06	2.47E+06
Tc-99	1.88E+05	1.95E+05	1.99E+05	2.15E+05	2.15E+05	2.15E+05
I-129	1.65E+03	1.72E+03	1.76E+03	1.90E+03	1.90E+03	1.90E+03
Cs-134	8.50E+07	6.32E+07	4.61E+07	3.56E+07	2.54E+07	1.81E+07
Pu-241	8.50E+06	7.40E+06	7.21E+06	6.68E+06	6.37E+06	6.07E+06

U-235	1.93E+00	1.76E+00	1.80E+00	1.75E+00	1.75E+00	1.75E+00
U-238	5.90E+01	5.38E+01	5.51E+01	5.36E+01	5.36E+01	5.36E+01
Pu-238	1.15E+05	1.04E+05	1.06E+05	1.02E+05	1.01E+05	1.01E+05
Pu-239	3.25E+04	2.96E+04	3.03E+04	2.95E+04	2.95E+04	2.95E+04
Pu-240	7.73E+04	7.05E+04	7.21E+04	7.02E+04	7.02E+04	7.02E+04
Am-241	2.58E+05	2.48E+05	2.65E+05	2.69E+05	2.68E+05	2.68E+05
Cm-244	2.69E+04	2.36E+04	2.32E+04	2.18E+04	2.09E+04	2.01E+04
In total:	**9.19E+09**	**1.12E+10**	**1.09E+10**	**7.14E+09**	**6.23E+09**	**5.50E+09**

Dose calculation methodology is analogous to the methodology, described in Sections 4.1.5.2.2 (releases to environmental water) and 4.2.3.2.2 (releases to environmental air). Annual exposure (annual effective doses) of a member of the critical inhabitant group of the INPP environment, generated by revised radioactive releases (to environmental water and environmental air) due to U1DP0 activity is summarized in Fig. 4.9.10. Contribution of separate radionuclides to annual exposure is detailed in Table 4.9.5.

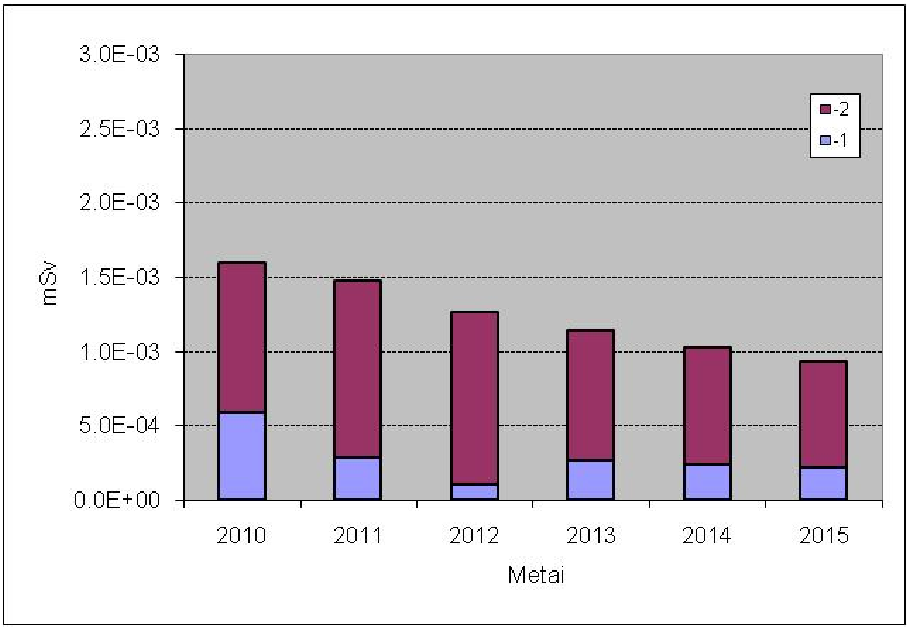

Fig. 4.9.10. Annual effective dose (mSv) due to revised radioactive releases of U1DP0 activity: 1 – to environmental water, 2 – to environmental air

Table 4.9.5. Annual effective dose (mSv), determined by separate radionuclides due to revised radioactive releases (to environmental water and environmental air) of U1DP0 activity

Radionuclides	Year					
	2010	2011	2012	2013	2014	2015
Co-60	7.95E-04	7.28E-04	7.28E-04	5.18E-04	4.54E-04	3.98E-04
C-14	7.26E-06	8.39E-07	9.66E-07	1.58E-06	1.58E-06	1.58E-06
Mn-54	6.41E-07	1.58E-07	8.05E-08	4.86E-08	2.16E-08	9.59E-09
Fe-55	1.92E-04	1.68E-04	1.48E-04	8.88E-05	6.87E-05	5.31E-05
Co-58	8.68E-15	1.92E-16	6.23E-18	2.41E-19	6.74E-21	1.89E-22
Ni-59	8.69E-08	1.19E-07	1.35E-07	9.19E-08	9.19E-08	9.19E-08
Ni-63	2.67E-05	3.19E-05	3.62E-05	2.62E-05	2.61E-05	2.59E-05

Radionuclides	Year					
	2010	2011	2012	2013	2014	2015
Nb-94	4.38E-06	5.98E-06	6.80E-06	4.62E-06	4.62E-06	4.62E-06
Cs-137	4.16E-04	4.21E-04	3.04E-04	4.36E-04	4.26E-04	4.16E-04
Sr-90	1.81E-06	1.70E-06	1.16E-06	1.74E-06	1.70E-06	1.66E-06
Tc-99	1.03E-08	9.94E-09	7.45E-09	1.08E-08	1.08E-08	1.08E-08
I-129	1.12E-08	1.16E-08	1.11E-08	1.28E-08	1.28E-08	1.28E-08
Cs-134	1.49E-04	1.09E-04	3.87E-05	5.94E-05	4.24E-05	3.03E-05
Pu-241	3.42E-06	1.71E-06	1.92E-06	1.55E-06	1.48E-06	1.41E-06
U-235	9.42E-13	6.50E-13	7.08E-13	6.47E-13	6.47E-13	6.47E-13
U-238	2.76E-11	1.90E-11	2.07E-11	1.90E-11	1.90E-11	1.90E-11
Pu-238	2.18E-07	1.86E-07	1.92E-07	1.83E-07	1.81E-07	1.80E-07
Pu-239	8.44E-08	5.82E-08	6.34E-08	5.80E-08	5.80E-08	5.80E-08
Pu-240	2.01E-07	1.39E-07	1.51E-07	1.38E-07	1.38E-07	1.38E-07
Am-241	7.53E-07	3.93E-07	4.91E-07	4.26E-07	4.26E-07	4.25E-07
Cm-244	4.06E-08	2.22E-08	2.45E-08	2.05E-08	1.97E-08	1.90E-08
In total:	**1.60E-03**	**1.47E-03**	**1.27E-03**	**1.14E-03**	**1.03E-03**	**9.34E-04**

As it may be seen from the presented assessments, the biggest exposure, determined by radioactive releases due to U1DP0 activity, should be in 2010. The maximum annual effective dose constitutes 1.6 µSv. In later years until the end of the project execution doses will decrease and will vary in the interval of approximately 1.5–1 µSv.

4.9.3.3.2 Radiological Impact during the Operation of the INPP Cementation Equipment for Solidification of Liquid Radioactive Waste

In 2006 the operation of a new cementation equipment for solidification of liquid radioactive waste (spent ion-exchange resins and perlite sediment), mixing them with cement, was begun in the INPP. The cementation equipment was installed in the existing INPP liquid radioactive waste treatment facility (building 150), and it is integrated into the engineering supply and maintenance systems, existing in the building. The manufactured packages of solidified radioactive waste are put for interim storage in the new interim storage facility, built on the INPP site. The interim storage facility is designed in such a way that packages of solidified waste may be safely stored in it for up to 60 years. Storage will be temporary, later packages of solidified radioactive waste will be disposed of in the near surface low and intermediate radioactive waste repository.

The radiological environmental impact of the cementation equipment is assessed in the EIA Report for the Cementation Equipment and Interim Storage Facility [8]. Annual exposure (annual effective dose) of a member of the critical inhabitant group of the INPP environment due to radioactive releases to the environment from the cementation equipment and the interim storage facility constitutes approximately 0.4 µSv.

4.9.3.3.3 Radiological Impact during the Implementation of INPP Equipment Dismantling Works

Pressurized tanks and piping of unit 1 emergency cooling systems and helium make up station are installed in building 117/1 of the INPP. Radioactive contamination of these systems is insignificant. Radiological impact during equipment decontamination and dismantling works in the INPP building 117/1 is assessed in the EIA report [9]. Calculations have shown that annual exposure (annual effective dose) for a member of the critical inhabitant group of the INPP environment due to radioactive releases into the environment will not reach 0.0004 µSv. Possible radiological impact is assessed as especially small, and therefore it is not further analysed.

Environmental impact assessment of other planned INPP equipment dismantling and decontamination works have not been performed yet. Currently there are no results of their possible radiological environmental impact.

4.9.3.3.4 Radiological Impact during the Transfer of SNF from Reactor Units to the New ISFSF

Radiological impact during the transfer of SNF from reactor units to the new ISFSF is assessed in the ISFSF EIA report [10]. Radiological impact assessment encompasses packaging and transfer of all SNF from both reactor units, with regard to possibly bigger releases when managing fuel of higher initial enrichment (2.8% U-235) and stored in cooling pools for a minimum amount of time, also when managing leaking and mechanically damaged fuel assemblies. Annual exposure (annual effective dose) of a member of the critical inhabitant group of the INPP environment due to radioactive releases into the environment changes from 0.0008 to 0.42 μSv depending on characteristics of managed fuel.

4.9.3.3.5 Radiological Impact during the Management of Solid Radioactive Waste in the New SWMSF

Radiological impact during the management of solid radioactive waste in the new SWMSF is assessed in the SWMSF EIA report [11]. Radioactive releases into the environment and public exposure were assessed based on the design capacity of the planned equipment conservatively taking into account activity of treated radioactive materials and treated amounts. Assessments were made for two stages of radioactive waste. During the first stage management of solid waste, generated during the INPP operation as well as during the decommissioning, is performed. This stage lasts for approximately 10 years; the proposed economic activity will be performed during this stage, too. Annual exposure (annual effective dose) of a member of the critical inhabitant group of the INPP environment due to radioactive releases into the environment during the first SWMSF activity stage constitutes approximately 7.4 μSv, approximately 4.4 μSv of which are determined by radioactive releases from the SWRF, and 3 μSv are determined by radioactive releases from the SWTSF.

4.9.3.3.6 Radiological Impact during the Operation of the New Very Low Level Solid Radioactive Waste Repository Storage Facility and Repository Modules

Radiological impact during storage of very low level solid radioactive waste in the new VLLW near surface repository storage facility and disposing of them in the VLLW repository is assessed in the VLLW EIA report [12].

The impact of radioactive releases into the environment will be very small. The maximum annual effective dose due to radioactive releases into environmental air from the VLLW storage facility constitutes 0.0025 μSv. The maximum annual effective dose due to radioactive releases into environmental air from the VLLW repository modules constitutes 0.0006 μSv.

4.9.3.3.7 Radiological Impact during the Operation of the New NPP

A possibility to build a new nuclear power plant with the power of up to 3,400 MW is researched in Lithuania. The number of nuclear reactors would vary from 1 to 5, depending on the chosen technology.

The newest III and III+ reactors constitute the technological alternatives, assessed in the EIA report of the new NPP [13]:

- Boiling water reactor (BWR);
- Pressurized water reactor (PWR);
- Pressurized hard water reactor (PHWR).

The new NPP would be built in the existing sanitary protection zone of the Ignalina NPP, Fig.

4.9.6. It is foreseen that the operation of the first unit of the new NPP would start after 2015. In the case of two or more reactors operation of the second reactor would start at least after two years, i.e. not before 2017.

Annual exposure of a member of the critical inhabitant group of the INPP environment due to radioactive releases into the environment during the operation of one reactor of the new NPP [13] is summarized in Table 4.9.6. Depending on the type and power of the chosen reactor, annual effective dose of a member of a critical inhabitant group of the INPP environment would vary from 1.4 to 8.6 μSv.

Table 4.9.6. Annual effective dose (mSv) of a member of the critical inhabitant group of the INPP environment due to radioactive releases into the environment during operation of one reactor of the new NPP

Reactor type	**BWR**		**PWR**					**PHWR**
Model	**ABWR**	**ESBWR**	**EPR**	**APWR**	**AP-600**	**AP-1000**	**WWER**	**EC-6**
Electrical power, MW	1300	1535	1660	1700	600	1100	995	750
Annual effective dose, mSv								
Due to releases into the air	3.36E-03	4.24E-03	8.19E-04	6.60E-04	1.14E-03	1.65E-03	5.04E-04	2.62E-03
Due to releases into the water	3.04E-03	4.40E-04	3.75E-03	7.96E-03	4.17E-03	5.38E-03	8.93E-04	5.63E-03
In total:	**6.40E-03**	**4.68E-03**	**4.57E-03**	**8.62E-03**	**5.31E-03**	**7.03E-03**	**1.40E-03**	**8.25E-03**

4.9.3.4 Total Radiological Impact of the Proposed Economic Activity and Other Nuclear Energy Objects, Existing and Planned in the INPP Sanitary Protection Zone

During the complex radiological impact assessment other activities, performed at the same time on the INPP industrial site and the INPP sanitary protection zone, that may also determine additional increase in public exposure, must be taken into account.

Radiological impact due to the planned radioactive releases from the nuclear facilities on the INPP site during the period of the proposed economic activity is summarized in Fig. 4.9.11 and Table 4.9.7.

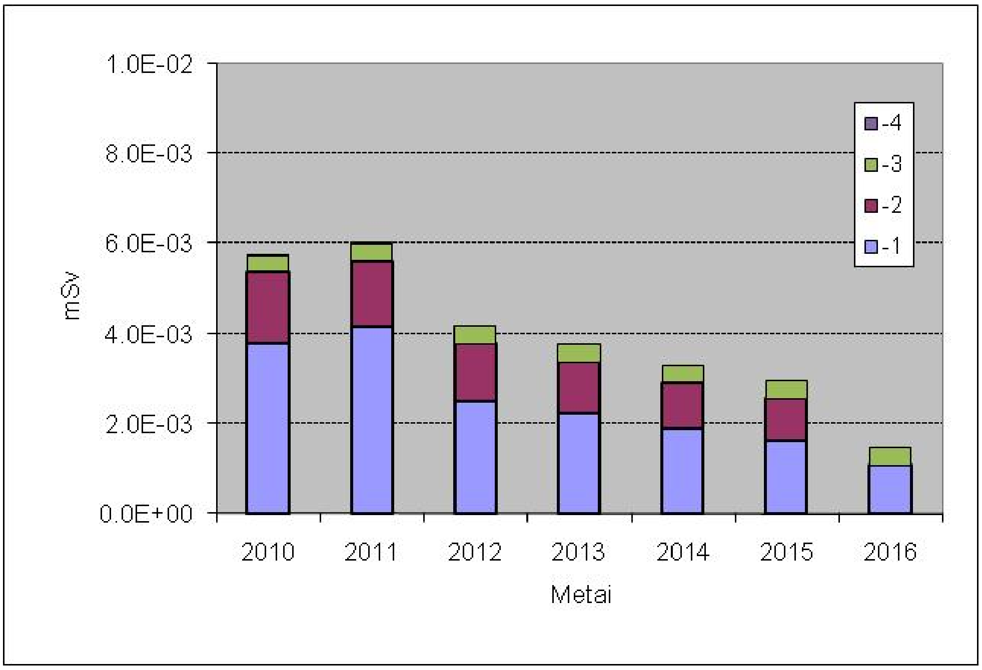

Fig. 4.9.11. Annual effective dose (mSv) due to the planned radioactive releases from the nuclear facilities on the INPP site. Impact sources: 1 – planned economic activity, 2 – U1DP0 activity, 3 – INPP grouting equipment, 4 – decontamination and dismantling of equipment of building 117/1

Table 4.9.7. Annual effective dose (mSv) due to the planned radioactive releases to environmental water and environmental air from the nuclear facilities on the INPP site

No.	Impact source	Year						
		2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1	Radioactive releases to the environment due to the proposed economic activity	3.78E-03	4.15E-03	2.50E-03	2.24E-03	1.88E-03	1.63E-03	1.07E-03
2	U1DP0 revised radioactive releases to the environment	1.60E-03	1.47E-03	1.27E-03	1.14E-03	1.03E-03	9.34E-04	0.00E+00
3	Radioactive releases to the environment of the INPP grouting equipment and interim storage facility	3.98E-04	3.98E-04	3.98E-04	3.98E-04	3.98E-04	3.98E-04	3.98E-04
4	Radioactive releases to the environment due to D and D of the equipment of building 117/1	3.76E-07	3.76E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	In total:	**5.78E-03**	**6.02E-03**	**4.17E-03**	**3.78E-03**	**3.31E-03**	**2.96E-03**	**1.47E-03**

As may be seen, annual effective dose determined by radioactive releases from the NF on the INPP site in 2010–2016 may reach approximately 6 μSv. The planned annual exposure is significantly smaller than the public annual effective dose constraint, set by radiation protection requirements, which is 200 μSv.

During the environmental impact assessments of new nuclear objects, newly planned in the INPP SPZ [10, 11, 12], it was planned that annual effective dose of radioactive releases from the INPP site may constitute 10 μSv. Results of this assessment show that the planned impact of INPP decommissioning is not exceeded, and it is not necessary to revise earlier performed total impact assessments of new nuclear objects in potential impact zones. It will be possible to perform the proposed economic activity may be performed together with other proposed INPP decommissioning activities in the existing SPZ of the INPP, without breaching valid radiation protection requirements.

Radiological impact due to radioactive releases, generated by the INPP decommissioning activity on the INPP site and operation of the newly planned SNF and solid radioactive waste management, storage and repository facilities in 2010–2016, is summarized in Table 4.9.8. Annual effective dose due to radioactive releases from the existing and newly planned NF on the INPP SPZ in 2010–2016 constitutes approximately 6–19 μSv. The planned annual exposure is significantly smaller than the public annual effective dose constraint, set by radiation protection requirements, which is 200 μSv. Significant impact of direct ionizing radiation, as shown by impact assessment results of separate NF [10–13], is felt only in close environment of these NF and may be limited by certain design solutions.

Table 4.9.8. Annual effective dose (mSv) due to the planned radioactive releases to environmental water and environmental air from the nuclear facilities on the INPP site and newly planned nuclear facilities on the INPP SPZ

No.	Impact source	Year						
		2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1	iNPP decommissioning activity, performed on the INPP site	5.78E-03	6.02E-03	4.17E-03	3.78E-03	3.31E-03	2.96E-03	1.47E-03
2	Transfer of SNF to ISFIS	0.00E+00	4.15E-04	4.15E-04	4.15E-04	4.15E-04	4.15E-04	4.15E-04
3	Retrieval of solid radioactive waste in SWRF	0.00E+00	4.48E-03	4.48E-03	4.48E-03	4.48E-03	4.48E-03	4.48E-03
4	Management of solid radioactive waste in SWTSF	0.00E+00	2.94E-03	2.94E-03	2.94E-03	2.94E-03	2.94E-03	2.94E-03
5	Management of solid radioactive waste in VLLW storage facility and repository	2.54E-06	3.10E-06	3.10E-06	3.10E-06	3.10E-06	3.10E-06	3.10E-06
6	Operation of one unit of the new NPP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.62E-03	8.62E-03
	In total:	**5.77E-03**	**1.39E-02**	**1.20E-02**	**1.16E-02**	**1.11E-02**	**1.94E-02**	**1.79E-02**

4.9.3.5 Dose to workers temporary working in SPZ of INPP

Lithuanian Hygiene Standard HN 87:2002 [2] states that persons who are permanently or temporarily employed at a nuclear facility or other objects related to operation or maintenance of a nuclear facility, as well as located within the sanitary protection zone of a nuclear facility, and who are not assigned to workers of either category A or category B shall be subject to the dose limit of 1 mSv per year, set out by the Hygiene Standard HN 73:2001 [1]. During the implementation of different Ignalina NPP decommissioning projects or during construction of the new NPP the workers who will carry out specific activities at INPP site or within existing INPP SPZ of 3 km fall within this category. It is expected that during the implementation period (2010-2016) of the proposed economic activity, in parallel other INPP decommissioning projects and the new NPP construction project will be carried out in the existing territory of INPP SPZ and the following nuclear facilities will be built:

- Interim Spent Fuel Storage Facility (ISFSF);
- Solid radioactive waste treatment and storage facility (SWTSF);
- Very low level radioactive waste disposal facility (VLLW buffer storage facility and VLLW repository);
- Near surface repository for short-lived low and intermediate level radioactive waste;
- Buildings of the new nuclear power plant.

Location of the existing and planned nuclear facilities in the existing INPP SPZ is shown in Fig. 4.9.6.

Assessment of the radiological impact to builders working within SPZ due to the radioactive releases from the existing and planned nuclear facilities and from the direct radiation from these facilities is presented below.

Radiological impact due to the releases from the nuclear facilities at INPP site during the implementation period of the proposed economic activity is summarized in Fig. 4.9.11 and Table 4.9.7. Since the releases will be from the existing INPP facilities (i.e. from reactor Units, liquid radioactive waste treatment facility, etc.), dose conversation factors specified in the normative document LAND 42-2007 [3] are used for evaluation of exposure caused by radionuclide dispersion through water (see Section 4.1.5.2) and air (see Section 4.2.3.2) pathways. These dose conversation factors consider the impacts due to the radioactive releases from existing INPP facilities and are defined taking into account specific radionuclide dispersion parameters at INPP site and lifestyle and nutrition habits of population in the INPP region. Dose conversation factors were defined making conservative assumptions also including rather conservative assumptions for lifestyle peculiarities of critical group member: exposure was calculated at the place of the highest radionuclide concentration, applying the maximal expected time duration of exposure and assuming two times higher foodstuff consumption rate than average value. Applied lifestyle peculiarities of critical group member also include possible behaviour of the builders – working at zone of maximum impact during the whole year, increased consumption of the local foodstuffs, etc. Therefore, annual exposure of the builders will not exceed of the exposure of critical groups of the population which are considered in LAND 42-2007, i.e. farmers, fishermen and gardeners. As can be seen from the Fig. 4.9.11 and Table 4.9.7, annual effective dose to builder due to radioactive releases from nuclear facilities at INPP site during 2010–2016 will be about 6 μSv.

Radiological impact due to radioactive releases caused by the implementation of INPP decommissioning activities and operation of the new SNF and solid radioactive waste treatment, storage and disposal facilities during 2010-2016 is summarized in Table 4.9.8. In this table beside the impact from the above mentioned existing INPP nuclear facilities, impact due to radioactive releases caused by newly built INPP nuclear facilities and from operation of the new NPP is evaluated additionally. Estimation of the impacts from the new INPP nuclear facilities and new NPP is performed conservatively applying dose conversion factors provided in LAND 42-2007

[10], [13] or if other radionuclide dispersion methods for impact assessment were used [11] it was assumed that person remains in the zone of maximum radiological impact not less 2000 hours in a year. Lifestyle peculiarities of critical group member used in this assessment also comprise the possible behaviour of the builders in case of most unfavourable conditions. Exposure time of 730 hours per year within the existing INPP SPZ was assumed in EIA study for VLLW buffer storage and repository facility [12]. Builders working time per year can be about 2.7 times longer; therefore exposure will be higher respectively. However, calculated effective dose is rather small (0.0031 μSv). Thus even a few times possibly higher effective dose will not change the results of the total impact. As can be seen Table 4.9.8, annual effective dose due to the radioactive releases from the existing and planned nuclear facilities at INPP SPZ during 2010-2016 will be about 6 – 19 μSv.

Dose and dose rate monitoring results at INPP site as well as results of EIA assessments for the new nuclear facilities have shown that the highest impact due to direct radiation is only relevant at short distances from certain nuclear facility.

ISFSF, SWTSF, VLLW repository and near surface repository for low and intermediate level radioactive waste sites are at the distance of about 1 km from the existing INPP nuclear facilities, therefore impact due to direct radiation from these existing facilities to builders of the new nuclear facilities will be insignificant. According to the report [17] of INPP monitoring results in 2008, average dose rate measured by the stationary detectors of the “Skylink” system within the SPZ was about 1.03E-04 mSv/h. It should be noted that detectors of the “Skylink” system detect the total dose from the nuclear facilities and from the natural radiation background. Assuming that builders of ISFSF, SWTSF, VLLW repository and near surface repository for low and intermediate level radioactive waste will work 2000 hours per year, annual effective dose to builders also including natural radiation background will not exceed 0.21 mSv per year. Similar exposure will be to the builders of VLLW buffer storage facility. Even the distances from the existing NF to this buffer storage are shorter, however measured dose rate by the detector of “Skylink” system located close to the VLLW buffer storage facility building site is not higher than average dose rate measured within SPZ in 2008. The highest exposure will be to the builders of the new NPP working in surroundings of the existing SNF storage facility. According to SNF storage facility annual operation report [18] average measured gamma and neutron dose rate around the perimeter of security fence of storage facility including natural radiation background was 3.58E-04 mSv/h in 2008. Conservatively assuming that builders of the new NPP spend the whole 2000 hours per year at the security fence of the SNF storage facility the annual dose to builders could be 0.72 mSv.

It can be concluded, that builders of the new nuclear facilities in the territory of INPP SPZ will receive insignificant exposure less than 0.014 mSv per year from the radioactive releases into environment. The highest exposure – about 0.72 mSv per year – will receive builders of the new NPP due to direct radiation from the existing SNF storage facility. However, even in the case of maximal exposure the annual dose limit of 1 mSv/year defined in HN 73:2001 [1] will not be exceeded.

4.9.3.6 Radiological Impact Mitigation Measures

The proposed economic activity will not negatively change the existing radiological condition beyond the limits of the INPP industrial site. A sanitary protection zone with a radius of 3 km is set around the INPP site, where there are no permanent inhabitants, and economic activity is limited there. Monitoring of the impact of ionizing radiation and possible changes in the environment is performed in the INPP environment. The maximum annual public exposure (effective dose) due to radioactive releases of the proposed economic activity will constitute approximately 4.2 μSv. It will be possible to perform the proposed economic activity together with other proposed INPP decommissioning activities in the existing SPZ of the INPP, without breaching valid radiation protection requirements. Impact mitigation measures, meant to decrease radiological contamination of environmental water and environmental air, generated by the proposed economic activity, are discussed in Chapters 4.1.5.3 and 4.2.3.3 correspondingly.

4.9.4 Summary of Impact on Public Health

With regard to the requirements of Methodological Guidelines for the Assessment of the Impact on Public Health [14], the most important factors of the proposed economic activity and impacts on public health are summarized and assessed in this chapter.

Direct and indirect impact of the proposed economic activity on factors that influence public health is summarized in Table 4.9.9. Possible impact on public groups is summarized in Table 4.9.10. Assessment of impact peculiarities is presented in Table 4.9.11.

Table 4.9.9. Direct and indirect impact of the proposed economic activity on factors that influence public health

Factors that influence health	Kind of activity or means, contamination sources	Impact on factors influencing health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
1. Factors of behaviour and lifestyle (nutrition habits, alcohol consumption, smoking, consumption of narcotic and psychotropic drugs, safe sex and other)	Impact sources are not foreseen	Not foreseen				The proposed economic activity will be implemented on the existing INPP industrial site and will not influence the way of lifestyle of inhabitants. The activity will be performed by existing INPP personnel. Working conditions will be assured in accordance with requirements or regulations in force.
2. Factors of physical environment						
2.1. Air quality	Airborne releases from reactor unit 2 and existing INPP radioactive waste treatment equipment or other INPP buildings during the proposed economic activity: SNF defueling and management, operation and maintenance of necessary systems, modification and isolation of unnecessary systems, in-line decontamination	Local increase of atmospheric contamination, radionuclide dispersion in environmental components	(–)	Impact of the proposed economic activity will be insignificant. The existing situation in the INPP environment will not change in essence. Releases to environmental air and environmental contamination will be the same or smaller as during INPP operation conditions. Changes will be temporary and reversible.	Releases to the environment are performed pursuing conditions, set in the Permit for Integrated Pollution Prevention and Control.	Air contamination and air quality in the INPP environment will be determined by other equipment, activity of which after the shutdown of both INPP reactors will become necessary. They are a new steam boiler room, old and new heat boilers, new radioactive waste burning equipment. Also releases will be determined by equipment dismantling works, performed according to

Factors that influence health	Kind of activity or means, contamination sources	Impact on factors influencing health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
	of closed circuits, management of radioactive waste.					separate INPP decommissioning projects.
2.2. Water quality	Radioactive releases into Lake Druksiai. INPP sanitary waste water into Lake Druksiai. Surface drainage water from the INPP industrial site into Lake Druksiai. Discharge of non-radioactive waster into Lake Druksiai.	Chemical and radiological contamination of Lake Druksiai	(–)	The existing situation in the INPP environment will not change in essence. Radioactive releases to environmental water and environmental contamination will be the same or smaller than under INPP operation conditions, see Chapter 4.1.5. Controlled small-scale non-radioactive contamination of is possible, determined by discharge of industrial and sanitary waste water into the environment, see Chapter 4.1.4.	Radioactive and non-radioactive releases into the environment are performed pursuing conditions, set in the Permit for Integrated Pollution Prevention and Control. The INPP sanitary waste water system conforms to all requirements of the standard document [15]. The INPP surface drainage water collection and drainage system conforms to all requirements of the standard document [16].	The INPP performs the environmental monitoring programme that encompasses radiological and chemical contamination of water environments of the INPP environment, see Chapter 7. Utility waste water treatment equipment, operated by VĮ “Visagino energija”, are planned to be modernized before 2010 so they would conform to waste water treatment requirements, valid in Lithuania and the EU.
2.3. Food quality	Radioactive and non-radioactive releases into the environment (air and water)	Pollutants passing to local product manufacturing and usage links.	(-)	Changes are not foreseen. The existing situation will not change in essence.		The proposed activity in many regard will be analogous to activity, performed in the INPP up till now under normal operation conditions. As long-term monitoring of regional environment shows, the impact of INPP operation on food quality is insignificant.

Factors that influence health	Kind of activity or means, contamination sources	Impact on factors influencing health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
2.4. Soil	Impact sources are not foreseen	Not foreseen				The proposed economic activity will be performed on the INPP industrial site. Material transportation will be performed by existing roads and set routes.
2.5. Non-ionizing radiation	Electrical power distribution network	Increased fields of electromagnetic radiation	(–)	Electrical power distribution network is not modified by the proposed economic activity. Current situation within INPP site and Unit will not be changed in essence. Pollution of the environment will be similar or less as during normal operation of INPP.		After the shutdown of INPP electrical power production will be interrupted, amount of distributed energy via network will decrease; correspondingly impact due to electromagnetic radiation will decrease at INPP surroundings.
2.6 Ionizing radiation	Management of SNF and radioactive waste in reactor unit 2 and existing INPP radioactive waste management equipment. Transportation of radioactive materials on the INPP site.	Direct exposure of ionizing radiation. Exposure by radioactive materials, released into the environment.	(–)	The proposed economic activity will not change negatively the existing radiological condition beyond the limits of the INPP industrial site. The maximum annual public exposure (effective dose) due to the radioactive releases constitutes approximately 4.2 µSv, see Section 4.9.3.2. .	A sanitary protection zone (SPZ) is established around the INPP site, where there are no permanent inhabitants, and economic activities are limited. Monitoring of the impact of ionizing radiation and of possible changes in the environment will be performed.	It will be possible to perform the proposed economic activity together with other planned INPP decommissioning activities in the existing SPZ of the INPP, without breaching valid radiation protection requirements, see Section 4.9.3.4.
2.7. Noise	Operation and maintenance of INPP	Noise, vibrations	(–)	The existing situation in the INPP environment	There are no inhabitants in the sanitary protection zone	The performed activity in many regards will be

Factors that influence health	Kind of activity or means, contamination sources	Impact on factors influencing health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
	equipment. Transport on the INPP industrial site (transportation of radioactive waste, etc.)			will not change in essence. No negative changes are foreseen.	(3 km radius around the INPP). Beyond the limits of the SPZ noise and vibrations will be particularly felt. Local traffic on the INPP site is not intensive.	analogous to activity, performed up till now in the INPP under normal operational conditions. The proposed economic activity does not foresee the performance of any building demolition or equipment dismantling works.
2.8. Accommodation conditions	Impact sources are not foreseen	Not foreseen				The proposed economic activity will be performed on the INPP industrial site.
2.9. Safety	Transfer of SNF from the reactor to hermetic dry storage containers. Decontamination of radiologically contaminated circuits. Management of radioactive waste.	Improvement of nuclear and radiation protection	(+)	Nuclear and radiation protection will improve. Possibility of accident situations will decrease when compared with the current situation		SNF and radioactive materials will be managed according to laws and regulations of the Republic of Lithuania, IAEA radioactive waste management principles, using modern technologies, already tested in countries – members of the EU.
2.10. Means of communication	Impact sources are not foreseen	Not foreseen				The proposed economic activity will be performed on the INPP industrial site
2.11. Territory planning	Impact sources are not foreseen	Not foreseen				The proposed economic activity will be performed on the INPP industrial site
2.12. Waste management	Radioactive and non-radioactive releases into the environment	Controlled local increase in contamination	(–)	The existing situation in the INPP environment will not change in	Waste will be managed in accordance with the requirements of waste	INPP decommissioning projects will decrease environmental impact

Factors that influence health	Kind of activity or means, contamination sources	Impact on factors influencing health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
				essence. Environmental contamination will be similar as under normal INPP operation conditions.	management legislation and regulations in force and Permission on integrated prevention and control of pollution	resulting from INPP operation
2.13. Power appliance	Works at the INPP during the implementation of the proposed economic activity	Not foreseen				
2.14. Risk of accidents	Works at the INPP during the implementation of the proposed economic activity	Not foreseen				The proposed economic activity will be performed on the existing INPP industrial site and will not influence inhabitants.
2. 15. Passive smoking	Impact sources are not foreseen	Not foreseen				
2.16. Other	Impact sources are not foreseen	Not foreseen				
3. Social and economic factors						
3.1. Culture	Impact sources are not foreseen	Not foreseen				
3.2. Discrimination	Impact sources are not foreseen	Not foreseen				
3.3. Property	Impact sources are not foreseen	Not foreseen				
3.4. Income	Implementation of the proposed economic activity	Employee occupation	(+)	The performance of the proposed economic activity using existing INPP personnel will decrease the impact on socio-economic		

Factors that influence health	Kind of activity or means, contamination sources	Impact on factors influencing health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
				environment, resulting from decommissioning of INPP reactors 1 and 2. The proposed economic activity is financed from the EU resources for INPP decommissioning.		
3.5. Education possibilities	Impact sources are not foreseen	Not foreseen				
3.6. Employment, labour market, work opportunities	Implementation of the proposed economic activity	Employee occupation	(+)	The performance of the proposed economic activity using existing INPP personnel will decrease the impact on socio-economic environment, resulting from decommissioning of INPP reactors 1 and 2.		
3.7. Criminality	Impact sources are not foreseen	Not foreseen				
3.8. Leisure, recreation	Impact sources are not foreseen	Not foreseen				
3.9. Movement possibilities	Impact sources are not foreseen	Not foreseen				
3.10. Social support (social contacts and welfare)	Impact sources are not foreseen	Not foreseen				
3.11. Social, cultural, spiritual communication	Impact sources are not foreseen	Not foreseen				
3.12. Migration	Works at the INPP during the implementation of the proposed economic	Keeping of work places decreases migration	(+)	The performance of the proposed economic activity using existing INPP personnel will		

Factors that influence health	Kind of activity or means, contamination sources	Impact on factors influencing health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
	activity			decrease the impact on socio-economic environment, resulting from decommissioning of INPP reactors 1 and 2.		
3.13. Family constitution	Impact sources are not foreseen	Not foreseen				
3.14. Other	Impact sources are not foreseen	Not foreseen				
4. Professional risk factors						
4.1 Chemical	Works at the INPP during the implementation of the proposed economic activity	Additional impact is not foreseen		Activities will be in many regards analogous to activities, performed in the INPP up till now. The existing situation in the INPP will not change in essence.	The proposed economic activity will be performed by existing INPP personnel. If necessary, employees will be additionally instructed.	Work conditions will be ensured with respect to the requirements of valid legal acts.
4.2. Physical	Works at the INPP during the implementation of the proposed economic activity	Additional impact is not foreseen		Activities will be in many regards analogous to activities, performed in the INPP up till now. The existing situation in the INPP will not change in essence.	The proposed economic activity will be performed by existing INPP personnel. If necessary, employees will be additionally instructed.	Work conditions will be ensured with respect to the requirements of valid legal acts.
4.3. Biological	Works at the INPP during the implementation of the proposed economic activity	Additional impact is not foreseen		Activities will be in many regards analogous to activities, performed in the INPP up till now. The existing situation in the INPP will not change in essence.	The proposed economic activity will be performed by existing INPP personnel. If necessary, employees will be additionally instructed.	Work conditions will be ensured with respect to the requirements of valid legal acts.
4.4. Ergonomic	Works at the INPP	Additional impact is		Activities will be in	The proposed economic	Work conditions will be

Factors that influence health	Kind of activity or means, contamination sources	Impact on factors influencing health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
	during the implementation of the proposed economic activity	not foreseen		many regards analogous to activities, performed in the INPP up till now. The existing situation in the INPP will not change in essence.	activity will be performed by existing INPP personnel. If necessary, employees will be additionally instructed.	ensured with respect to the requirements of valid legal acts.
4.5. Psychosocial	Works at the INPP during the implementation of the proposed economic activity	Additional impact is not foreseen		Activities will be in many regards analogous to activities, performed in the INPP up till now. The existing situation in the INPP will not change in essence.	The proposed economic activity will be performed by existing INPP personnel. If necessary, employees will be additionally instructed.	Work conditions will be ensured with respect to the requirements of valid legal acts.
4.6. Manual work	Works at the INPP during the implementation of the proposed economic activity	Additional impact is not foreseen		Activities will be in many regards analogous to activities, performed in the INPP up till now. The existing situation in the INPP will not change in essence.	The proposed economic activity will be performed by existing INPP personnel. If necessary, employees will be additionally instructed.	Work conditions will be ensured with respect to the requirements of valid legal acts.
5. Psychological factors						
5.1. Aesthetical appearance	Impact sources are not foreseen	Not foreseen				The proposed economic activity does not foresee the performance of building demolition or equipment dismantling works.
5.2. Comprehensibility	Impact sources are not foreseen	Not foreseen				The proposed economic activity is performed according to the approved INPP decommissioning plan

Factors that influence health	Kind of activity or means, contamination sources	Impact on factors influencing health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
5.3. Capability to control the situation	Impact sources are not foreseen	Not foreseen				
5.4. Significance	Impact sources are not foreseen	Not foreseen				
5.5. Possible conflicts	Impact sources are not foreseen	Not foreseen				
6. Social and health services (acceptability, suitability, succession, efficiency, protection, availability, quality, self-help technique)	Impact sources are not foreseen	Not foreseen				

Table 4.9.10. Possible impact on public groups of the proposed economic activity

Public groups	Kind of activity or means, contamination sources	Group size	Impact: positive (+) negative (-)	Comments and remarks
1. Public groups (local population) in the zone of activity impact	Ionizing radiation, radioactive and non-radioactive releases into the environment	There are no permanently living population in the sanitary protection zone, economic activity is limited		The impact of the proposed economic activity will be insignificant. The existing situation in the INPP environment will not change in essence. Releases to the environment and environmental pollution will be the same or smaller than during INPP normal operation conditions.
2. Personnel	Ionizing radiation, other professional risk factors	Personnel of INPP	(–)	The activity in many regards will be analogous to activities, performed in the INPP up till now. The existing situation in the INPP will not change in essence. The proposed economic activity will be performed by existing INPP personnel. Employees will be additionally trained, if necessary. Work conditions will be ensured with regard to requirements of valid legal acts. Personnel exposure shall be controlled and limited by workplace and individual monitoring, work planning with consideration of ALARA principle and use of personal protective means.

3. Uses of activity products	Not distinguished			
4. People with low income	Not distinguished			
5. The unemployed	Not distinguished			
6. Ethnic groups	Not distinguished			
7. People with certain diseases (chronic dependences, etc.)	Not distinguished			
8. The disabled	Not distinguished			
9. Single persons	Not distinguished			
10. Refugees, emigrants and persons seeking political asylum	Not distinguished			
11. The homeless	Not distinguished			
12. Other population groups (arrestees, persons of special occupations, manual hard workers etc.)	Not distinguished			
13. Other groups (individual persons)	Not distinguished			

Table 4.9.11. Assessment of features of impacts

Impact induced by factor	Impact features									Comments and remarks
	Number of persons under the impact			Evidence (possibility), strength of the evidentiary material			Duration			
	Up to 500 persons	501–1000 persons	More then 1001 persons	Clear	Probable	Possible	Short (up to 1 y)	Medium (1–3 y)	Long (more than 3 y)	
1. Local increase of environmental pollution, resulting from radioactive releases, radionuclide dispersion in environmental components			X			X			X	Releases to the environment are performed with regard to the conditions, set in the Permit for Integrated Pollution Prevention and Control. Environmental pollution will be the same or smaller than under INPP operation conditions.

2. Direct exposure to ionizing radiation	X				X				X	Possible local impact on INPP personnel, directly involved in the planned activity. Possible exposure will not exceed limits prescribed by radiation protection requirements. The existing situation will not change with regard to inhabitants.
3. Controlled small-scale pollution of non-radioactive nature, resulting from discharge of industrial and sanitary waste water into the environment			X			X			X	Releases will be performed with regard to the conditions, set in the Permit for Integrated Pollution Prevention and Control.
4. Waste generation and management			X	X					X	The existing situation in the INPP environment will not change in essence. Environmental pollution will be similar as under normal INPP operation conditions. Waste management will be performed according to requirements of valid laws and other legal acts and conditions set in the Permit for Integrated Pollution Prevention and Control

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5 TRANSBOUNDARY IMPACT

Two countries, i.e. the Republic of Belarus and the Republic of Latvia, are relatively close to the INPP site. The state border Lithuania–Belarus is in about 5 km to the east and southeast from the INPP Power Units. The state border Lithuania–Latvia is in about 8 km to the north from the INPP Power Units.

Other countries are at a distance of at least hundred kilometres away from the INPP site and will not be affected by the proposed economic activity.

5.1 General Information on Neighbouring Countries

The Daugavpils region of Latvia and the Braslav region of Belarus are in the immediate vicinity of the INPP (Figure 5.1).

Figure 5.1. The Daugavpils region of Latvia and the Braslav region of Belarus

5.1.1 Daugavpils Region

Daugavpils region borders with Lithuania and Belarus. Total area of the Daugavpils region is 2598 km^2.

Land use of the region is as follows: farm lands – 48 %, wooded areas – 34 % and other uses – 18 %. However, agriculture does not significantly contribute to the economic output of the region, as Daugavpils region can be considered as an industrial one. Though there is a lot of land fit for cultivation, the conditions for farming are not very advantageous. The hilly terrain is not conducive to cultivating large fields.

Total population of the Daugavpils region is 159 000 (population census in 2000). Population density is 61 inhabitants per km^2. Daugavpils, the second big city in Latvia after Riga, is an independent structural unit with 115 300 inhabitants in 2000 and 112 000 in 2004. In the region there are 24 small rural areas and 2 towns (Ilukste – 3 177 inhabitants and Subate – 1 013 inhabitants). Approximately 75 % of the inhabitants of the Daugavpils region live in urban areas. Population density in rural areas is low and the population is rather old.

There are good road and rail connections from Daugavpils region to Riga and also with Lithuania, Belarus and Russia. Most important are the Warsaw-Vilnius-Daugavpils-St Petersburg connection and the railroad to Riga. The national major road Riga-Daugavpils, as well as the road connection to Zarasai in Lithuania and the route Daugavpils-Rezekne-Pskov in Russia have intemational significance.

A number of historical monuments provide good background for the development of tourism. The most popular objects in the region are Daugavpils fortress from the 17th century, Peter-Paul Cathedral, a fortress from the beginning of the 19th century and Vaclaiciena Palace. One unique object is the Duke Jacob's Channel in Asare (500 m long), built in 1667–1668 to link the two rivers, Vilkupe and Eglaine, to connect Daugava and Lielupe water routes.

Latvia's largest river, the Daugava flows through the region from Belarus towards the Gulf of Riga. The length of the Daugava river is 1040 km (367 km in the territory of the Republic of Latvia). Watershed area is 87 900 km^2; average water yield is 678 m^3/s.The Daugava river meanders throughout all the territory of the Daugavpils region, making 10 loops from Kraslava to Krauja and running calmly from Liksna and Nicgale. There are 194 lakes in Daugavpils region. Some lakes (Skujines, Medumu, Bardinska, Sventes etc.) are the nature reserves.

Daugavpils region has plenty of attractive natural landscapes. The Daugava’s stretch from Kraslava to Daugavpils, where the river flows in a primeval hollow, which is almost 40 metres deep, is sometimes called the Switzerland of Latgale. Two significant highland areas – the Augszeme and Latgale highlands are located in Daugavpils region. Latvia's biggest boulder (174 m^3) is in Nicgale.

5.1.2 Braslav Region

Braslav region is administrative part of Vitebsk district. The only town in the region is Braslav with 10 thousand inhabitants. Other settlements are Vidzy, Pliusy and smaller villages (Figure 5.2). Braslav town is on a shore of Lake Driviaty, in a distance of 30 km from railway station Druia, 220 km from Minsk and 238 km from Vitebsk. There are factories of building materials, greengrocery production etc. in the town.

National park “Braslav Lakes” occupies 69.1 thousand hectares or about one third of Braslav region territory. The most picturesque and precious areas around the Braslav town forms a core of the national park. Extension of the park from north to south is 56 km and the width varies from 7 to 29 km. There are more than 60 lakes in the national park; they occupy 17 % of its territory. The first-rate lakes are Driviaty, Snudy, Strusto, Boginskoie (Figure 5.3). The Lake Volos South is the deepest in the park and region; it is as deep as 40.4 m.

Figure 5.2. The Braslav region of Belarus

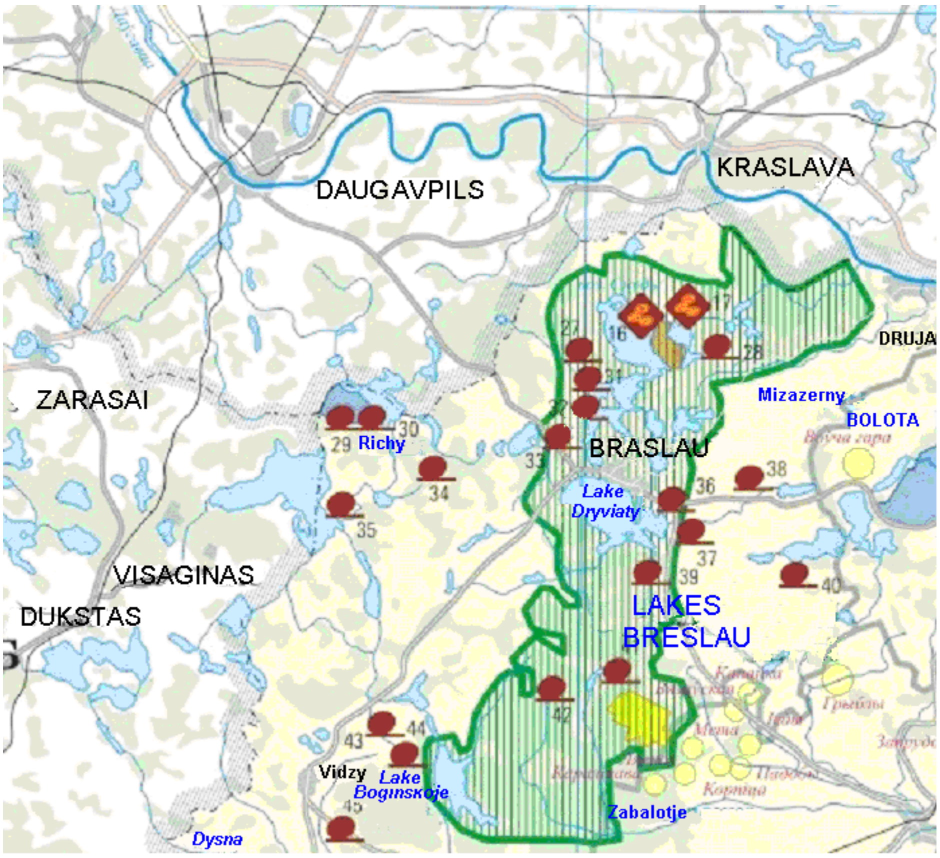

Figure 5.3. The national park “Braslav Lakes”

There are 4 functional zones in the national park “Braslav Lakes”:

- The reserved zone – 3452 hectares (4.9 %). This zone is in the most precious area of forest tract Boginskoie. The purpose of the reserved zone is preservation in untouched condition of typical and unique ecosystems and a gene pool of flora and fauna;
- The zone of controllable use – 27746 hectares (39.0 %). The purpose of this zone is studies of restoration, moving forces and trends of inviolate ecosystems;
- The recreational zone – 12103 hectares (17.0 %). This zone is assigned for allocation of units and buildings for rest and tourism, for actions on cultural work among the masses and for car parking management;
- The zone for economical activity – 25815 hectares (36.3 %). This zone is assigned for allocation of park visitors’ service units, living quarters and for economical activities.

The territory of national park “Braslav Lakes” presents the most peculiar natural complex of the Republic of Belarus. Unique combination of hills, lakes, marshlands and river valleys make this land extraordinary picturesque.

The typical forest inhabitants are elk, wild boar, deer, squirrel, mountain hare, brown hare, fox etc. The rare species from the Red Book of Belarus are badger, lynx and brown bear. There are about 200 species of birds in the national park “Braslav Lakes”. The rare species are black stork, crane, herring gull, ptarmigan, dunlin etc.

5.2 Potential impact and impact mitigation measures

5.2.1 Water

5.2.1.1 Non-radiological impact

The water of Lake Druksiai is used for cooling INPP Unit 2, the lake is located in the border with Belarus, which owns 14% of the total area [1]. Non-radiological impacts of proposed economic activity to the component of environment water are assessed in Section 4.1.4. Liquid waste arising after relevant processing in INPP liquid radioactive waste treatment facility during the process of proposed economic activity will be discharged into Lake Druksiai as non-radioactive industrial waste. Discharged water will make no significant impacts to the hydrology of the lake.

INPP municipal waste water are monitored and released to the existing sewage system following the requirements of the normative document [2]. Mechanical grease traps are installed opposite to rain-water outlet cavity into the Lake Druksiai. INPP site surface water drainage system meets all requirements of the normative document [3].

Proposed economic activity will make no significant non-radiological impacts to the surface and groundwater neither in the territory of Lithuania, nor in the Braslav region in Belarus and Daugavpils region in Latvia.

Groundwater monitoring bore holes network is installed in the INPP site. Groundwater monitoring programme [4] is prepared following normative document [5].

There also should be mentioned thermal effects while discussing non-radiological impacts of proposed economic activity to Lake Druksiai. Heated water, released from INPP, increases the temperature of the lake water and respectively increases water evaporation. Consequently it increases eutrophication and salinity of the lake. One of the effects of the final shut-down of Unit 2 is the decrease of thermal discharges into Lake Druksiai. After the final shut-down of the unit, gradually there will be returned to the similar thermal conditions, that were before commissioning of INPP, although the state of the lake won‘t return to its former stage which was before the commissioning of INPP.

5.2.1.2 Radiological impacts

Impacts of proposed economic activity are analysed on Lake Druksiai as a whole, although one part of the lake is in the territory of Lithuania and the other is in the territory of Belarus, but the impacts will not differ. Possible radioactive discharges to the lake are presented in section 4.1.5.2.1. Total activity of radionuclides, released over proposed economic activity to Lake Druksiai, will be about 3.42E+09 Bq. Highest discharges to the lake are expected in 2012, when decontamination of the main circulation circuit will be performed.

Assessment of the exposure of population, determined by radioactive discharges into the lake, is presented in Section 4.1.5.2.2. Maximum annual effective dose, which population gets due to proposed economic activity, during which radionuclides, discharged into the water, makes 1.4E-03 mSv/year (1.4 µSv). Volumetric activity of radionuclides in the river Prorva, which outflows from Lake Druksiai will be lower than in Lake Druksiai, thus, respectively annual effective dose, which population get, will be less. Therefore, impacts of radioactive water contamination resulting from proposed economic activity will be minor (less than exemption level – 0.010 mSv per year). Exceptional and specifically with this proposed economic activity related means of mitigation of radioactive water contamination are not planned.

5.2.2 Air

5.2.2.1 Non-radiological impacts

Non-radiological impacts of proposed economic activity to the component of environment air are evaluated in chapter 4.2.2. There will be no significant non-radioactive releases to the air of environment caused by the final shut-down of INPP Unit 2 decommissioning project and defuelling phase. Proposed economic activity will be developed within the Ignalina NPP industrial site and within sanitary protection zone of INPP and will not make any essential impacts to the air of Braslav region in the territory of Belarus and Daugavpils region in the territory of Latvia.

5.2.2.2 Radiological impacts

Radiological impacts of proposed economic activity to the environment of neighbouring countries during normal operation might potentially result from the dispersion of radioactive particles in air. Assessment of radioactive discharges into the air is presented in chapter 4.2.3. Total activity, discharged into the air during planned economic activity will be approximately 9.71E+10 Bq.

Radiological impacts, caused by radioactive releases into air, depend on the distance from the source. In case to assess how population exposure depends on distance, there were performed calculations of dispersion of radionuclides and volumetric activity in the air in various distances from the source of outlet. According to the IAEA recommendations of safety standards No. 19 “General models, used for environment impact assessment of radioactive releases to the air” [7] variation of radionuclide volumetric activity was assessed, when the distance from the source is increased to the 20 km. Respectively there can be assessed tendencies of declining exposure doses, because population exposure is merely proportional to the volumetric activity of radionuclides in the air.

Assessing dose changes from the distance it is accepted that 95% of discharged radionuclide activity passes to the environment through stacks of 75 m and 5% of radionuclide activity – through stacks of 10 m height.

The results of assessment of dose dependence on the distance are shown in Figure 5.4. As it is seen in the figure, dose is two times lesser when it is 4 km from outlet source, than when it is 3 km from outlet source, and dose which is 10 km away – approximately 10 times lesser than when it is 3 km away from outlet source. According to the results of assessment, presented in Table 4.2.7, dose, which results from radionuclide releases into the air during planned economic activity is the highest in 2011 and makes approximately 2.83E-03 mSv/year. Distance from the outlet source to the border of Belarus is approximately 5 km, and to the border of Latvia – approximately 8 km. There can be stated that transboundary impacts, resulted from radionuclide discharge into the air during planned economic activity is not significant, because dose, which population gets yet when the distance is 3 km away from the outlet source is lesser than exemption level (0.010 mSv per year) and it becomes lesser with the distance. Thus, exceptional and specifically with this planned economic activity related radioactive contamination impact measures of mitigation are not planned.

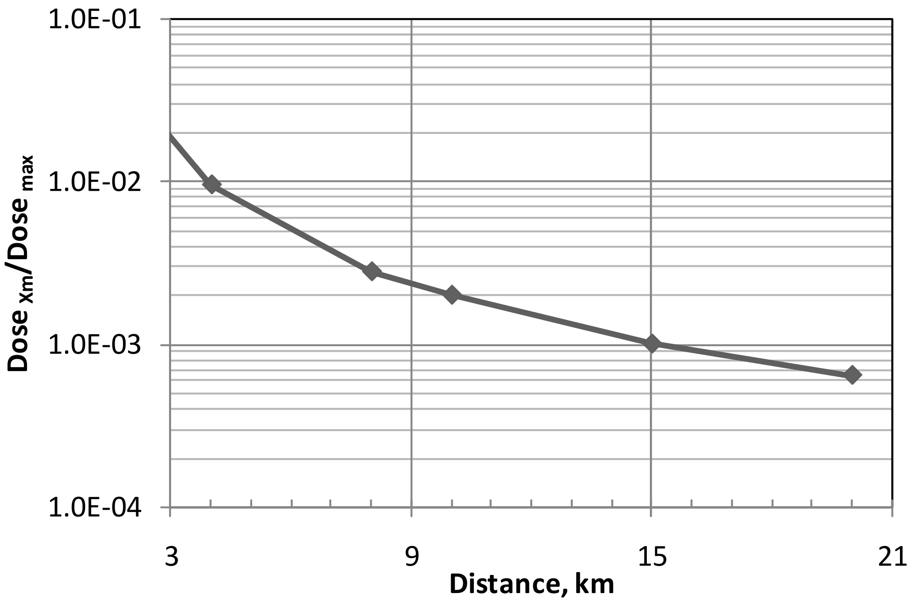

Figure 5.4. Dose variation with the distance

5.2.3 Soil

Proposed economic activity will be developed in INPP site. Significant radiological or non-radiological impacts to the landscape or to the flora, beyond the site of IAE, are not expected. There will not be any impact to the soil of the region of Braslav in Belarus and to the region of Daugavpils in Latvia.

5.2.4 Geology

Additional impacts to the geological structure of the ground will not be done, since construction works, new foundations, mounds and land transfers are not expected. Proposed economic activity will make no impact to the geology of the region of Braslav in Belarus and to the region of Daugavpils in Latvia.

5.2.5 Biodiversity

Possible impacts to the biodiversity of Lake Druksiai are evaluated in section 4.5.3. After decommissioning of INPP Unit 2, lake temperature will remind its natural state, decrease of thermal discharges should make positive effect (e.g. for stenothermal fish species), although eutrophic state of the lake will not return to its former stage, which was before operation of INPP.

Proposed economic activity will make no impacts to the land habitations and to the species of that zone, since there is not expected any construction or destruction works.

Impacts to the reservation zone of Belarusian national park “Braslav Lakes“, which purpose is to preserve characteristic and unique ecosystems and gene pool of flora and fauna and to the biodiversity of Daugavpils region in Latvia will not be made.

5.2.6 Landscape

There will not be any new building constructions or demolition of existing buildings during proposed economic activity and the features of INPP site landscape will not change. Impact to the inhabited and resting zones in the surroundings of INPP is not expected.

5.2.7 Socio-economic environment

Proposed economic activity will be developed far from constantly living population of Belarus and Latvia. Impacts to the socio-economic environment or significant changes are not expected.

But there is possible distrust and dissatisfaction of people living in Belarus and Latvia. Such psychological effect is caused by changes of existing nuclear practice (final shut-down of INPP and decommissioning) and the construction of new nuclear objects, such as interim spent fuel storage facility, solid radioactive waste management and storage facility, a repository for very low level radioactive waste etc.

Psychological effect might be mitigated explaining necessity, ideas and advantages of this proposed economic activity:

- Decommissioning of the INPP Unit 2 is inevitable, it should be implemented due to the important public interest;
- Decommissioning project for Ignalina NPP Unit 2 final shutdown and defuelling phase is funded by the Ignalina Programme of the European Union. The Ignalina Programme is a financial instrument to support the decommissioning of the Ignalina Nuclear Power Plant and consequential measures in the energy sector for Lithuania;
- Experience, gained during the parallel activity in INPP Unit 1, will be used, developing proposed activity;
- Calculations and assessment made in this report of environment impact assessment clearly showed that proposed economic activity will not result to significant impacts – nor to radiological, neither to non-radiological impacts, which could affect environment and health of the population physically.

Proposed economic activity will be developed strictly being controlled by national control institutions. These state institutions forces to keep the requirements of Lithuanian laws and other legislative certificates, matched with legal basis of European Union, applicable recommendations of international organizations, such as International Atomic Energy Agency (IAEA) and regulations of convention.

5.2.8 Ethnic-cultural environment, cultural heritage

Interface between proposed economic activity and ethnic-cultural conditions of Latvia and Belarus, objects of immovable cultural heritage and zones will not exist.

5.2.9 Public health

5.2.9.1 Non-radiological impacts

Proposed economic activity will be developed within the Ignalina NPP industrial site and within the existing 3 km radius sanitary protection zone of INPP, i.e. the distance from constant living population of Latvia and Belarus will be adequate. Non-radiological impact will be limited by workspace of INPP and will not influence the health of population of neighbouring countries.

5.2.9.2 Radiological impacts

Radiological impacts to the public health are potentially probable due to the radioactive discharges into atmosphere, water or due to the direct exposure, which would be determined by radioactive waste existing in buildings or facility.

Assessment of the discharges into water due to the radiological impacts determined by proposed economic activity is presented in section 5.5.1 and radiological impacts due to the radioactive releases into the air in section 5.5.2. Dose to the population of neighbouring countries results from proposed economic activity in the circumstances of water discharges and air discharges will be less than exemption level (0.010 mSv per year).

Proposed economic activity will be developed within the INPP site. Results of radioactive fields monitoring, performed in INPP industrial site and its surroundings, show that increase of radiation dose rate is supervised locally and only near to some facilities of radioactive waste treatment. Thus, radiological impacts to the population of Latvia and Belarus resulting from direct radiation are insignificant and further not to be analysed.

It is necessary to consider impact of other nuclear objects planned or existing in INPP SPZ, because proposed economic activity will be developed within INPP site, located in existing 3 km radius sanitary protection zone (SPZ), evaluating impact to the public health of neighbouring countries. Objects planned or existing in INPP SPZ and its stages of activity are shown respectively in pictures 4.9.6 and 4.9.7. Works of INPP decommissioning (projects B9-X) and projects related with radioactive waste treatment, planned to be performed during proposed economic activity are presented in Table 2.1. Also, project of INPP Unit 1 decommissioning for the phase of the shut-down of the unit and discharged gaseous effluents (U1DP0) will be developed.

General radiological impact to the Lithuanian population, resulting from existing and planned BEO in INPP sanitary protection zone covers 3 km radius zone around INPP. Results of the assessment are presented in Table 4.9.8. As it is seen in the table, annual effective dose due to the radioactive discharges into the water and air from the nuclear objects existing within INPP site (including planned economic activity) and new planned BEO within INPP SPZ in single years varies from 5.77E-03 mSv/year to 1.94E-02 mSv/year. Shortest distances to the borders of Latvia and Belarus is respectively approximately 5 and 8 km, i.e. further than the distance, which is respected assessing radiological impact to the members of critical group of population (3 km). Thus, using the same methods of contamination transfer as to the members of critical population group in INPP neighbourhood, radiological population exposure will be less than 0.014 mSv/year and familiar to exemption level (0.010 mSv per year).

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6 ANALYSIS OF ALTERNATIVES

6.1 Location Alternatives

The proposed economic activity considers the different activities, which will be initiated inside INPP Unit 2 and INPP site after Unit 2 reactor shutdown. The proposed economic activity foresees further maintenance and safety assurance of the reactor and complete unloading of nuclear fuel from the reactor core to spent nuclear fuel storage pools. Isolation, modification and decontamination (including in-line decontamination of the main circulation circuit) of the systems are also considered in the frame of this proposed economic activity. Also radioactive and other waste will be management during the implementation of the proposed economic activity. Since the location of the proposed economic activity is determined beforehand, location alternatives are not considered further.

6.2 Time (Dismantling) Alternatives

INPP decommissioning is a strong agreement between the Republic of Lithuania and the European Union, therefore INPP Unit 2 reactor was shutdown on 31 December 2009. Based on worldwide experience the following dismantling strategies (alternatives) were considered and analyzed in the INPP Preliminary Decommissioning Plan (INPP-PDP) [1]:

- Immediate dismantling;
- Deferred dismantling (with four variants for the safe enclosure: successively restricted; small; extended and maximum safe enclosure corresponding in turn to reactor core; hermetic zone of the Accident Localization System; reactor building A and all A, B, V, G and D buildings);
- Entombment.

Besides these alternatives there is “zero” (no action) alternative, when the reactor is maintained in a state where it is shut down but can be restarted as a power generator. The essential criterion for the rejection of this alternative is safety. Fuel unloading from Unit 2 reactor core eliminates the risks related to nuclear power generation in RBMK reactor. Moreover, “zero” alternative has never been selected. On the other hand, Unit 2 reactor will not be started again, since all INPP decommissioning process is determined by international agreements and assurance of required financial support.

In the analysis of the dismantling strategies presented in INPP-PDP the following aspects has been considered: planning, predicted expenses, waste categories and generated amounts, exposure of personnel. However, clear recommendations which strategy is the most reasonable were not provided in this document. Immediate dismantling and deferred dismantling alternatives analyzed in INPP-PDP have been further considered during the development of INPP decommissioning plan. Entombment was rejected due to the following main reasons:

- entombment option for decommissioning of nuclear fuel cycle facilities that are contaminated with long lived nuclides, implies that radioactive materials will be kept inside engineered structures for a very long period (~ 200 years), whereas IAEA recommends not to dispose of such waste in near surface facilities;
- due to the possible changes in legislation during 200 years.

Dismantling and deferred dismantling alternatives were analyzed further taking into account the following items:

- revised decommissioning expenses;
- existing waste management technologies;
- predicted disposal expenses and measures;
- expenditure of human resources.

Seeking to pass a final decision on the INPP dismantling strategy that would encompass the global socio-economical situation of Lithuania, the Government of Lithuania complemented the technical and financial elements with general social, political and economical arguments.

On the 26th of November 2002, in the Government of the Lithuanian Republic in its decree No. 1848 [2] has stated that: "… *in order to prevent the heavy long-term social, economical, financial and environmental consequences… Decommissioning of Unit 1 of the State Enterprise Ignalina NPP shall be planned and implemented in accordance with the Immediate Dismantling Strategy*".

Based on the Resolution of the Government of the Republic of Lithuania of 2002 on the Method of Decommissioning of Unit 1 of the State Enterprise Ignalina Nuclear Power Plant [2], the immediate dismantling strategy of the INPP was accepted, further investigated and prepared. The results of this work are presented in the INPP Final Decommissioning Plan (FDP) [3]. The FDP was approved by the Ministry of Economy in 2005.

6.3 Alternatives of Technological Solutions

During the proposed economic activity the main tasks will be: defuelling of the reactor and fuel storage pools, systems operation, modification and/or isolation, and decontamination works (see Chapter 2).

Reactor defuelling will be performed according to the standard defuelling procedure, and no alternatives are evaluated further.

System modification or isolation according to its nature will be similar to maintenance works, performed during normal operation conditions of the INPP. Besides, works performed during the proposed economic activity will be analogous to the works planned in the Unit 1 Decommissioning Project. Therefore technological solutions are analogous to those that were passed when planning and performing the works of decommissioning Unit 1 of the INPP. Technological solutions for the INPP Unit 1 final reactor shutdown and defuelling phase were selected based on the general final INPP decommissioning plan [3].

Defuelling from SNF storage pools is analysed in detail in the scope of project B1.

Therefore, talking about technological alternatives, the main questions are evaluation of the necessity for decontamination and selection of the appropriate decontamination process.

The system analysis, performed in the frame of the project U2DP0, shows that all major turbine systems will be available for decontamination and dismantling after RFS. Also, after reactor defuelling, the MCC, PCS, CEPS cooling circuit and refuelling machine can be decontaminated. A significant reduction of the collective dose is reached as a result of these works. On the other hand decontamination operations require investments, materials and equipment. Besides, as a result of decontamination process a certain amount of liquid radioactive waste will be generated and it will have to be treated in the existing liquid radioactive waste treatment facility. Therefore the necessity of this process is evaluated in the frame of the project U2DP0, having performed cost-benefit analysis.

Radiological analysis of the turbine hall systems showed that their in-line decontamination is either not economically justified or does not provide higher benefits than other decontamination methods. A huge majority of the turbine hall systems equipment comply with the preliminary waste acceptance criteria for disposal in a very low level waste repository. Systems decontamination until they conform to the clearance levels would require more expenditure than disposal in a VLLW repository. Nevertheless, having evaluated more precisely the cost for disposal in a VLLW repository, economical efficiency of turbine hall decontamination will be revised.

The MCC and PCS in the reactor unit are the most contaminated systems and must be decontaminated according to the ALARA principle. The contamination of the CEPS cooling circuit is substantially smaller. With regard to the fact that the system will be dismantled after at least six years after the final reactor shutdown, it was evaluated that the in-line decontamination of this system is not economically beneficial. The refuelling machine must also be decontaminated.

The analysis of advantages and disadvantages of decontamination processes of large volume closed systems is presented in Annex 5.2 of project U1DP0 [5].

The decontamination processes can be classified into 2 categories:

- The “hard processes”;
- The “soft processes”.

The “hard processes” use high chemical reagent concentrations for both the oxidation and dissolution steps (typically 50-150 g/l), leading to several disadvantages: large decontamination solution preparation equipment is needed, large volume of rinsing water is needed, large amounts of waste is generated, difficulties arise to immobilize the waste, etc. For the above reasons and mainly due to the waste management issue the “hard processes” are almost no longer used in practice.

The “soft processes” use reagent concentrations lower than 1 g/l for the oxidation step and < 10 g/l for the dissolution (decontamination) step. The industrial experience resulting from the implementation of these processes widely varies from the decontamination of components to the full decontamination of large circuits. When selecting the INPP MCC decontamination process several variants on the market were analysed: CANDECON and CANDEREM; Dilute CITROX; LOMI; MOPAC 88; CORD.

For the decontamination of the INPP MCC and PCS the CORD process was selected, with regard to:

- proven efficiency in large industrial similar applications;
- ease of implementation (no technological constraints);
- low concentration of reagents and absence of chemicals incompatible with INPP bitumenisation process;
- no production of solid waste, the produced liquid waste can be processed by the INPP existing installations.

Detailed substantiation of the decontamination process selection may be found in Annex 5.2 of project U1DP0 [5].

Since the Unit 1 Decommissioning Project (U1DP0) will be executed before this proposed economic activity, it will be possible to use experience gained during the performance of project U1DP0 when performing Unit 2 Decommissioning Project and, if necessary, to correct technological solutions accordingly.

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7 MONITORING

Since startup of operation the INPP performs monitoring of environment within 30 km radius monitoring zone around the power units. The monitoring is performed in accordance with regulatory approved environment monitoring program. The monitoring program is based on Lithuanian radiation protection standards [1], Lithuanian legislation and regulations on environment monitoring [2, 3] and regulatory documents on the environment [4, 5]. Monitoring data is being summarized and submitted to competent institutions annually.

The existing INPP environment monitoring program [6] includes:

- Monitoring of radioactive and non-radioactive discharges into water bodies;
- Monitoring of radioactive and non-radioactive releases into the air;
- Monitoring of water quality in the Lake Druksiai and of groundwater (physical and chemical parameters);
- Monitoring of radionuclides specific activities in the air and atmospheric fallouts;
- Monitoring of radioactivity of sewage and drainage water from the INPP site;
- Meteorological observations;
- Monitoring of radionuclides specific activities in Lake Druksiai and underground water;
- Dose and dose rate monitoring in the sanitary protective zone (3 km) and observation zone (30 km);
- Monitoring of radionuclides specific activities in the fish, algae, soil, grass, sediments, mushrooms, leaves;
- Monitoring of radionuclides specific activities in food products (milk, potatoes, cabbage, meat, grain-crops).

The chemical content of sewage (domestic) discharges from the industrial site of INPP is monitored by „Visagino energija“.

The radiological measurements performed according to the INPP current environment monitoring Programme [6] are summarized in the subsections below.

Radiological monitoring results for the INPP region are provided in the annual reports [7]. Report on radiation monitoring results contains data for the last year on radionuclides specific activities in the environment, exposure dose and dose rate for the year under review as well as monitoring data for the previous years. Also necessity and sufficiency analysis for monitoring is provided in the report and conclusions on extension or reduction of monitoring programme are done.

7.1 Monitoring of Radioactive Water Discharges

During the implementation of proposed economic activity the radionuclides can be discharged into environmental water from the Unit 2 (see Section 4.1.5) and from the existing INPP liquid waste treatment facility (building 150). Radioactive water is discharged through existing INPP water discharge systems which are continuously monitored. The same equipment can be used for monitoring of radioactive water discharges. Radioactive discharges caused by the proposed economic activity will be similar as during INPP normal operation. Periodicity and extent of monitoring objects can be revised during the preparation design documentation of proposed economic activity. The current monitoring of radioactive water discharges is summarized in Table 7.1.

Table 7.1. Monitoring of radioactive water discharges [6]

No.	Component of monitoring	Nb of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits
1	Water samples from Lake Druksiai	2	Total β activity	Radiometric	Reactor units 1 and 2, 1 time per week.	0.1–3×10^3 Bq/l
2	Permanent discharges into Lake Druksiai	4	Total β activity	Radiometric	Reactor units 1 and 2 (reactor and turbine departments), technical water from bl. 150, 1 time per week; Technical water after heat exchanges, 1 time per month.	0.1–3×10^3 Bq/l
		4	Volumetric activity	Spectrometric	Reactor units 1 and 2 (reactor and turbine departments), pits in corridor 003 of bld. D1 and D2; Technical water after heat exchanges and technical water from bl. 150 when total β activity > 7.4 Bq/l; 1 time per month.	0.74–1.85×10^8 Bq/l
		2	Sr-89, Sr-90	Radiometric	Reactor units 1 and 2 (reactor and turbine departments), 1 time per month.	0.1–3×10^3 Bq/l
		3	Total α activity	Radiometric	Reactor units 1 and 2 (reactor and turbine departments), technical water from bl. 150, 1 time per month.	0.01–1×10^3 Bq/l
3	Periodic discharges into Lake Druksiai from bld. 150	1	Volumetric activity	Spectrometric	Technical waste water from bl. 150, each time before release.	0.74–1.85×10^8 Bq/l
		1	Total β activity	Radiometric	Waste water from special laundry, after treatment in bld. 150, each time before release.	0.1–3×10^3 Bq/l

In the table: bld. 150 is the INPP existing liquid radioactive waste treatment facility.

7.2 Monitoring of Radioactive Airborne Discharges

During the implementation of proposed economic activity the radionuclides can be released into environmental air from the Unit 2 (see Section 4.2.3), from the existing INPP liquid waste treatment facility (building 150) and from other existing INPP waste management facilities (special laundry, cementation facility, etc.). Radionuclides are discharged through existing INPP ventilation systems which are continuously monitored. The same equipment can be used for monitoring of radioactive airborne discharges. Radioactive discharges caused by the proposed economic activity will be similar as during INPP normal operation. Periodicity and extent of monitoring objects can be revised during the preparation design documentation of proposed economic activity. The current monitoring of radioactive airborne discharges is summarized in Table 7.2.

Table 7.2. Monitoring of radioactive airborne discharges [6]

No.	Component of monitoring	Nb. of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits
1	Discharges from reactor units	2	Total β activity of aerosols	Radiometric	Reactor units 1 and 2 ventilation stacks. Measurements are performed periodically 1 time per day, week and month. Measurement range and limits depend on filters expose and detection duration.	2.4×10^{-8}–1.85×10^{7} Bq/l
		2	Sr-89, Sr-90	Radiometric	Reactor units 1 and 2 ventilation stacks, 1 time per month.	0.1–3×10^{3} Bq/l
		2	Total α activity of aerosols	Radiometric	Reactor units 1 and 2 ventilation stacks, 1 time per month.	0.01–1×10^{3} Bq/l
		2	Content and volumetric activity of noble gases	Spectrometric	Reactor units 1 and 2 ventilation stacks, 1 time per day. During unit's maintenance time – 1 time per week.	1.85–3.7×10^{5} Bq/l
		2	Content and volumetric activity of aerosols	Spectrometric	Reactor units 1 and 2 ventilation stacks. Measurements are performed periodically 1 time per day, week and month. Measurement range and limits depend on filters expose and detection duration.	2.5×10^{-6}–1.3×10^{4} Bq/l
		2	I-131	Spectrometric	Reactor units 1 and 2 ventilation stacks. Measurements are performed periodically 1 time per day, week and month. Measurement range and limits depend on column expose duration.	2.2×10^{-6}–26 Bq/l
		1	H-3	Radiometric	Reactor unit 2 ventilation stack, 1 time per month.	0.1-1.7×10^{9} Bq/l
		1	C-14	Radiometric	Reactor unit 2 ventilation stack, 1 time per month.	5.9×10^{-5}–3.6×10^{9} Bq/l
2	Discharges from bld. 150	1	Total β activity of aerosols	Radiometric	Bld. 150 ventilation stack. Measurements are performed periodically 1 time per day, week and month. Measurement range and limits depend on filters expose and detection duration.	2.4×10^{-8}–1.85×10^{7} Bq/l
		1	Sr-89, Sr-90	Radiometric	Bld. 150 ventilation stack, 1 time per month.	0.1–3×10^{3} Bq/l
		1	Total α activity of aerosols	Radiometric	Bld. 150 ventilation stack, 1 time per month.	0.01–1×10^{3} Bq/l

No.	Component of monitoring	Nb. of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits
		1	Content and volumetric activity of noble gases	Spectrometric	Bld. 150 ventilation stack, 1 time per day.	1.85–3.7×10^{5} Bq/l
		1	Content and volumetric activity of aerosols	Spectrometric	Bld. 150 ventilation stack. Measurements are performed periodically 1 time per day, week and month. Measurement range and limits depend on filters expose and detection duration.	2.5×10^{-6}–6.7×10^{3} Bq/l
		1	I-131	Spectrometric	Bld. 150 ventilation stack. Measurements are performed periodically 1 time per day, week and month. Measurement range and limits depend on column expose duration.	2.2×10^{-6}–26 Bq/l
		1	H-3	Radiometric	Bld. 150 ventilation stack, 1 time per month.	0.1-1.7×10^{9} Bq/l
		1	C-14	Radiometric	Bld. 150 ventilation stack, 1 time per month.	5.9×10^{-5}–3.6×10^{9} Bq/l
3	Discharges from bld. 130, 156, 157 and 159	4	Total β activity of aerosols	Radiometric	Bld. 130 controlled area ventilation stack, bld. 156, 157 and 159 ventilation stacks, 1 time per month.	2.4×10^{-8}–6.2×10^{5} Bq/l
		3	Sr-89, Sr-90	Radiometric	Bld. 130 controlled area ventilation stack, bld. 156 and 159 ventilation stacks, 1 time per month.	0.1–3×10^{3} Bq/l
		4	Content and volumetric activity of aerosols	Spectrometric	Bld. 130 controlled area ventilation stack, bld. 156, 157 and 159 ventilation stacks, 1 time per month.	2.5×10^{-6}–2.2×10^{2} Bq/l
4	Discharges from bld. 158/2	1	Total β activity of aerosols	Radiometric	Bld. 158/2 ventilation stack, 1 time per week.	1.1×10^{-7}–2.6×10^{4} Bq/l
		1	Content and volumetric activity of aerosols	Spectrometric	Bld. 158/2 ventilation stack, 1 time per week.	1.0×10^{-5}–1.1×10^{2} Bq/l
		1	I-131	Spectrometric	Bld. 158/2 ventilation stack, 1 time per week.	2.2×10^{-6}–26 Bq/l

In the table, the INPP existing buildings: bld.130 – repair building, bld. 150 - liquid radioactive waste treatment facility, bld. 156 – special laundry, bld. 157 – solid radioactive waste storage facility, bld. 158/2 – cemented radioactive waste storage facility, bld. 159 – special cars garage and washing facility.

7.3 Monitoring of External Radiation (Dose Rate)

The INPP environment monitoring includes monitoring of the irradiation dose and dose rate in different locations of the INPP region.

Permanent dose rate monitoring is performed with the help of stationary sensors of the system “SkyLink”. 10 sensors are installed in the settlements of the monitoring zone, see Figure 7.1, and 12 sensors are installed in the sanitary protection zone around the perimeter of the INPP, see Figure 7.2.

In addition to stationary devices, the dose rate is measured with portable devices in various locations of the monitoring zone, see Figure 7.3.

The exposure equivalent dose is measured with the help of thermo-luminescent dosimeters. Thermo-luminescent dosimeters are located in the sanitary protection zone and monitoring zone in different directions and at different distances from INPP, see Figure 7.4. The exposure time of the thermo-luminescent dosimeters is 6 months; the dose measurement error is no more than 15 %.

It is not expected that during the normal operation conditions of the proposed economic activity radiation levels outside INPP site can increase. INPP equipment dismantling works that would cause the opening of contaminated equipment or decrease in efficiency of the barriers are not planned in the frame of the proposed economic activity (see Section 2). Other potentially identifiable impacts, such as change of ionizing radiation fields (increase or decrease) in the INPP environment due to modification or isolation of non-operational systems, in-line decontamination of closed circuits, etc., are considered as insignificant or not making existing radiological situation at INPP site worst. The same equipment can be used for monitoring of external radiation during the implementation of proposed economic activity. The monitoring of external radiation performed according to the INPP current environment monitoring programme is summarized in Table 7.3

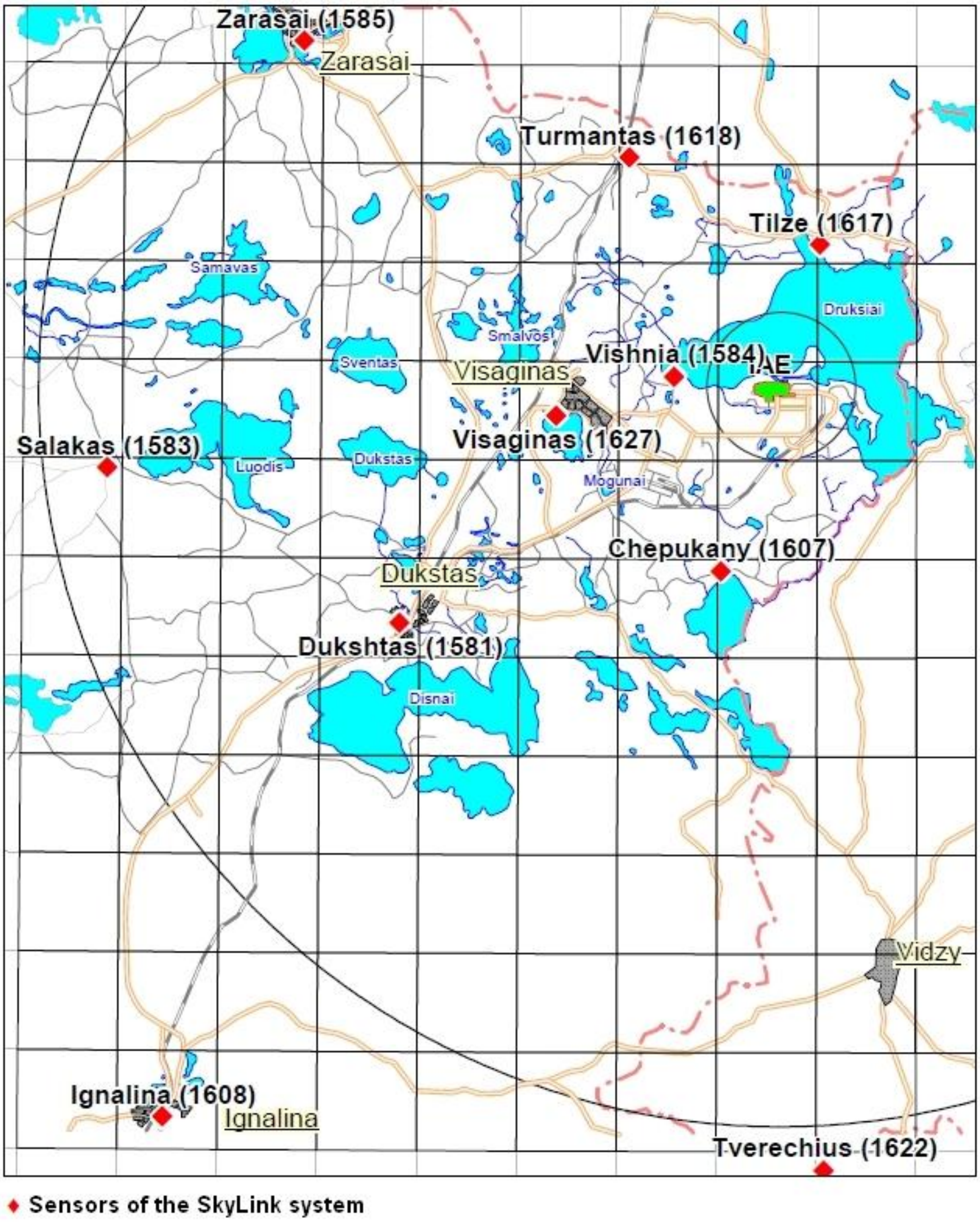

Figure 7.1. Location of the SkyLink system sensors in the 30 km radius INPP monitoring zone [6]

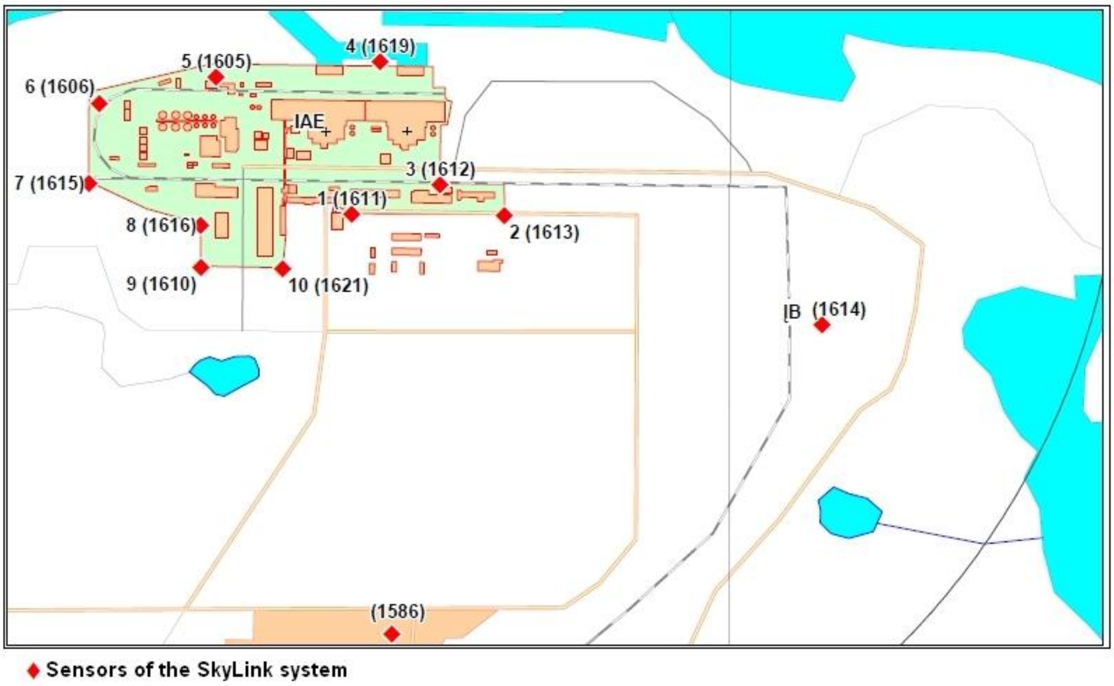

Figure 7.2. Location of the SkyLink system sensors around the perimeter of the INPP [6]

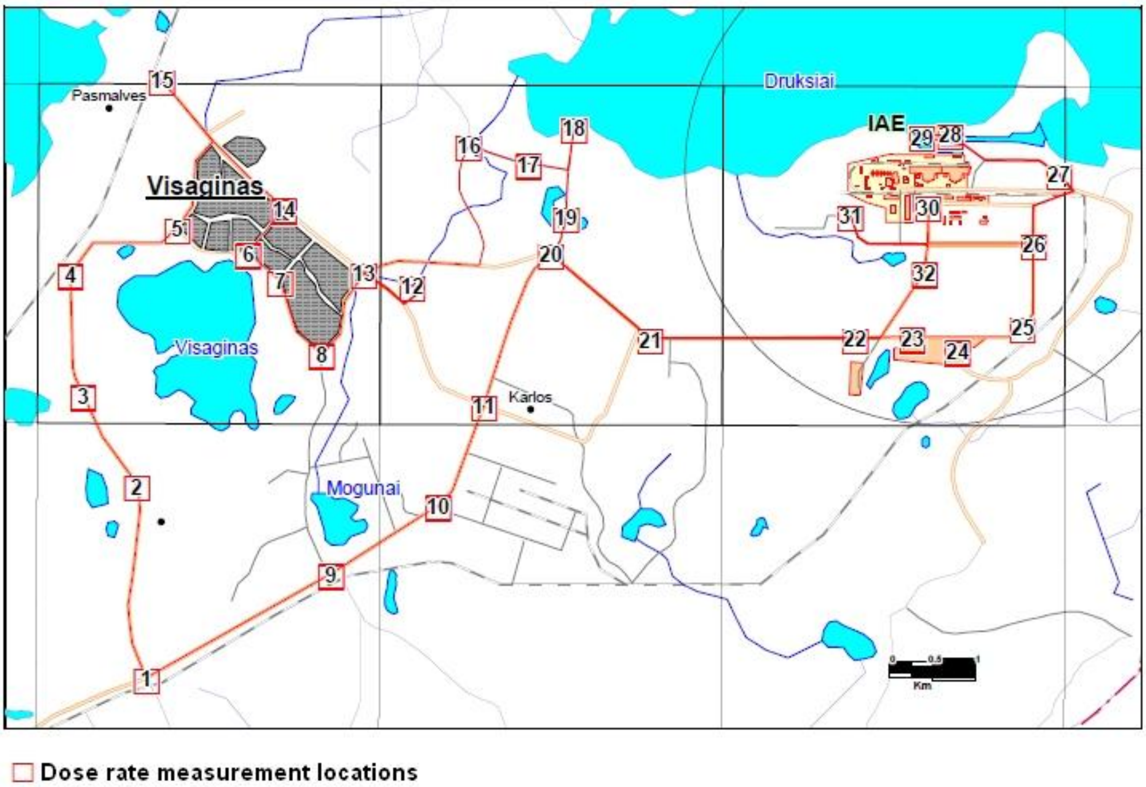

Figure 7.3. Transport path and dose rate measurement locations in the 30 km radius INPP monitoring zone [6]

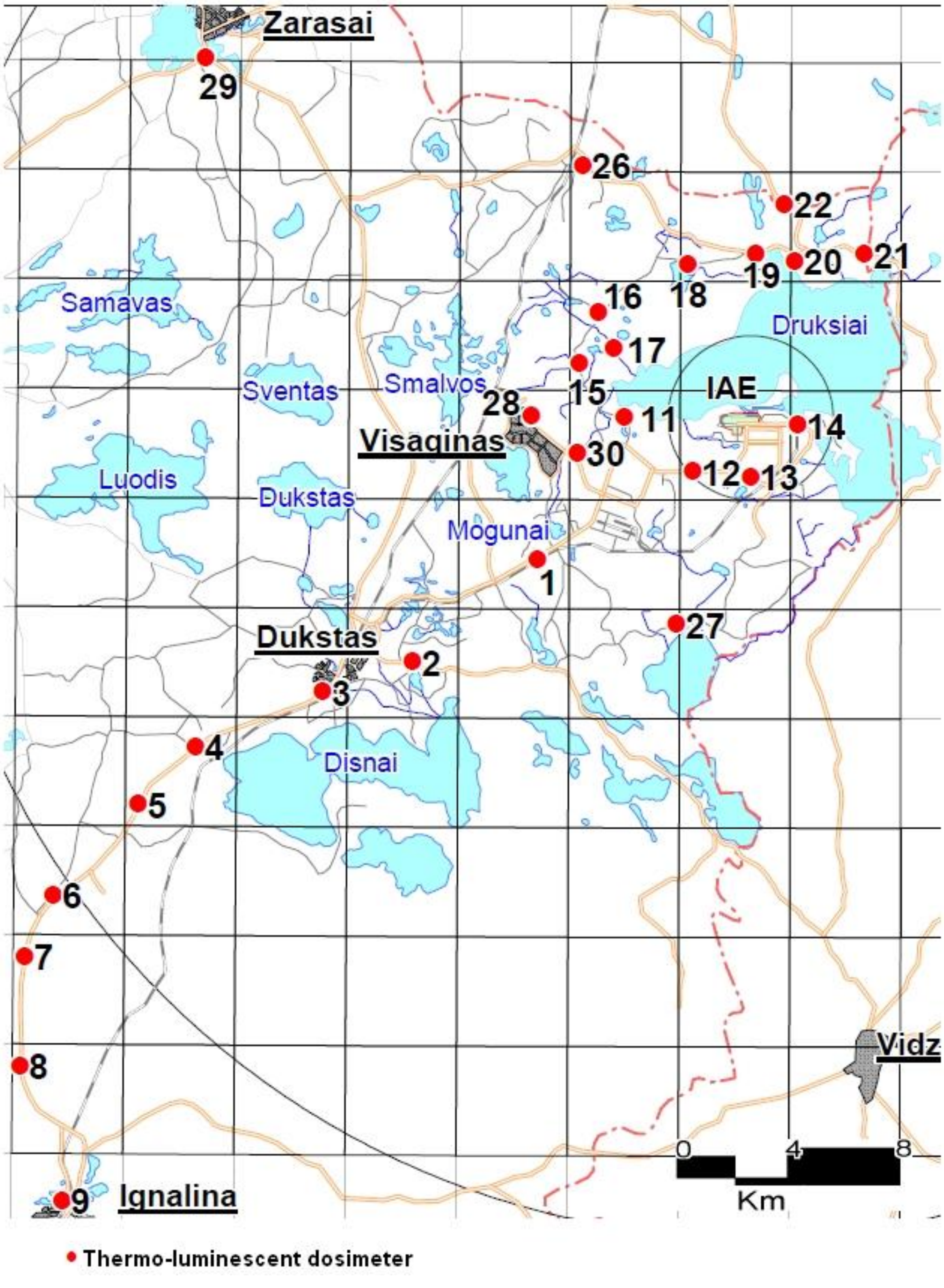

Figure 7.4. Location of thermo-luminescent dosimeters around the INPP [6]

Table 7.3. Monitoring of external radiation [6]

No.	Component of monitoring	Number of measuring locations	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring range
1	Dose rate	22	γ radiation dose rate	Automatic, SkyLink system	Dose rate around the perimeter of the INPP and in the monitoring zone, permanently	3×10^{-8}–1×10^{-2} Sv/h
2	Dose rate	32	γ radiation dose rate	Radiometric	Dose rate in the dump of construction materials and on the roads, 4 times per year (in February, May, August, November)	3×10^{-8}–1×10^{-2} Sv/h
3	Dose rate	2	γ radiation dose rate	Radiometric	Dose rate from SPD-1, SPD-2 equipment, clothes, shoes and machinery, 1 times per quarter	3×10^{-8}–1×10^{-1} Sv/h
4	Dose	26	γ radiation equivalent dose	Radiometric, TLD	Dose at locations of TLD in sanitary protection and monitoring zones, permanent exposition, TLD are changed 2 times per year (in spring, autumn)	1×10^{-5}–10 Sv

In the table: SPD-1, 2 – fire protection and rescue services of the INPP; TLD - thermo-luminescent dosimeter.

7.4 Monitoring of Radioactivity in Air, Water, Soil and Food Chains

The INPP environment monitoring includes monitoring of radioactivity in air, water, soil and food chains. The radiation monitoring is carried out on objects of major importance, including personnel and the population living in locations around the INPP. Monitoring of environmental exposure pathways that may exhibit long term concentration effects, such as sediments, silts, algae, mussels and milk, is also undertaken.

Seven permanent stations for sampling of environmental parameters (e.g. atmospheric air, precipitation, grass, soil etc.) are established in the INPP monitoring zone. Monitoring stations are located in different directions and distances around the INPP, see Figure 7.5.

Sampling the aquatic environment is performed in the monitoring boreholes and channels of the INPP industrial site, Lake Druksiai water intake and discharge channels, water and sediments of Lake Druksiai, potable water from wells etc. Sampling locations on Lake Druksiai water intake and discharge channels are shown in Figure 7.6 and sampling locations in the water body of Lake Druksiai are shown in Figure 7.7.

Selection of the monitoring and sampling locations is based on the following principles:

- The planned or existing environmental pollution (chemical and physical, content of released materials), peculiarities of the population demography and habits of population shall be considered;
- All radionuclides dispersion and human exposure pathways shall be considered on purpose to have a possibility to evaluate annual activities of radionuclides discharged into air and water, short-term changes in radionuclide discharges and effective doses to members of critical group.

The preparation and measurement of the radionuclide content and the concentration of the detected radionuclides in the environmental samples are carried out in accordance with the documents [5, 8]. The same equipment and methods for monitoring of radioactivity in air, water, soil and the food can be used during the implementation of proposed economic activity. The monitoring of INPP environment quality parameters according to the INPP current environment monitoring programme is summarized in Table 7.4.

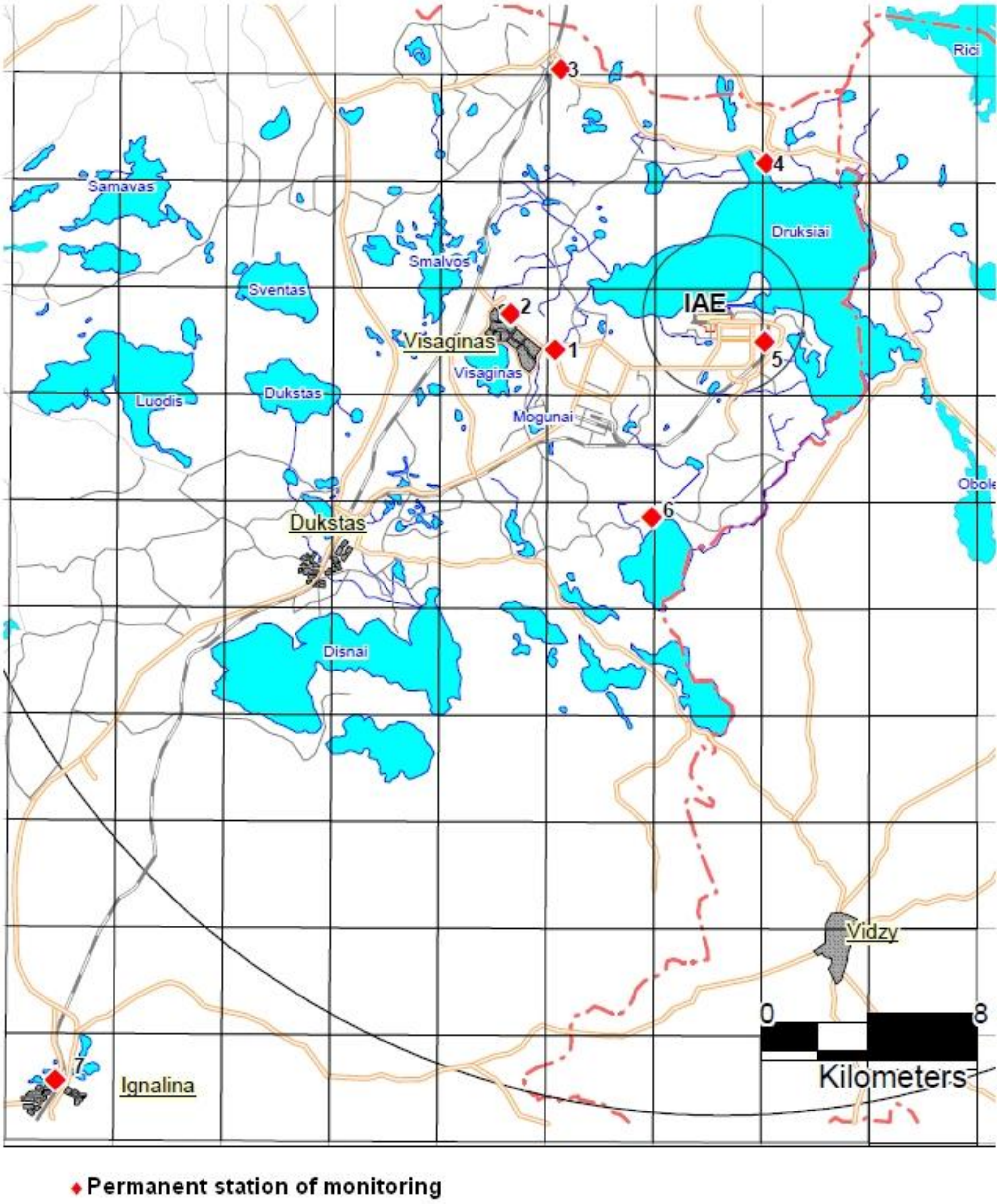

Figure 7.5. Locations of permanent stations for monitoring around the INPP [6]

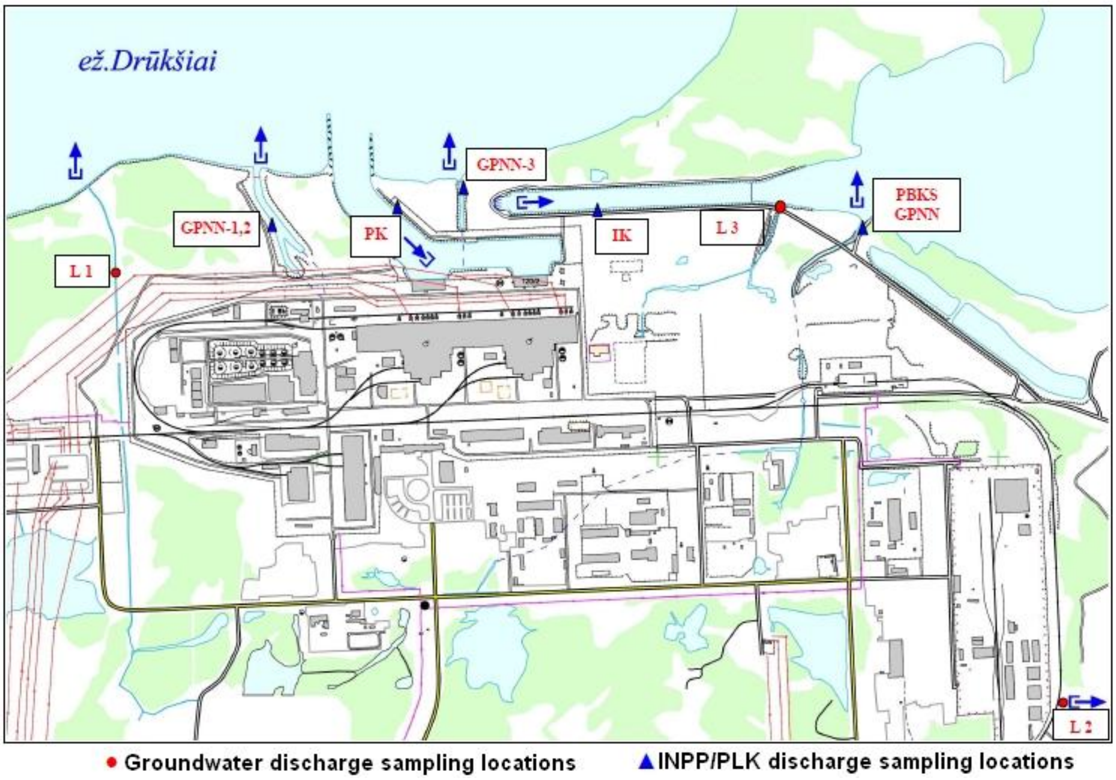

Figure 7.6. Aquatic environment sampling locations on Lake Druksiai water intake and discharge channels [6]

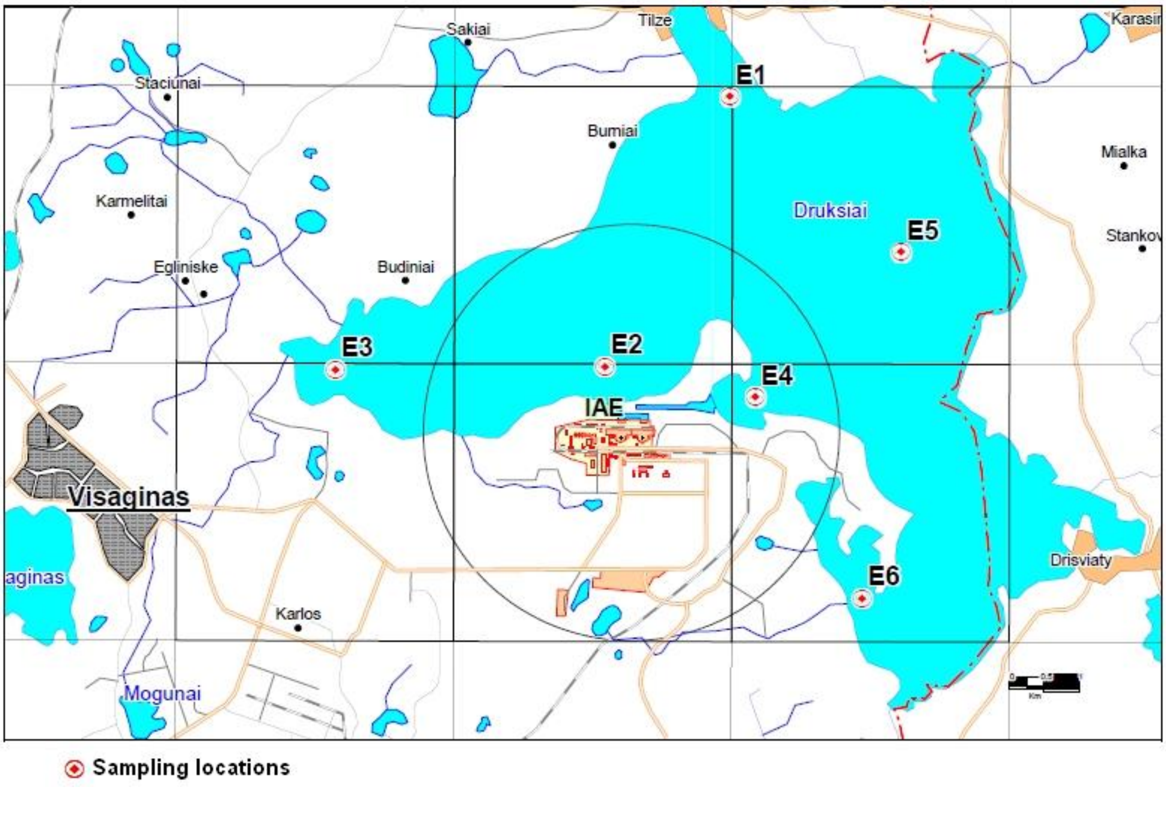

Figure 7.7. Sampling locations in Lake Druksiai [6]

Table 7.4. Monitoring of radioactivity in air, water, soil and the food chains [6]

No.	Component of monitoring	Number of measuring locations	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring range / detecting limit *)
1.	Atmospheric air	6	Activity of γ nuclides	Spectrometric	Atmospheric air at the monitoring stations, 3 times per month	2×10^{-8}–5×10^{-6} Bq/m^3 *)
			Sr-90	Radiometric	2 times per year	3×10^{-5}–1×10^{-6} Bq/m^3 *)
2	Atmospheric precipitation	17	Activity of γ nuclides	Spectrometric	1 time per month	130–4×10^4 Bq/(km^2 day)
		1	H-3	Without concentration during filtering	At the monitoring stations, 2 times per year (in winter and summer)	4 Bq/l *)
3.	Aquatic environment of INPP	104	Activity of γ nuclides	Spectrometric after evaporation	Discharge of technical water and water of intake channel, 20 times per month (on working days) Household waste water, water of industrial site PLK-1,2, PLK-3, PLK-SFSF, 1 time per 10 days Water from channel surrounding landfill of industrial waste, drainage water from INPP industrial site, 1 time per month Water of heating networks, 1 time per quarter (in January, April, July, October) Water of surveillance boreholes in the industrial site and area of SFSF, 2 times per year (in spring, autumn) Potable water from water supply (watering-place), potable water from wells in Tilze and Gaide, 4 times per year (in February, May, August, November) Water of Lake Druksiai, 1 time per year (in summer) Snow at the monitoring stations, INPP industrial site and SFSF site, 1 time per year (in winter)	1×10^{-3}–0.7 Bq/l *)

No.	Component of monitoring	Number of measuring locations	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring range / detecting limit *)
			Sr-90	Radiochemical segregation	Discharge of technical water and water of intake channel, household waste water, water of surveillance boreholes in the industrial site and area of SFSF, 2 times per year (in spring, autumn) Water of Lake Druksiai, 1 time per year (in summer) Water of heating networks, water from channel surrounding landfill of industrial waste, snow at the monitoring stations, INPP industrial site and SFSF site, water of industrial site PLK-1,2, PLK-3, PLK-SFSF, drainage water of INPP industrial site, 1 time per year (in winter)	0.003-0.3 Bq/kg *)
			Activity of Pu isotopes	Radiochemical segregation	Discharge of technical water and water of intake channel, 2 times per year (in spring, autumn)	6×10^{-4}-2×10^{-2} Bq/kg *)
			H-3	Without concentration during filtering	Discharge of technical water , household waste water, precipitation in industrial site of INPP and SFSF site, water of industrial site PLK-1,2, PLK-3, PLK-SFSF, 1 time per month Water from channel surrounding landfill of industrial waste; 1 time per quarter Water of monitoring boreholes in the industrial site and area of SFSF, 2 times per year (in spring, autumn) Potable water from wells in Tilze and Gaide, 4 times per year (in February, May, August, November)	4 Bq/l *)
			Total α activity	Concentrated sample	Potable water from water supply (watering-place), potable water from wells in Tilze and Gaide, 4 times per year (in February, May, August, November)	0.1 Bq/l *)

No.	Component of monitoring	Number of measuring locations	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring range / detecting limit *)
			Total β activity	Concentrated sample	Potable water from water supply (watering-place), potable water from wells in Tilze and Gaide, 4 times per year (in February, May, August, November)	0.01 Bq/l *)
4.	Sludge from storage area	1	Activity of γ nuclides	Without concentration	1 time per month	15 Bq/kg *)
			Activity of Pu isotopes	Radiochemical segregation	2 times per year	300 Bq/kg *)
5.	Bottom sediments in channels and Lake Druksiai	11	Activity of γ nuclides	Dried sample. Spectroscopic	In discharge channel of industrial site PLK-1, PLK-3, SFSF site, PLK-SFSF, downstream purification plant, 3 times per year	3 Bq/kg *)
			Activity of γ nuclides of upper layer (2 cm)	Dried sample. Spectroscopic	At sampling points of Lake Druksiai, 1 time per year	15 Bq/kg *)
			Sr-90	Burning and radiochemical segregation	1 time per year	30 Bq/kg *)
			Distribution profile of gamma nuclides (3-10 cm)	Dried sample. Spectroscopic	1 time in 6 years	15 Bq/kg *)
			Distribution profile of Pu isotopes (3-10 cm)	Radiochemical segregation	1 time in 6 years	300 Bq/kg *)
6.	Aquatic vegetation in channels and Lake Druksiai	11	Activity of γ nuclides	Dried sample. Spectroscopic	In discharge channel of industrial site PLK-1, PLK-3, SFSF site, PLK-SFSF, downstream purification plant and at sampling points of Lake Druksiai, 1 time per year	3 Bq/kg *)

No.	Component of monitoring	Number of measuring locations	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring range / detecting limit *)
			Sr-90	Burning and radiochemical segregation	In discharge channel, downstream purification plant and at sampling points of Lake Druksiai, 1 time per year	3 Bq/kg *)
7.	Foodstuff, plants, soil	34	Activity of γ nuclides	Concentrated /not concentrated sample depending on measuring object	Milk in Tilze, 1 time per month Pasture grass at the monitoring stations, 1 time per month (during growing season) Fish from Lake Druksiai, 2 times per year Cabbage in Tilze, 1 time per year Potatoes in Tilze, 1 time per year Soil at the monitoring stations, mushrooms and moss at locations of Vilkaragis, Grikeniskes, Tilze, Gaide, Visaginas, deer meat in the radius of 10 km around INPP, grain crops (rye or oats) in Tilze, meat (pork and beef) in Tilze and at location of Turmantas, 1 time per year (in autumn)	3 Bq/kg *)
			Sr-90	Radiochemical segregation	Pasture grass at the monitoring stations, 1 time per year	3 Bq/kg *)
					Fish from Lake Druksiai, 1 time per year Cabbage in Tilze, 1 time per year Milk in Tilze, 1 time per year	0.3 Bq/kg *)
					Soil at the monitoring stations, 1 time per year (in autumn)	30 Bq/kg *)

*) In the table: indicated detecting limit corresponds to the lowest measured activity in the sample with trustiness of 95%. The lower activities can be measured, but trustiness will be lower. Also, samples of the same type may be of different composition (e.g. samples of the soil may be of different composition) therefore detection limits will be different. The table provides conservative (maximum) values of the detecting limits.

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7. Annual Reports on Radiation Monitoring Results at the INPP Region. INPP, PTOot-0545-4 – PTOot-0545-16.
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8 RISK ANALYSIS AND ASSESSMENT

8.1 Identification and Assessment of Potential Emergency Situations

The Lithuanian legal document "Regulations on Preparation of Environment Impact Assessment Program and Report" (State Journal 2006, No. 6-225) defines that the emergency situations of a proposed economic activity and their potential risks should be assessed according to normative document "Recommendations for Assessment of Potential Accident Risk of Proposed Economic Activity" (Information Publications, 2002, No. 61-297).

Risk assessment for environmental impact assessment (EIA) differs from risk assessment which is performed later in the Safety Analysis Report (SAR). Usually during the environmental impact assessment process a Technical Design of the proposed economic activity is not available yet, therefore for EIA it is important to identify potential emergency situations and to define emergency situations which have bounding impact on the environment. The risk assessment as presented in an EIA Report shall be considered as preliminary and does not substitute necessity for more sophisticated and detailed risk analysis which has to be based on actual design solutions.

Emergency situations, which could lead to releases and cause radiological exposure of personnel and/or general public, are of primary concern for environmental impact assessment. For this proposed economic activity most of the potential emergency situations can cause radiological and non-radiological or only non-radiological consequences. Accidents with non-radiological consequences as a rule lead to considerably lower impacts, therefore in the further analysis consequences of radiological accidents are considered only.

Risk assessment performed in this EIA Report contains the following steps:

- identification of the initiating events and accidents;
- screening and selection of accidents which have bounding impact to environment;
- definition of source terms and releases into environment in case of accidents;
- dispersion modelling of accidental releases and public exposure assessment.

The possible accidents while performing the proposed economic activity can be grouped into the following groups of accidents:

- First group of accidents is related to reactor conditions after RFS and possible accidents while performing activities of defueling Stage 1. During this stage nuclear fuel remains in reactor core and also in SNF storage pools. The following accidents can be assigned to this group:
  - accidents caused by the loss of reactivity control;
  - loss of coolant accidents;
  - loss of essential supply systems.
- Second group of accidents is related to specific activities mainly performed during defueling Stage 2. During Stage 2 nuclear fuel is completely removed from the reactor core, however storage pools still contain spent nuclear fuel. The following accidents belong to this group:
  - loss of cooling of SNF storage pools;
  - accidents caused by fuel handling errors during the defueling of the SNF storage pools;
  - loss of decontamination solution;
  - generation of explosive gases during MCC decontamination.

While identifying initiating events and accidents it is important to consider the fact, that nature of events and accidents that can be caused by of proposed economic activity is the same as during reactor operation, for example damage of fuel rod cladding, loss of reactivity control, drop of fuel assembly and etc. Also it should be mentioned, that proposed economic activity will be implemented within the existing INPP buildings (in the reactor hall, storage pool hall and other rooms) the safety of which is substantiated in the numerous safety justification reports evaluating the possible impacts due to external events (airplane crash, extreme meteorological conditions, terrorist attacks and other) and planning administrative and technical safety measures for mitigation of these impacts and also protective actions of the public. Therefore, the events and accidents which are specific to proposed economic activity and which have not been evaluated in other INPP safety justification and environmental impact assessment reports are only considered in details in this section.

The list of potential initiating events and accidents resulting from proposed economic activity are presented in Table 8.1. Possible hazards, except which are already analyzed in the Safety Analysis Report of Unit 2 and other safety justification reports of Ignalina NPP, are classified according to consequences for health, environment, property, risk level and etc. in accordance to “Recommendations for Assessment of Potential Accident Risk of Proposed Economic Activity” [2]. Details on the classification of consequences are provided in Table 8.2.

Table 8.1. Risk analysis of potential accidents resulting from proposed economic activity

Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
					L	E	P	S	Pb	Pr		
Keeping nuclear fuel in the core of shutdown reactor	Loss of reactivity control	Nuclear incident /Ra-diological accident	Environment, personnel	Release of radionuclides, exposure of personnel	-	-	-	-	1	A	After reactor final shutdown all control rods are inserted into the core. Technical and administrative ensure that extraction of these control rods is not possible.	Preventive measures and parameters of the reactor core are such that the loss of reactivity control during implementation of the proposed economic activity is practically impossible.
Keeping nuclear fuel in the core of shutdown reactor	Loss of coolant	Nuclear incident /Ra-diological accident	Environment, personnel	Release of radionuclides, exposure of personnel	-	-	-	1	2	A	After reactor shutdown water temperature in MCC does not exceed 100 °C, pressure is atmospheric, therefore the risk for the loss of coolant is significantly lower in comparison with reactor in operation. Moreover, the technical measures how to compensate the loss of coolant and to avoid the damages of fuel assemblies are foreseen.	Loss of coolant potentially can lead to damage of fuel rod cladding. However the parameters of the reactor core during implementation of the proposed economic activity are such that even in case of coolant loss and in absence of compensating measures, damage of fuel rod cladding can occur only after rather long time period, which is sufficient to resume coolant supply.
Keeping	Loss of	Anticipated	If the loss of	If the loss does not	-	-	-	1	4	A	After reactor shutdown the	Loss of electrical power or

Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
					L	E	P	S	Pb	Pr		
nuclear fuel in the core of shutdown reactor	electrical power, water supply	Operational Occurrence; Lost of coolant accident is possible in the worst case scenario	electrical power or water supply does not lead to an accident there are no threatened objects. In case of accident, see above.	lead to an accident there are no consequences, electrical power or water supply is just renewed. In case of accident, see above.							removal of the remaining decay heat is performed by natural convection. There is no need for the large amount of cooling water. The designs of electrical power and water supply systems ensure continuous supply of electrical power or water.	water supply are comprehensively analysed in the Safety Analysis Report of the Unit 2.
SNF handling and storage in the storage pools	Loss of the cooling	Radiological accident	Environment, personnel	Release of radionuclides, exposure of personnel	-	1	-	1	2	A	Redundant and backup technical measures ensure continuous cooling.	Loss of the cooling potentially can cause the damaged to fuel rod cladding. However, this hazard in SNF storage pools is comprehensively analysed in the safety justification reports of Ignalina NPP, in which is demonstrated that mitigation measures assure that fuel assemblies are not damaged. Proposed economic activity does not initiate the new accidents that were not analyzed before.

Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
					L	E	P	S	Pb	Pr		
SNF handling and storage in the storage pools	Drop of fuel assembly, transfer basket, storage cask	Radiological accident	Environment, personnel	Release of radionuclides, exposure of personnel	1	1	1	5	2	A	Design of cranes, grabs and other components ensures that a risk of drop is minimal. In order to avoid the impact of dropped container, shock absorbers are installed on bottom of the pool.	Drops of SFA, storage cask are comprehensively analysed in the safety justification reports of Ignalina NPP and in the Safety Analysis Report of the project "Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Units 1 and 2 (B1)". Environmental impact assessment of these accidents is provided in [1].
Deconta-mination of MCC	Leakage of the decontamin-ation solution	Radiological/ Chemical accident	Environment, personnel	Release of radionuclides or chemical materials, radiation exposure or chemical impact to personnel	1	2	1	3	2	B	The decontamination of the MCC is performed straight after the defueling of reactor core, when the MCC components are tight and in good working conditions. Loads during decontamination (pressure <10 bar and temperature ≤100 ºC) are significantly lower than those during normal operation.	Leakage of the decontamination solution is the accident which can be caused by proposed economic activity. This accident is analyzed in Section 8.2.2.1. Ignalina Unit 1 MCC in-line decontamination will be evaluated in separate project B12. Safety issues and possible environmental impacts

Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
					L	E	P	S	Pb	Pr		
												will be evaluated in the technical documentation of this project. Taking into account the gained experience in Unit 1 the decontamination of the Unit 2 MCC will be accomplished in a separate project B24.
Deconta-mination of MCC	Generation of explosive or hazardous gases	Explosion / Fire / Chemical accident	Environment, personnel, property	Release of chemical materials, damages due to impact of explosion wave to persons, constructions, equipment	1	2	2	3	2	B	The formation of H_2 and CO_2 is a possible during decontamination process. Ventilation systems ensures that these gases are removed from rooms. The activity of the discharged gases is monitored by the existing devices.	Generation of explosive or hazardous gases during the decontamination of MCC is the hazard which can be caused by proposed economic activity. This hazard is analyzed in Section 8.2.2.2. Ignalina Unit 1 MCC in-line decontamination will be evaluated in separate project B12. Safety issues and possible environmental impacts will be evaluated in the technical documentation of this project. Taking into account the gained experience in Unit 1 the

Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
					L	E	P	S	Pb	Pr		
												decontamination of the Unit 2 MCC will be accomplished in a separate project B24.
Keeping nuclear fuel in the core, SNF storage in storage pool or decontamination activities	Failure in ventilation system	Radiological accident / Generation of explosive gases	Environment, personnel, property	Release of radionuclides, impacts of explosion wave	1	2	2	5	2	B	Components of ventilation system (fans, dampers and etc.) are redundant, also backup measures are foreseen. Therefore, the failure in ventilation system, which leads to generation of explosive gases is very improbable. In order to avoid the rupture of aerosol filter, the pressure drop is continuously monitored and the filters are replaced if the pressure drop exceed the pre-set threshold limit. Moreover, the aerosols filters are replaced on a preventive basis during the maintenance.	Failure in ventilation system during reactor operation is analyzed in the existing INPP safety justification reports. During the implementation of the proposed economic activity reactor will be shutdown, possible releases will be different, therefore analysis of this event is presented in Section 8.2.2.3.

Table 8.2. Classification of consequences for life and health (L), environment (E), property (P), accident development speed (S), accident probability (Pb) and prioritization of consequences (Pr) according to recommendations [2]

Classification of consequences for life and health (L)

ID	Class	Characteristic
1	Unimportant	Temporary slight discomfort
2	Limited	A few injures, long lasting discomfort
3	Serious	A few serious injuries, serious discomfort
4	Very serious	A few (more than 5) deaths, several or several tenths serious injuries, up to 500 evacuated
5	Catastrophic	Several deaths, hundredths of serious injuries, more than 500 evacuated

Classification of consequences for the environment (E)

ID	Class	Characteristic
1	Unimportant	No contamination, localized effects
2	Limited	Simple contamination, localized effects
3	Serious	Simple contamination, widespread effects
4	Very serious	Heavy contamination, localized effects
5	Catastrophic	Very heavy contamination, widespread effects

Classification of consequences for property (P)

ID	Class	Total cost damage, thousands Lt
1	Unimportant	Less than 100
2	Limited	100 - 200
3	Serious	200 - 1000
4	Very serious	1000 - 5000
5	Catastrophic	More than 5000

Classification of accident development speed (S)

ID	Class	Characteristic
1	Early and clear warning	Localized effects, no damage
2		
3	Medium	Some spreading, small damage
4		
5	No warning	Hidden until the effects are fully developed, immediate effects (explosion)

Classification of accident probability (Pb)

ID	Class	Frequency (rough estimation)
1	Improbable	Less than once every 1000 years
2	Hardly probable	Once every 100 – 1000 years
3	Quite probable	Once every 10 – 100 years
4	Probable	Once every 1 – 10 years
5	Very probable	More than once per year

Prioritization of consequences (Pr)

ID	Characteristic of consequences
A	Unimportant
B	Limited
C	Serious
D	Very serious
E	Catastrophic

8.2 Assessment of Potential Emergency Situations

8.2.1 Reactor related accidents (first group of accidents)

The reactor related accidents that can occur during the implementation of the Stage 1 tasks of proposed economic activity of defueling phase of Unit 2 decommissioning are similar to the accidents (loss of coolant, damage of fuel rod cladding and others) which were possible during the operation of reactor. However, extent, consequences and mitigation measures of the accidents when reactor is shutdown are much less than during reactor operation. As it was mentioned above, when reactor is shutdown and cooled-down, water temperature in MCC does not exceed 100 °C and pressure is atmospheric. Such conditions automatically exclude possibility of accidents initiated by high pressure or generated steam. The residual thermal power of 2.5 MW_{th} or less (during reactor operation this thermal power is about 4200 MW_{th}) will be generated due to natural radioactive decay. Therefore, parameters of the reactor core after the shutdown are such that there are no conditions for occurrence of nuclear or radiological accident.

After reactor final shutdown all control rods will be inserted into the reactor core and appropriate measures will be implemented to prevent any withdrawal possibility of these rods. Therefore the loss of reactivity control during implementation of the proposed economic activity is very unlikely. Moreover, as the reactor defueling continues the probability of a criticality accident continuously decreases until conditions for a criticality accident is no longer possible at all.

Initiating events leading to loss of coolant accident are the same for shutdown reactor and reactor in operation. These initiating events, accident consequences and preventive measures are analysed in the Safety Analysis Report of the Unit 2. It should be emphasized, that after reactor shutdown water temperature in MCC does not exceed 100 °C and pressure is atmospheric, therefore the risk of initiating event (e.g. pipe rupture) significantly decreases. Moreover, the parameters of the reactor core during implementation of the proposed economic activity are such that even in case of coolant loss and in absence of compensating measures, damage of fuel rod cladding can occur only after rather long time period, which is sufficient to resume coolant supply.

The removal of the remaining decay heat from the reactor core is performed by natural convection, i.e. without pumps and other active elements, therefore the loss of electrical power or water supply is not so important as in case of operating reactor. Also there is no need for the large amount of cooling water. The loss of power or water supplies is important for safety only in case if it leads to the loss of coolant accident. However, the designs of these supply systems ensure continuous supply of electrical power or water.

It can be concluded that reactor related accidents during implementation of the proposed economic activity will not cause the impacts to environment and will not exceed Level 1 of INES scale (see Table 8.9)

8.2.2 Accidents related to the decommissioning activities (second group of accidents)

As it was mentioned above, these accidents are related to Stage 2 tasks of proposed economic activity when nuclear fuel is completely removed from the reactor core and all spent nuclear fuel is stored in storage pools.

Various possible accidental conditions in the SNF storage pools: loss of the cooling, fire, criticality accidents, drop of fuel assembly, generation of explosive gases, leakage from pool and other are analysed in the existing safety justification reports of Ignalina NPP. Possible accidents during spent nuclear fuel loading from storage pools into storage casks and transfer of these casks to interim spent nuclear fuel storage facility are analysed in the EIA Report and Safety Analysis Report of the decommissioning project “Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Units 1 and 2 (B1)”. In these reports it is demonstrated that existing technical and administrative measures ensure that even in case of accidents impact to environment and population is insignificant.

The events and accidents which are possible for proposed economic activity and which are not analysed in the existing Ignalina NPP reports, but are evaluated in the subsections below, are as follows:

- Leakage of the MCC decontamination solution;
- Generation of explosive or hazardous gases during decontamination process;
- Failure in ventilation system when reactor is shutdown.

It should be noted that Ignalina Unit 1 MCC in-line decontamination will be evaluated in separate project B12. Safety issues and possible environmental impacts will be evaluated in the technical documentation of this project. Taking into account the gained experience in Unit 1 the decontamination of the Unit 2 MCC will be accomplished in a separate project B24.

8.2.2.1 Leakage of the MCC decontamination solution

Scenario and consequence assessment of MCC decontamination solution leakage are based on EIA Report of INPP Unit 1 decommissioning project for defueling phase.

Since MCC has the highest radiological contamination, the consequences of MCC decontamination solution leakage are maximal in case of the rupture of the suction header of main circulation pumps (MCPs) of one MCC loop (each loop of the MCC is decontaminated separately). Firstly due to this rupture the complete drain of the water from two separator drums and their equilibrium lines; from pipes going down from separator drums and from the MCPs drum header occurs. Conservatively it is assumed that after the rupture three MCPs (such number of MCP are in operation during in-line decontamination to provide the appropriate circulation rates and to keep the temperature of the decontamination solution at the required temperature level of 95ºC) will continue to operate for some time before being shut-off. This means that after the rupture of the suction header, the separator drums will still be fed with decontamination solution from the bottom feed water lines, from the reactor channels and from the steam-water lines. Therefore, conservatively it is assumed that the whole volume of water from the MCC loop which is under decontamination will be lost.

Even deterministic evaluation of the consequences in case of the MCC decontamination solution leakage is performed, it should be noted that probability of occurrence of such accident is low because:

- The decontamination of the MCC will be performed straight away after the reactor defueling, i.e. when the MCC components are tight and in good working conditions;
- The operating conditions during the decontamination (pressure <10 bar and temperature ≤100 ºC) are significantly lower than those during normal operation (pressure ~70 bar and temperature ~260 ºC).

The following conservative assumptions are done in the analysis of radiological consequences in case of the loss of decontamination solution:

- The activity inventory in the circulating decontamination solution is maximal, i.e. it is assumed that the efficiency of the decontamination process is equal to 100 % and it means that the whole inventory of the deposited activity onto the inner walls of the MCC and PCS equipment has been removed and is present in the decontamination solution;
- Temperature of the decontamination solution will be limited to 95 ºC, however conservatively it is accepted equal to 100 ºC, therefore at the location of the rupture a fraction of the leaking fluid will flash into steam with release of the activity inventory in aerosols form;
- The whole inventory of the lost spent decontamination solution is assumed to be equal to the water inventory of the MCC loop undergoing decontamination, i.e. 825 tons.;
- Decontamination process starts right after nuclear fuel is removed from the reactor core, i.e. after four years since reactor shutdown;
- MCC and PCS equipment contamination is described in Section 2.2.

Taking into account above mentioned assumptions and based on information provided in EIA Report of INPP Unit 1 decommissioning project for defueling phase, activities of released radionuclides into the atmosphere in case of the loss of decontamination solution accident are provided in Table 8.3. The height of release is equal 150 m, release duration – 8 hours.

Evaluation of the consequences to population in case of this accident is presented in Section 8.3.

Table 8.3. Release of radionuclides into the atmosphere in case of the loss of MCC decontamination solution

Radionuclide	Release into atmosphere, Bq
C-14	$3.13 \cdot 10^{8}$
Mn-54	$3.04 \cdot 10^{9}$
Fe-55	$9.68 \cdot 10^{10}$
Co-58	$2.13 \cdot 10^{4}$
Ni-59	$6.76 \cdot 10^{7}$
Co-60	$3.67 \cdot 10^{10}$
Ni-63	$1.56 \cdot 10^{10}$
Nb-94	$1.28 \cdot 10^{8}$
Sr-90	$1.20 \cdot 10^{7}$
Tc-99	$8.99 \cdot 10^{4}$
I-129	$7.97 \cdot 10^{2}$
Cs-134	$6.72 \cdot 10^{7}$
Cs-135	$7.21 \cdot 10^{2}$
Cs-137	$2.02 \cdot 10^{8}$
Pu-238	$2.20 \cdot 10^{7}$
Pu-239	$5.92 \cdot 10^{6}$
Pu-240	$1.41 \cdot 10^{7}$
Pu-241	$1.73 \cdot 10^{9}$
Am-241	$4.59 \cdot 10^{7}$
Cm-244	$5.24 \cdot 10^{6}$

The following measures are implemented to eliminate the consequences of the loss of MCC decontamination solution accident:

- The lost decontamination solution is collected by the sumps of the drainage system of the leak tight confinement. Later the lost decontamination solution is transferred to the tanks of liquid waste storage facility for evaporation. The floors and walls of the contaminated areas then are decontaminated.
- The ruptured components are repaired and a new decontamination cycle is executed.

8.2.2.2 Generation of explosive or hazardous gases

Explosion hazard is possible due to the hydrogen generation during some decontamination processes applied to specific materials (for example, steel). The materials of the MCC and PCS, which are in contact with the circulating acidic decontamination solutions, consist of austenitic stainless steel, Zr-Nb alloys, graphite and PTFE compounds. Similar materials are used in other nuclear power plants and no hydrogen generation has been observed as a result of the CORD process implementation.

Although hydrogen generation during decontamination is prevented, however generation of CO_2 can't be prevented. Per decontamination cycle and per loop, 457 m^3 of CO_2 are produced and accumulated into the steam phase of the separator drums, leading to a pressure increase of about 6.3 bar. Therefore separator drums are vented and CO_2 is led to the ALS tower.

The CO_2-steam mixture due to the pressure difference driving force is progressively discharged to chambers of the ALS where the steam condensation occurs, CO_2 concentration in ALS tower delay chambers decreases and after that gases are discharged to the atmosphere via ventilation system provided with aerosols filters. The residual activity of the discharged gases (air-CO_2) is monitored by the existing monitoring devices.

8.2.2.3 Failure in Ventilation System

Ventilation systems that are important for safety are designed to ensure the uninterruptable extraction of the air from corresponding rooms. There are redundant or backup ventilators, also emergency backup power supply is foreseen. Single failure analysis justifies that in case of failure the operability of ventilation system that important for safety is not lost. Although operability of ventilation system is assured in all cases, the rupture of an aerosols filter due to an excessive and abrupt pressure drop increase, unfavourable environmental parameters or inappropriate maintenance cannot be excluded. After the rupture, most of the aerosols already trapped in the filtering medium (for example, in Petrianov membranes) remain fixed and are not released into environment. Moreover, the large particulates released from the filtering medium at the location of the rupture will be retained by the wire-mesh post-filter installed in the filter frame downstream of the high efficiency filtering membrane, so that only some fine aerosols will be released to the atmosphere.

It should be mentioned, that the rupture of an aerosols filter has never occurred during the whole INPP operation period. The pressure drop of the aerosols filters is continuously monitored and the filters are replaced should the pressure drop exceed the pre-set threshold limit. The operation experience shows that this threshold value is practically never reached because the aerosols filters are replaced on a preventive basis during the maintenance outages of the Units, (at least once per year).

Based on information provided in the documentation (EIA Report and Safety Analysis Report) of INPP Unit 1 decommissioning project for defueling phase, where assumptions and evaluations of the radionuclide content in aerosols filters and possible releases into environment are presented, it is assumed that the same releases will occur in case of failure in ventilation system at Unit 2. The list of released radionuclides into the atmosphere and their activities are provided in Table 8.4.

Evaluation of the consequences to population in case of this accident is presented in Section 8.3.

Table 8.4. Releases into the atmosphere in case of failure in ventilation system

Radionuclide	Release into atmosphere, Bq
C-14	$1.6 \cdot 10^{7}$
Mn-54	$4.1 \cdot 10^{9}$
Fe-55	$1.4 \cdot 10^{10}$
Co-58	$1.3 \cdot 10^{9}$
Co-60	$3.5 \cdot 10^{9}$
Ni-59	$3.5 \cdot 10^{6}$
Ni-63	$8.4 \cdot 10^{8}$
Nb-94	$5.7 \cdot 10^{6}$
Sr-90	$2.4 \cdot 10^{7}$
Tc-99	$1.4 \cdot 10^{6}$
I-129	$1.3 \cdot 10^{4}$

Cs-134	$4.2 \cdot 10^9$
Cs-137	$3.5 \cdot 10^9$
Pu-238	$6.0 \cdot 10^4$
Pu-239	$1.5 \cdot 10^4$
Pu-241	$5.6 \cdot 10^6$
Am-241	$8.4 \cdot 10^4$
Cm-244	$1.6 \cdot 10^4$

8.3 Assessment of consequences to population due to the potential emergency situations

8.3.1 Methodology for Assessment of Public Exposure Determined by Airborne Radioactive Materials

In case of accidents with release of airborne activity, the calculation of the atmospheric dispersion and the calculation of public exposure are based on the methodology recommended by German incident guideline [3]. This methodology is in accordance with requirements of European [4] and international normative documents [5]. This methodology has been successively applied in assessing of potential emergency consequences for the new INPP cement solidification facility and solidified waste interim storage project [6]. The dispersion modelling methodology used in [3] is described and recommended by IAEA Safety Series publication [7].

The dispersion and deposition of airborne material is calculated, using the short-term two-dimensional Gaussian distribution model for a source which also may be elevated to a certain height above ground. Gaussian distribution central axis activity concentration is used for assessment of maximal potential radiological consequences. Building wake effect is assumed if the release point is within the building wake influence zone. The terrain in the vicinity of the INPP up to distances of several tens of kilometres is sufficiently flat, so it can be stated that the dispersion is not influenced by the orography.

In general, accidents can happen at any time of the day and during unfavourable weather conditions. The most unfavourable factors for fallout and washout were defined to be representative for the investigated situations. The calculations were performed assuming no rain and heavy rain conditions (amount of rain of 5 mm/h). The calculations were performed for all different atmospheric stability conditions from class A (very unstable conditions) to class F (very stable conditions). The wind speed data for the height of 10 m used in the calculations are presented in Table 8.5.

Table 8.5. Wind speed parameters according to atmospheric stability class

Atmospheric stability class	A	B	C	D	E	F
Wind speed at the height of 10 m, m/s	1	2	4	5	3	2

The effective dose due to design basis accidents is calculated for a member of the population considering the following external and internal exposure pathways:

External exposure:

- exposure due to gamma radiation of the passing radioactive cloud (gamma submersion);
- exposure due to beta radiation of the passing radioactive cloud (beta submersion);
- exposure due to gamma ground radiation of the radioactive fallout and washout (exposure due to radioactive material on ground surface);

Internal exposure:

- exposure due to radioactive intake by respiration (inhalation);
- exposure due to radioactive intake by consumption of foodstuffs (ingestion), such as milk, meat, green vegetables and other plant products (grain, grain products, root vegetables, potatoes, fruit, fruit juice).

The assessment of accidents considers the specificity of the existing INPP sanitary protection zone. The presence of members of population within the SPZ is assumed to be 730 h per year or 2 hours per day. This corresponds to the time period which is need for member of population to cross (forward and backward) the SPZ with diameter of 6 km. No restrictions are imposed outside the boundary of the SPZ. Accident consequences are calculated assuming no changes in daily life outside the borders of the SPZ. The annual external exposure time is assumed to be 8766 h per year, production and consumption of food products are not specially limited.

The main parameters used for assessment of human exposure under design and beyond design basis accidents are presented in Table 8.6.

Table 8.6. The main parameters used for assessment of exposure to a member of population during accident conditions [3]

Parameter	Value	Remark
Adult breathing rate, m^3/s	3.8E-04	Conservative value for short time exposure
Annual exposure duration within SPZ, h	730	-
Annual exposure duration outside SPZ, h	8766	Conservative value
Annual intake of crop products (grain, grain products, potatoes, root vegetables), kg/a	610	Conservative value, 95% percentile
Annual intake of fresh (sheet) vegetables, kg/a	39	Conservative value, 95% percentile
Annual intake of milk and milk products, l/a	390	Conservative value, 95% percentile
Annual intake of meat and meat products, kg/a	180	Conservative value, 95% percentile
Amount of feed consumed by milk/meat produced animal, kg/d	65	Fresh mass
Average time between slaughter and human consumption of meat and meat products, d	20	Generic value
Food crops exposure period (growing season), d	60	Generic value
Yield (fresh mass) of pasture grass, kg/m^2	0.85	Generic value
Yield (fresh mass) of sheet vegetable, kg/m^2	1.6	Generic value
Yield (fresh mass) of other products, kg/m^2	2.4	Generic value

Parameter	Value	Remark
Surface dry weight of the pasture soil (depth of 10 cm), kg/m^2	120	Generic value
Surface dry weight of the plough land (ploughshare depth of 20 cm), kg/m^2	280	Generic value

Radiation dose coefficients for inhalation and ingestion are taken from the normative document [11].

8.3.2 Assessment of Radiological Consequences

8.3.2.1 Loss of MCC decontamination solution

Release of radionuclides into the atmosphere in case of the loss of MCC decontamination solution and their activities are evaluated in Section 8.2.2.1 (see Table 8.3). Radionuclides are released via the main chimney of the plant (at 150 m height).

Results of calculated doses are summarized in Table 8.7. As can be seen from the Table 8.7, the dose due to the passing of the radioactive cloud is much smaller than doses due to deposition of radioactivity on the ground and ingestion. Doses to a member of the critical group of population both inside and outside SPZ mainly are determined by the radionuclides deposited on the ground. Table 8.7 shows that with the increase of distance from the SPZ boundary doses to population are decreasing gradually. At the state boundary with Belarus dose decreases more than 1.5 times, while at the state boundary with Latvia about 2.5 times in comparison with dose value at SPZ boundary.

Contribution of certain radionuclide to the total dose inside the SPZ (at the distance of 200 m from release point) and outside SPZ (at the distance of 2.8 km) is shown in Figure 8.1. In case of loss of MCC decontamination solution exposure due to released radionuclides inside the SPZ is determined by Co-60 (about 97% of the total dose) and outside the SPZ – Co-60 is also dominating radionuclide (about 84% of the total dose). Besides Co-60 other radionuclides such as Mn-54 (inside and outside SPZ) and Fe-55, Pu-241, Am-241 (outside SPZ) can be mentioned. Contribution of the rest radionuclides to the total dose is not significant (less 1%).

Table 8.7. Doses to a member of the critical group of population due to the releases into the atmosphere in case of the loss of MCC decontamination solution

Exposure type	Effective dose (mSv) in a certain distance from release point, m			
	200 [1)]	**2 800 [2)]**	**5 000 [3)]**	**8 000 [4)]**
Dose due to passing of the radioactive cloud (gamma, beta submersion, inhalation)	3.34E-06	1.85E-03	6.27E-04	2.56E-04
Exposure due to deposition of radioactivity on the ground	5.98E-02	9.84E-02	5.86E-02	3.85E-02
Ingestion (consumption of radioactive foodstuffs)	-	5.11E-02	3.01E-02	1.97E-02
Total	**5.98E-02**	**1.51E-01**	**8.93E-02**	**5.85E-02**

[1)] At the security fence of the INPP industrial site.
[2)] At the INPP SPZ boundary.

3) At the state boundary with Belarus.
4) At the state boundary with Latvia.

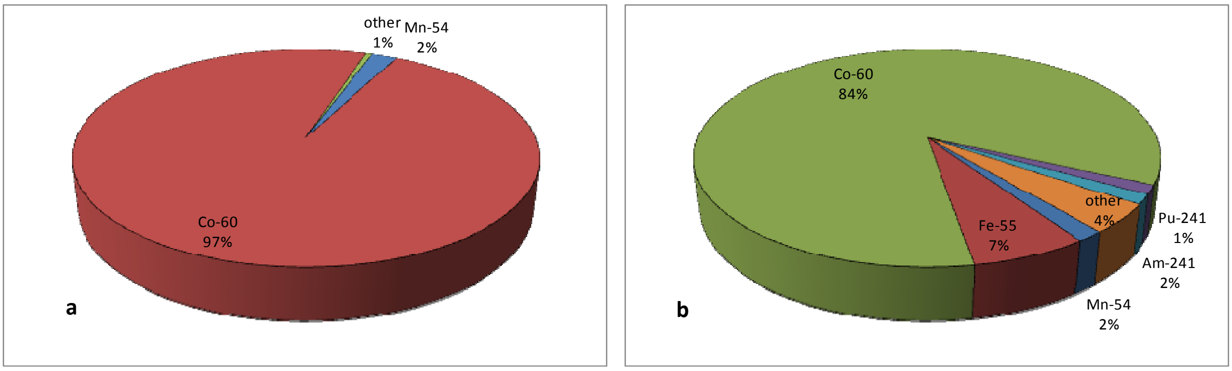

Figure 8.1. Contribution of certain radionuclide to the total dose in case of the loss of MCC decontamination solution (a – at the distance of 200 m, b – at the distance of 2800 m)

It can be concluded that effective dose to a member of the critical group of population due to the releases into the atmosphere in case of the loss of MCC decontamination solution will not exceed the limits defined in the radiation safety requirements. The maximal calculated dose at the SPZ boundary for the worst weather conditions can be $1.51 \cdot 10^{-1}$ mSv and this value is less than the limit for effective dose to population in case of design basis accident, which is 10 mSv [12].

8.3.2.2 Failure in Ventilation System

Release of radionuclides into the atmosphere in case of the loss of MCC decontamination solution and their activities are evaluated in Section 8.2.2.3 (see Table 8.4). Radionuclides are released via the main chimney of the plant (at 150 m height).

Results of calculated doses are summarized in Table 8.8. As can be seen from the Table 8.8, the dose due to the passing of the radioactive cloud is not so significant in comparison to doses due to deposition of radioactivity on the ground and ingestion. Doses to a member of the critical group of population inside SPZ mainly are determined by the radionuclides deposited on the ground. Doses to outside SPZ are determined by radionuclide ingestion with foodstuff. Table 8.8 shows that with the increase of distance from the SPZ boundary doses to population are decreasing gradually. At the state boundary with Belarus dose decreases more than 1.5 times, while at the state boundary with Latvia about 2.5 times in comparison with dose value at SPZ boundary.

Contribution of certain radionuclide to the total dose inside the SPZ (at the distance of 200 m from release point) and outside SPZ (at the distance of 2.8 km) is shown in Figure 8.2. In case of failure in ventilation system exposure due to released radionuclides is mainly determined by six radionuclides: Mn-54, Fe-55 (only outside the SPZ), Co-58 (only inside the SPZ), Co-60, Cs-134 and Cs-137. Contribution of the rest radionuclides to the total dose is not significant (less 1%). Co-60 and Cs-134 are the main radionuclides contributing to the total dose inside SPZ, outside SPZ – Cs-134 is the dominating radionuclide.

Table 8.8. Doses to a member of the critical group of population due to the releases into the atmosphere in case of the failure in ventilation system

Exposure type	**Effective dose (mSv) in a certain distance from release point, m**			
	200 [1)]	**2 800** [2)]	**5 000** [3)]	**8 000** [4)]
Dose due to passing of the radioactive cloud (gamma, beta submersion, inhalation)	7.65E-07	4.86E-05	1.65E-05	6.74E-06
Exposure due to deposition of radioactivity on the ground	1.30E-02	2.14E-02	1.28E-02	8.40E-03
Ingestion (consumption of radioactive foodstuffs)	-	6.56E-02	3.86E-02	2.52E-02
Total	**1.30E-02**	**8.71E-02**	**5.14E-02**	**3.36E-02**

[1)] At the security fence of the INPP industrial site.
[2)] At the INPP SPZ boundary.
[3)] At the state boundary with Belarus.
[4)] At the state boundary with Latvia.

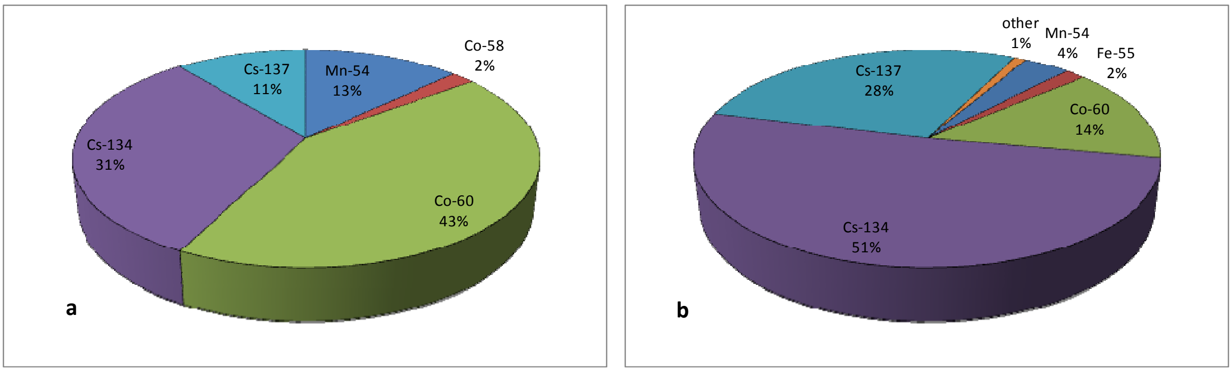

Figure 8.2. Contribution of certain radionuclide to the total dose in case of failure in ventilation system (a – at the distance of 200 m, b – at the distance of 2800 m)

It can be concluded that effective dose to a member of the critical group of population due to the releases into the atmosphere in case of the failure in ventilation system will not exceed the limits defined in the radiation safety requirements. The maximal calculated dose at the SPZ boundary can be $8.71 \cdot 10^{-2}$ mSv and this value is less than the limit for effective dose to population in case of design basis accident, which is 10 mSv [12].

8.4 Protective actions of the public in case of a radiological or nuclear accident

Final shutdown of the Unit 2 reactor of Ignalina NPP has resulted in reduction of radiological or nuclear accident risk and the potential scale of impact. However, the risk of accidents remains due to various INPP decommissioning activities, dismantling of buildings and equipment, as well as handling and storage of radioactive waste and spent nuclear fuel. It is therefore necessary to ensure the provision of population protection measures and the actions of responsible public, county and local authorities, as well as of economic entities when informing residents and organizing rescue and remedial actions in the event of a radiological or nuclear accident during Ignalina NPP decommissioning, in accordance with the procedure laid down by the law. The following main legislation for civil defence, emergency preparedness, rescue and emergency response actions in the event of a radiological or nuclear accident can be identified:

- The Republic of Lithuania Law on Civil Protection [8];
- Emergency Preparedness Requirements for an Organization Operating a Nuclear Facility [9];
- Procedure of Warning of Public in Case of a Radiological or Nuclear Accident [10];
- Protective Actions of Public in Case of Radiological or Nuclear Accident [13].

During Ignalina NPP operation the structure of emergency preparedness organization was developed, the tasks for the offices and departments of INPP emergency response organisation were provided. Moreover, the following was foreseen: measures and actions in case of an accident at Ignalina NPP, the necessary technical facilities and measures to implement the emergency preparedness functions; collaboration with other organizations involved in providing assistance in case of emergency; INPP resources available for emergencies, as well as additional supplies from other organizations. The Ignalina NPP scheme of the emergency notification and submission of operative information and communication and information means used during accident elimination at Ignalina NPP are provided in Figure 8.3 and Figure 8.4.

Emergency preparedness and emergency elimination are described in detail in the emergency preparedness plan – this is a document providing for the organizational, financial, technical, medical, evacuation and other measures taken in the event of an accident at a nuclear facility, in order to protect workers, residents and the environment from the consequences of the accident. Emergency preparedness plan shall be prepared and coordinated with the VATESI and other public administrations and regulatory bodies. At present, after the final shutdown of Ignalina NPP reactors which result in a considerable reduction in radiation or nuclear accident threat, the Ignalina NPP Emergency Preparedness Plan (internal) is being updated, and the new State Plan on the protection of the population (external plan), dedicated to protect the residents living beyond the Ignalina NPP sanitary protection zone, by evacuating from the municipalities of Ignalina district, Zarasai district and city of Visaginas, is being developed.

Assessment of consequences to population due to the potential accidents caused during the implementation of the proposed economic activity is presented in Section 8.3. Calculated doses to population due to the releases into the atmosphere in case of the loss of MCC decontamination solution and in case of failure in ventilation at the SPZ boundary is $1.51 \cdot 10^{-1}$ mSv and $8.71 \cdot 10^{-2}$ mSv respectively and this is much less than the dose limit of 10 mSv defined for design basis accident [12]. Exposure doses (see Table 8.7 and Table 8.8) to a member of the critical group of population through various exposure pathways (due to the radioactive cloud, deposited radionuclides and consumption of radioactive foodstuffs) and maximal calculated soil contamination (1.02 kBq/m^2) with Cs-137 for the worst weather conditions are less than operational intervention levels defined in Hygiene Standard HN 99:2000 [13]. Therefore, no urgent and long term protective actions are required for considered accidents.

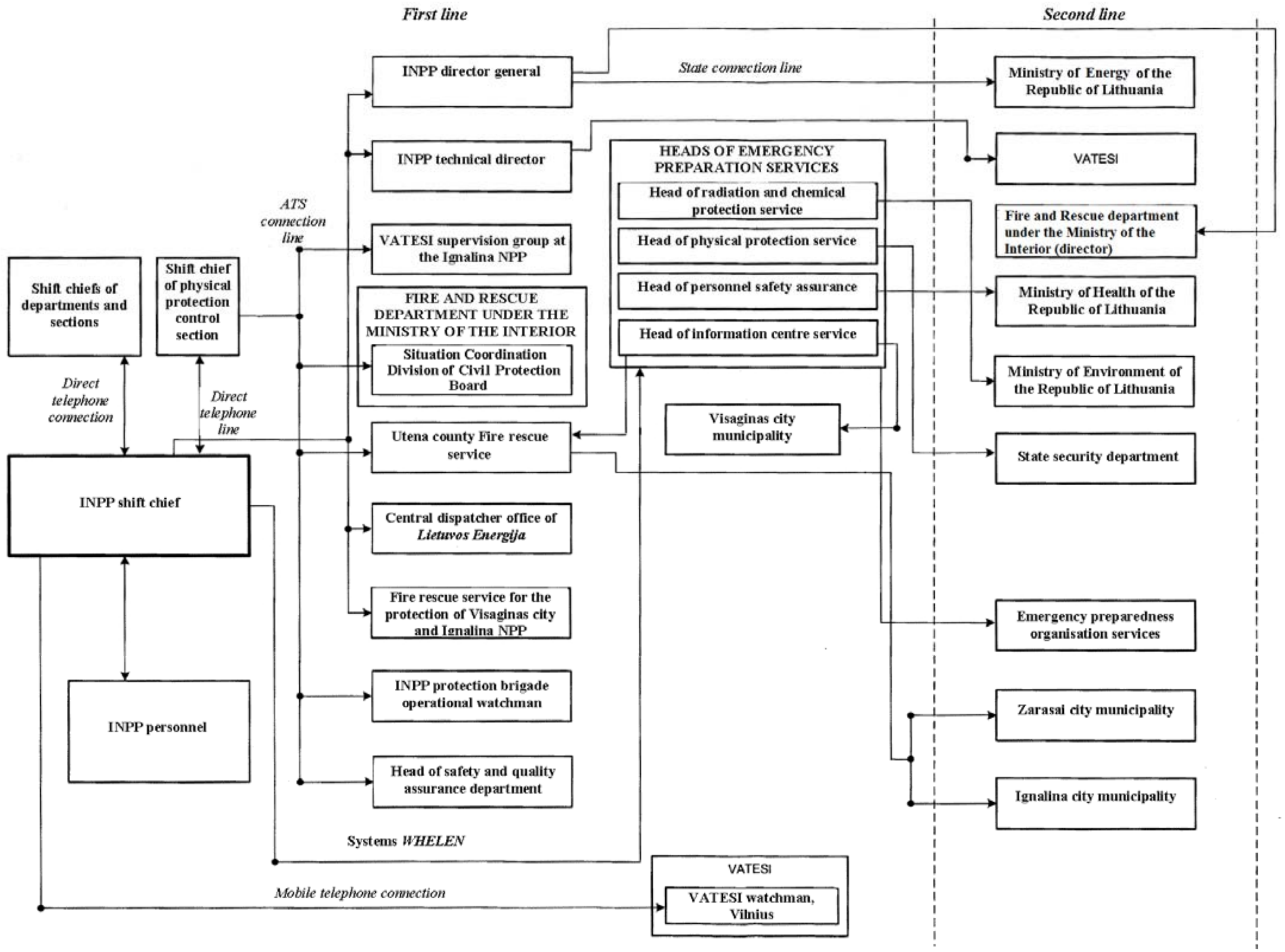

Figure 8.3. Emergency notification and submission of operative information of Ignalina NPP [14]

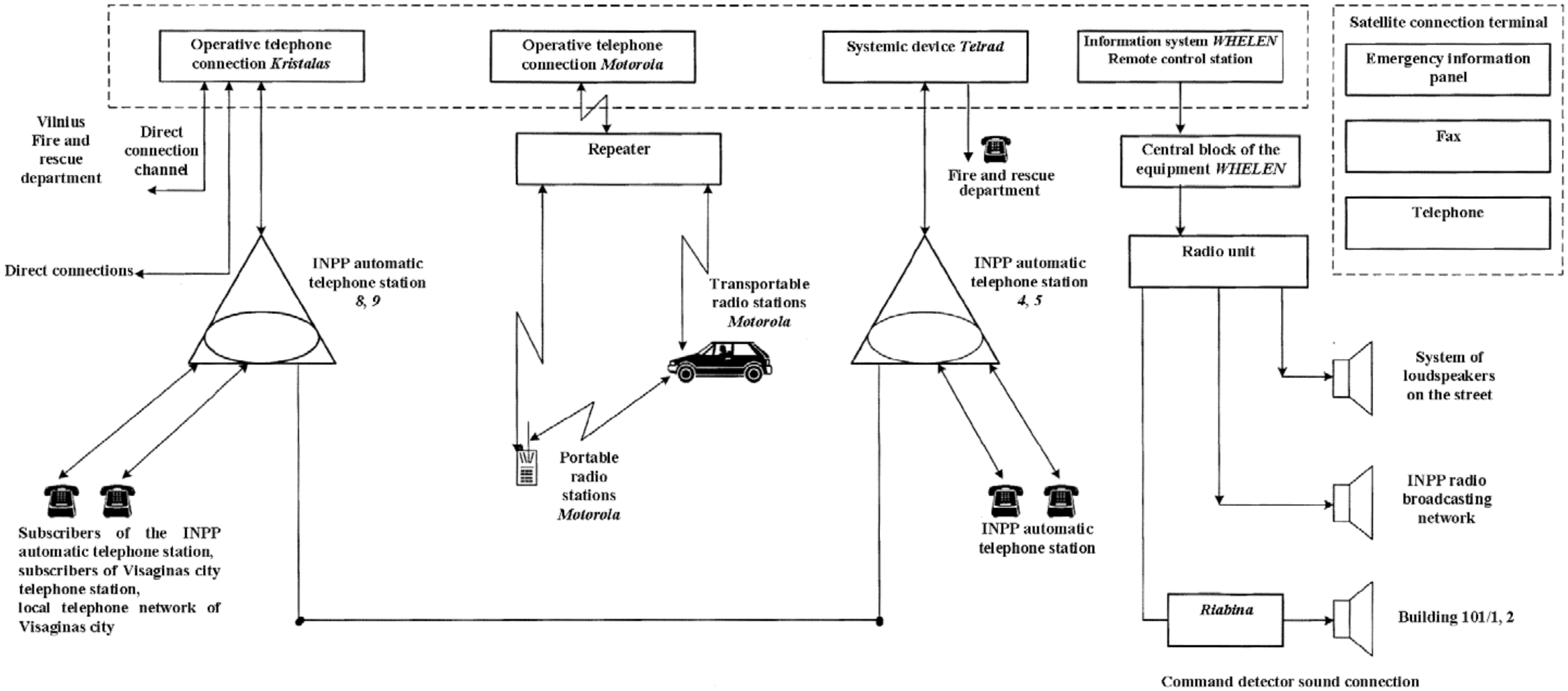

Figure 8.4. Communication and information means used during accident elimination at Ignalina NPP [14]

International Atomic Energy Agency has developed International Nuclear Event Scale (INES) which includes all possible events (starting from events that have no impacts on safety and finishing with severe accidents) in nuclear power facilities. Events that occur in nuclear facilities are recorded according to this scale and information including the level of event according to INES scale is provided for local and worldwide media.

The loss of MCC decontamination solution accident, which is possible during the implementation of the proposed economic activity, can cause the maximal exposure dose to population of $1.51 \cdot 10^{-1}$ mSv. According to definitions of INES levels, i.e. the external release of radioactivity resulting in a dose to the critical group of the order of tenths of mSv, this accident can be rated as Level 3 event. Off-site protection measures are not required for this level events. This is also proved by comparing the consequence assessment results of the loss of MCC decontamination solution accident with criteria defined in HN 99:2000 [10], according to which it can be concluded that no protective actions are required for this accident.

Exposure dose to population in case of failure in ventilation system is about 2 times less than in case of the loss of MCC decontamination solution accident, however conservatively it is assumed that the failure in ventilation can be also classified as INES Level 3 event.

Hence the possible accidents during the implementation of the proposed economic activity will not exceed Level 3 events according to INES scale. Description of INES Level 0-3 events are provided in Table 8.9.

It should be noted although the consequences of potential accidents analyzed that can occur during the planned economic activity do not endanger the population, in parallel other Ignalina NPP decommissioning projects will be implemented (see section 2.4), as well as the existing and new facilities of radioactive waste and spent nuclear handling, storage and disposal will be operated at the same time, which may cause the radiological or nuclear accident. Considering the risks due to these new nuclear facilities, as well as dangers due to possible external events (e.g., explosion, aircraft crash, external fire, terrorist attack, etc.), the fire and rescue service forces, population warning system, population protection means, personnel evacuation areas, decontamination stations and other emergency response actions in the event of a radiological or nuclear accident should essentially remain the same as there were the ones during Ignalina NPP operation. Undoubtedly, as mentioned above, Ignalina NPP shutdown has resulted in reduction of radiological or nuclear accident risk, therefore INPP Emergency Preparedness Plan and the State Plan on the protection of the population are being updated. However, the risk of radiological or nuclear accident remains while radioactive waste and spent nuclear fuel is handled and stored within the INPP territory.

Table 8.9. International Nuclear Events Scale

Level / Descriptor	Nature of the events
INES 0 Deviating events	Deviations from normal operating conditions can be classed as INES 0, where operational limits and conditions are not exceeded and are properly managed in accordance with adequate procedures. Examples include: a single random failure in a redundant system discovered during periodic inspections or tests, a planned reactor trip and minor spread of containment within controlled area without wider implications for safety culture.

Level / Descriptor	Nature of the events
INES 1 Anomaly	Anomaly beyond the authorised regime, but with significant defence in depth remaining. This may be due to equipment failure, human error or procedural inadequacies and may occur in areas covered by the scale, such as plant operation, transport of radioactive materials, fuel handling and waste storage. Examples include: breached of technical specifications or transport regulations and minor defects in the pipe work beyond the expectations of the surveillance programme.
INES 2 Incident	Includes incidents with significant failure in safety provisions but with sufficient defence in depth remaining to cope with additional failures. Events resulting in a dose to a worker exceeding a statutory annual dose limit and/or an event which leads to the presence of the significant quantities of radioactive in the installations in areas not expected any design and which require corrective action.
INES 3 Serious incident	The external release of radioactivity resulting in a dose to the critical group of the order of tenths of mSv. With such a release, off-site protection measures are not required. On-site events resulting in sufficient dose to workers to cause acute health effects and/or resulting in sever spread of contamination. Or the further failure of safety systems could lead to accident conditions.

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9 DESCRIPTION OF DIFFICULTIES

This chapter includes description of difficulties (technical or practical) encountered while performing EIA and preparing the EIA Report.

Some of EIA Relevant parties have not approved EIA Report. Visaginas municipal administration and Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania essentially have not accepted the responses to their proposals and it was required to include in EIA Report the information which according to Organizer of proposed economic activity and EIA Developer is not related to EIA process. Letters with comments of EIA Relevant parties, responses to these comments and other correspondence documents are presented in Annexes 3 and 4 of the EIA Report.