NUKEM Technologies GmbH

Subcontractor
Lithuanian Energy Institute

Environmental Impact Assessment Report

New Solid Waste Management and Storage Facility at Ignalina NPP

Organizer of the Proposed Economical Activity	**State Enterprise Ignalina Nuclear Power Plant**
Developer of the EIA Report	**NUKEM Technologies GmbH (Germany)** **Lithuanian Energy Institute, Nuclear Engineering Laboratory**

2008

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Organizer of the Proposed Economical Activity	**State Enterprise Ignalina Nuclear Power Plant**
Developer of the EIA Report	**NUKEM Technologies GmbH (Germany)** Mr. R. W. Henderson
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TABLE OF REVISIONS

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Draft Revision 0	December 1, 2006 December 11, 2006	Developed basing on the EIA program, revision 3. For internal NUKEM Technologies GmbH review.
Draft Revision 1	December 15, 2006	Developed basing on the EIA program, revision 3. Incorporates remarks for the Draft Revisions 0 issue date December 1 and December 11, 2006. For internal INPP review.
Revision 0	March 2, 2007	Updated basing on the approved EIA program (revision 4) and INPP comments for the Draft revision 1. For internal NUKEM Technologies GmbH review.
Revision 1	March 30, 2007	Updated considering additional INPP remarks. For NUKEM Technologies GmbH review and approval.
Revision 2	April 13, 2007	Updated considering additional NUKEM Technologies GmbH remarks. For INPP review and approval.
Revision 3	June 18, 2007	Updated according to the results of public review. For authorities review and approval.
Revision 4	December 22, 2007	Updated according to the results of authorities review. For competent authority review and approval.
Revision 5	July 8, 2008	Updated according to the results of neighboring countries review. Updated according to the results of competent authority review. For competent authority approval.

ABBREVIATIONS AND DEFINITIONS

ALARA	As Low As Reasonable Achievable This is an internationally recognized acronym which requires that the radiation dose to personnel which results from work with radioactive substances is minimized to the greatest possible extent, except where the additional cost or impracticality of further dose-reduction measures would be unreasonable when compared to the additional dose-reduction obtained by the adoption of those measures. The ALARA principle is progressively used in environmental issues as well.
CCTV	Closed Circuit Television. A system containing TV-cameras, monitors and a switching device, which is not connected to any other TV-system.
Contractor	NUKEM Technologies GmbH, Germany
Controlled area	An area subject to special rules for the purpose of protection against ionizing radiation or of preventing the spread of radioactive contamination and to which access is controlled.
EIA	Environment Impact Assessment
EIA Program	A study, which defines structure and content (questions to be investigated) of the EIA report. Requirements for the EIA program are defined in the Law on Assessment of the Impact on the Environment of the Planned Economical Activities [5] and detailed in the Regulations on Preparation of Environment Impact Assessment Program and Report [6].
EIA Report	A systematic prediction, identification and evaluation of environmental impacts of a proposed development. The EIA report shall investigate all questions, which have been identified in the EIA program. The requirements for the EIA report are defined in the Law on Assessment of the Impact on the Environment of the Planned Economical Activities [5] and detailed in the Regulations on Preparation of Environment Impact Assessment Program and Report [6].
Employer	State enterprise Ignalina Nuclear Power Plant
G1 waste	Group 1 waste (low active solid combustible and non-combustible radioactive waste) according to presently existing INPP classification
G2 waste	Group 2 waste (intermediate active solid combustible and non-combustible radioactive waste) according to presently existing INPP classification
G3 waste	Group 3 waste (high active non-combustible solid radioactive waste) according to presently existing INPP classification
IAEA	International Atomic Energy Agency
INPP	Ignalina Nuclear Power Plant

Ignalina NPP	The INPP possesses two RBMK-1500 type Power Units. The first Power Unit was shut down on 31 December 2004. The shut down of the second Power Unit is scheduled for the end of 2009.
ISFSF	Interim Spent Fuel Storage Facility The ISFSF will be constructed aside the SWTSF. Both facilities will have a common sanitary protection zone and some shared services, like a site perimeter a physical protection system.
Landfill repository	A repository for Short-Lived and very low level radioactive waste (i.e. waste of group A) which meets the Waste Acceptance Criteria for a Landfill repository.
LEI	Lithuanian Energy Institute
LL	Long-Lived
LSF	Landfill waste Separation Facility. A part of SWRF.
LWTF	Liquid radioactive Waste Treatment Facility An existing INPP facility designed for storage and treatment of all liquid radioactive waste produced during the operation of INPP. The facility is planned to operate till 2022 with the possibility to prolong its operation for approximately 10 years (in case of reconstruction).
ILW-LL	Long-Lived Intermediate Level Waste Solid radioactive waste of group E according to the new waste classification system, which is to be used as the basis for the future waste classification and management system at INPP.
LILW-SL	Short-Lived Low and Intermediate Level Waste Solid radioactive waste of groups B and C according to the new waste classification system which is to be used as the basis for the future waste classification and management system at INPP. The Short-Lived Very Low Level (i.e. class A) waste, which does not meet the acceptance criteria for Landfill waste will be treated in SWTSF as LILW-SL.
Near surface repository	A facility for disposal of radioactive waste located at or within a few tens of meters from the earth's surface.
RU1 (2, 3)	Retrieval Unit 1 (2, 3) The RU will be installations within which the waste retrieval (presorting and packaging for transfer) from existing INPP solid radioactive waste storage facility (i.e. buildings 155, 155/1, 157 and 157/1) take place.
SAR	Safety Analysis Report
SL	Short-Lived
SPZ	Sanitary Protection Zone A special territory or a site of radioactive contamination where the irradiation level may exceed the prescribed norms under normal operational conditions of a nuclear facility.

SSC	Structures, Systems and Components
SSS	Spent Sealed Source
Supervised area	A defined area not designated as a controlled area but for which occupational exposure conditions are kept under review, even though specific protection measures and safety provisions are not normally needed.
SWMSF	Solid radioactive Waste Management and Storage Facility The SWMSF includes the SWRF, which will be located at the INPP solid radioactive waste storage facility site inside the INPP supervised area, and the SWTSF which is planned to be erected in a separate site in about 0.6 km to the south from INPP.
SWRF	Solid radioactive Waste Retrieval Facility SWRF is used to extract existing waste from its present storage location within the INPP solid radioactive waste storage facility, presort it, segregate adequate material for Landfill disposal and package non Landfill material for transfer to the SWTF. Waste Retrieval Units RU 1(2, 3) and Landfill waste Separation Facility (LSF) are parts of the SWRF.
SWSF	Solid radioactive Waste Storage Facility The SWSF consist of two separate storages, i.e. the Interim Storage for Short-Lived Waste and the Interim Storage for Long-Lived Waste.
SWTF	Solid radioactive Waste Treatment Facility The SWTF will house equipment and facilities necessary for the treatment of the solid radioactive waste. The design for the SWTF is based on different sorting cells and subsequent waste processing (incineration, high force compaction, grouting etc.) facilities.
SWTSF	Solid Waste Treatment and Storage Facility, i.e. SWTF and SWSF
VATESI	The Republic of Lithuania State Nuclear Power Safety Inspectorate
Waste of classes A, B, C, D, E and F	Solid radioactive Short-Lived (classes A, B C) and Long-Lived (classes D, E) waste, spent sealed sources (class F) classified in accordance with newly introduced waste classification system [15]. This new solid radioactive waste classification system considers ultimate waste destination (i.e. landfill disposal, near surface disposal etc.) and is to be used as the basis for the future waste classification and management system at INPP.
WTS	Radioactive Waste Transfer System

TABLE OF CONTENTS

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. It is approximately one hundred and twenty kilometers away from the capital city Vilnius. 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] adopted by the Lithuanian Parliament the first unit of INPP was shut down on December 31, 2004. The shut down of the second 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.

In the framework of the preparation for the decommissioning of the INPP a new Solid Waste Management and Storage Facility (SWMSF) [3] will be built under a Grant Agreement between the European Bank for Reconstruction and Development (EBRD) as administrator of a grant fund provided by the Ignalina International Decommissioning Support Funds and the Lithuanian Government. NUKEM Technologies GmbH, Germany, which was awarded a turnkey basis contract, will implement these new facilities.

The new SWMSF will provide a modern solid radioactive waste management and storage system for existing, future operational and decommissioning waste [4]. It will comply with the Lithuanian legislation requirements and also shall bring management of radioactive waste in Lithuania in compliance with radioactive waste management principles of IAEA and with good practices in force in European Union Member States.

The proposed economic activity, to which the present Environmental Impact Assessment (EIA) is associated, concerns the design, erection, installation, setting-to-work, commissioning, operation and decommissioning of the new SWMSF at INPP.

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 Planned 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 EIA assessment content and structure follows the requirements of the Republic of Lithuania Law on the Assessment of the Impact on the Environment of the Planned Economic Activities [5] and the Regulations on Preparation of Environment Impact Assessment Program and Report [6].

SUMMARY

The proposed economical activity is named as the "New Solid Waste Management and Storage Facility at Ignalina Nuclear Power Plant".

By this proposed economic activity a new Solid Waste Management Facility (SWMSF) at Ignalina Nuclear Power Plant (INPP) will be designed and constructed for the purpose of retrieving, transferring, presorting, sorting, treating (as applicable), packaging, characterization and storage of:

- Short and Long-Lived solid radioactive waste currently stored at the INPP site;
- Operational solid and combustible liquid radioactive wastes that will be produced by INPP until the final closure of Unit 2;
- Solid radioactive waste from decommissioning produced by INPP.

The SWMSF consists of several facilities, which will be located in two separated sites. The Solid Waste Retrieval Facility (SWRF) will be built in connection with the existing INPP solid radioactive waste storage buildings inside the perimeter of the INPP. The Solid Waste Treatment and Storage Facility (SWTSF) will be built on a new site close to the INPP and adjacent to the Interim Spent Nuclear Fuel Storage Facility (ISFSF) site.

The purpose of the SWRF is to extract existing waste from its present storage location within the INPP solid radioactive waste storage facility, presort it, segregate adequate material for the Landfill disposal and package non Landfill material for transfer to the SWTF.

A new site for the SWTSF is selected at about 0.6 km to the south from the INPP perimeter. The approximate site dimensions are 250 × 350 m, the land use is owned by INPP. The SWTSF site together with the ISFSF site will form a joint site and share some internal (i.e. physical security) and external (supplies from INPP) services. The new site with its Sanitary Protection Zone (SPZ) will fall within the boundaries of the existing INPP SPZ.

A radioactive Waste Transfer System (WTS) will be established in between the INPP and SWTSF sites for the transfer of SWRF retrieved waste, for operational waste from Unit 2 and for the waste produced by decommissioning of INPP.

The Solid Waste Treatment Facility (SWTF) will house equipment and facilities necessary for the treatment of the solid radioactive waste. The design for the SWTF is based on different sorting cells and subsequent waste processing facilities. In the sorting cells the waste will be processed in parallel streams according to its respective radiological properties. Then sorting, size reduction and other preparations will take place prior to incineration, high force compaction and/or grouting. After sorting, the waste will be finally categorized to classes from B to F according to its ultimate destination:

- Class B and C waste: low and intermediate-level for short-lived (SL) intermediate storage;
- Class D waste: low-level graphite waste for long-lived (LL) intermediate storage;
- Class E waste: intermediate-level waste for LL intermediate storage;
- Class F waste: spent sealed sources for LL intermediate storage.

The Solid Waste Storage Facility (SWSF) will comprise two stores, which will be directly connected to the SWTF: one store for short-lived (SL) and the other for long-lived (LL) waste.

The SL store will be capable of containing approximately 2500 m^3 of processed SL-waste (net, without containers, grout, crane space, etc) and allow the waste packages to be stored for a period of 50 years. The store will be designed so that it can be extended by the addition of up to three similar modules, so that a total storage volume of 10000 m^3 can be provided.

The LL store will be capable of containing approximately 2000 m^3 of LL-waste (net, without containers, crane space, etc) and allow the waste packages to be stored for a period of 50 years. The store is also designed so that it can be extended in modules.

The necessity to extend the SL or LL waste interim stores will depend on the overall implementation of the INPP decommissioning process (i.e. availability of waste disposal facilities, waste properties and amounts which will be generated during dismantling and decommissioning etc.).

The potential environmental impacts arising due to the implementation of the proposed economical activity can be divided into two main groups – radiological impacts and non radiological impacts. Impacts will be different during different stages of the implementation of the proposed economical activity – construction, operation and decommissioning. Generation of secondary waste is also an important issue and is considered by the EIA. The proposed economical activity will not produce any hazardous waste. Amounts of other resulting waste are small and will be managed in accordance with the requirements of the waste management legislation in force.

The potential public health impact sources of conventional (i.e. non radiological) nature could be noise and airborne pollutants. The proposed economic activity will not produce any other significant impacts of conventional nature, which could physically affect environment components or public health. Appropriate impact mitigation measures are proposed to reduce a potential impact on these environmental components.

A local noise increase might be expected during SWMSF construction works. Other local noise increase sources might be the radioactive waste transfers from the SWRF and INPP to the SWTSF.

The construction of the SWTSF will take approximately 2 years. Since construction machines operate intermittently and the types of machines in use at the construction site change with the phase of the project, noise emitted during the construction will be highly variable. However, since the nearest residential properties are located at least 2 km away from the SWTSF site, it is estimated that construction noise will rarely exceed existing levels. Consequently, construction activities are expected to have minimal and only temporary impacts on the noise environment in the communities south and west of the SWTSF site. Once operational the proposed SWMSF will produce no noise that will be perceptible at the nearest residential receptors.

The operation of the incineration facility will result in emission of a certain amount of airborne pollutants. The results of dispersion calculations show compliance with limiting concentrations as defined in the Lithuanian Hygiene Standard HN 35:2002 what will enable to operate the incineration facility at the projected load with a negligible impact on the environment. The concentrations of pollutants will not exceed the allowed values even in case of the most adverse atmospheric conditions.

A potential radiological impact (release of radioactivity and exposure of the public) under normal operation conditions of the proposed economical activity may result due to the release of airborne activity, or due to direct irradiation from structures containing radioactive materials. No release of radioactive liquids into the environment from the proposed economical activity under normal operation conditions is planned. All liquid radioactive waste generated during the operation of the SWMSF will be safely collected and transferred into the existing liquid radioactive waste treatment facility for appropriate treatment. Therefore the EIA considers the following radiological impact sources as relevant under normal operation conditions:

- Radiological impact due to the release of airborne activity at the SWRF and SWTSF sites including the operation of the RU1, Landfill separation facility, RU2, RU3 and the SWTF;
- Radiological impact due to direct irradiation resulting from the radioactive waste transfer in-between INPP and SWTSF sites;

- Radiological impact due to direct irradiation from structures containing radioactive material. An impact assessment conservatively considers the impact from all relevant structures at the SWTSF and neighboring ISFSF sites – an operating SWTF, a fully extended and completely loaded SWSF, and a completely loaded ISFSF;
- According to the radiation protection requirements in force the average annual effective dose to the critical group members due to the operation of the nuclear facility, including anticipated short-time operational increase, shall not exceed the dose constraint. If several nuclear facilities are located in the same sanitary protection zone, the same dose constraint value shall envelope radiological impacts from all operating and planned nuclear facilities. Therefore the radiological impact from other existing and planned nuclear facilities located in the same INPP SPZ is considered as well.

Maximally expected annual airborne emissions due to normal operation of the proposed economical activity are calculated to be about 2.6×10^9 Bq/a. Radioactive emissions due to the proposed economic activity together with planned emissions from the INPP site are below presently in force permissible release limits for the INPP site. The resulting exposure of the population will also be low. The annual effective doses due to radioactive airborne emissions are below 0.010 mSv for the most exposed member (infant) of the critical group of the population.

The total (resulting from all impact sources) annual effective dose is calculated for the potentially most exposed locations (along the permanent security fence of the SWTSF site and waste transfer road connection) and other proposed economic activity relevant locations – along the SWTSF site border and the SWTSF site proposed SPZ border.

The highest annual effective dose to a member of the critical group of the population is expected at the permanent security fence of the SWTSF/ISFSF site and is 0.190 mSv. The annual effective dose in all locations around the permanent security fence is below the dose constraint (which is 0.200 mSv/a), therefore the radiological protection requirements are not violated.

At the more distant locations from the permanent security fence exposure of the population is decreasing (with exception close to the INPP – SWTSF road connection and only during G3 waste transfer).

On the border of the SWMSF/ISFSF site (at the distance of 50 m of from the permanent site security fence) an annual effective dose of a critical group member in the southern direction (towards one of the potential locations for the Landfill repository) is 0.099 mSv. The reserve of about 0.1 mSv from the dose constraint is available for the Landfill repository project at the SWTSF/ISFSF site border.

The annual effective dose to a member of the critical group of the population at the distance of 500 m from the SWTSF/ISFSF site is below 0.020 mSv in the eastern, southern and western directions (and the northern direction after the G3 waste transfer is finished). The radiological impact on the environment from existing and future planned activities at INPP site becomes prevailing. Basing on radiation exposure assessment results at least a 500 m wide SPZ around the site security fence could be recommended for the SWTSF/ISFSF site.

Outside the boundary of the proposed SPZ the new SWMSF practically imposes no restrictions regarding the usage of dose constraint for other nuclear activities with the condition, that impacts from these new activities are limited by the border of the proposed SPZ for the SWMSF/ISFSF site.

A special consideration shall be given to the G3 waste transfer from INPP to the SWTSF site. The G3 waste retrieval and treatment phase will last approximately 5 years. In the close vicinity to the planned waste transfer connection fence (assuming that the same member of population will accompany all waste transfers passing aside) the annual exposure of this member of the population may exceed the dose constraint. While it cannot be reasonable to expect that such situation might be relevant, the presence of population in the close vicinity of the connection fence during G3 waste transfer shall be limited. Other technical solutions can be foreseen by the design as well. No additional constraints are imposed to the existing SPZ requirements for exposure locations starting from the distance of 30 m from the connection fence.

Emergency situations (emergencies) potentially resulting from the proposed economic activity which could lead to an environmental impact are addressed in this EIA with the purpose to demonstrate that the proposed economic activity by virtue of its nature and environmental impacts may be carried out in the chosen sites. Therefore, hazards and factors, which could potentially cause an impact on the environment, are subject of investigation and assessment.

The risk analysis of potential emergency situations and the evaluation of potential consequences show that the impact due to design basis accidents is expect to be reasonably low. For the majority of potential design basis accidents an annual effective dose from the relevant external and internal exposure pathways is at least by one order of magnitude below the annual dose limit (1 mSv). The most severe consequences might be expected in case of the damage of a G3 waste transfer container leading to spill out of the G3 waste in open air conditions. The calculated maximal one year effective dose to a member of the population is below 0.3 mSv and is also below the annual dose limit of 1 mSv.

Airplane crash related accidents are of very low probability (below 10^{-7} per year). Therefore they are considered as beyond design basis accidents. The analysis of potential radiological consequences provides the assessment of an exposure to a member of the population due to passing through of a radioactive cloud. These consequences cannot be mitigated due to the short time of activity dispersion in the atmosphere.

In case of a severe beyond design basis accident leading to partial loss of waste confinement within the waste treatment and storage facilities mitigation measures shall be implemented to assess situation, define contamination zones and, if necessary, mitigate the consequences due to external irradiation from the activity deposited on ground and to avoid ingestion of food products exhibiting high specific activities due to the accidental releases. The exposure of a member of the population due to passing through of a radioactive cloud is below the annual dose limit (1 mSv) for most of the beyond design basis accidents. The most severe consequences can be expected in the case of an airplane crash on the LLW store G3 waste section. A calculated maximal effective dose to a member of the population due to passing through of a radioactive cloud is below 2.2 mSv. This value is below the annual effective dose limit which is allowed in special circumstances (5 mSv).

Two countries, i.e. Belarus and the Latvia Republics, can be considered as being relatively close to the sites of the proposed economic activity. It is foreseen that no direct impact of physical nature on social and economic components of Latvia and Belarus will occur at all during normal operation of a proposed economic activity. In case of design and beyond design accidents population exposure can be assured to be within acceptable radiation protections limits (with implementation of accident consequences mitigation measures for beyond design accidents, if necessary).

However, population discontent and distrust is possible. Such a psychological impact is stipulated by changes in the existing nuclear practice (shut down and decommissioning of INPP), which results in construction of new nuclear objects such as the SWMSF and others. A psychological impact can be mitigated by explaining the necessity, goals and benefits of the proposed economic activity. The proposed economic activity will introduce advanced and practically proven waste management technologies for converting existing radioactive waste into long term stable and storage safe forms. The nuclear safety will increase and the risk of possible accidents will reduce in comparison with the existing waste management and storage practice. The new SWMSF will be consistent with the current international requirements, principles, standards and guidance for the safe management of radioactive waste.

1 GENERAL INFORMATION

1.1 Organizer of the Proposed Economical Activity

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

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1.2 Developers of the EIA

The developers of EIA are NUKEM Technologies GmbH (Germany) and Lithuanian Energy Institute (Lithuania)

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1.3 Name and Concept of the Proposed Economical Activity

The proposed economical activity is named as the "New Solid Waste Management and Storage Facility at Ignalina Nuclear Power Plant".

By this proposed economic activity a new Solid Waste Management Facility (SWMSF) at Ignalina Nuclear Power Plant (INPP), cf. Figure 1.1 and Figure 1.2, will be designed and constructed for the purpose of retrieving, transferring, presorting, sorting, treating (as applicable), packaging, characterization and storage of:

- Short and Long-Lived solid radioactive waste currently stored at the INPP site;
- Operational solid and combustible liquid radioactive wastes that will be produced by INPP until the final closure of Unit 2;
- Solid radioactive waste from decommissioning activities produced by INPP.

The SWMSF consist of several facilities, cf. Figure 1.3, which will be located in two separated sites. The Solid Waste Retrieval Facility (SWRF) will be built in connection with the existing INPP solid radioactive waste storage buildings inside the perimeter of the INPP. The Solid Waste

Treatment and Storage Facility (SWTSF) will be built on a new site close to the INPP and adjacent to the Interim Spent Nuclear Fuel Storage Facility (ISFSF) site [7].

The purpose of the SWRF is to extract existing waste from its present storage location within INPP solid radioactive waste storage facility, presort it, segregate adequate material for Landfill disposal and package non Landfill material for the transfer to the SWTF.

A new site for SWTSF is selected at about 0.6 km to the south from INPP perimeter, cf. Figure 1.2. The approximate site dimensions are 250 × 350 m, land use is owned by INPP. The SWTSF site together with the ISFSF site will form a joint site and share some internal (i.e. physical security) and external (supplies from INPP) services. The new site with its Sanitary Protection Zone (SPZ) will fall within the boundaries of the existing INPP SPZ.

A radioactive Waste Transfer System (WTS) will be established in between the INPP and SWTSF sites for the transfer of SWRF retrieved waste, for the operational waste from Unit 2 and for the waste produced by decommissioning activities of INPP.

The Solid Waste Treatment Facility (SWTF) will house the equipment and facilities necessary for the treatment of the solid radioactive waste. The design for the SWTF is based on different sorting cells and subsequent waste processing facilities. In the sorting cells the waste will be processed in parallel streams according to its respective radiological properties. Then sorting, size reduction and other preparations will take place prior to incineration, high force compaction and/or grouting. After sorting, the waste will be finally categorized to classes from B to F according to its ultimate destination:

- Class B and C waste: low and intermediate-level for short-lived (SL) intermediate storage;
- Class D waste: low-level graphite waste for long-lived (LL) intermediate storage;
- Class E waste: intermediate-level waste for LL intermediate storage;
- Class F waste: spent sealed sources for LL intermediate storage.

The Solid Waste Storage Facility (SWSF) will comprise two stores, which will be directly connected to the SWTF: one store for short-lived (SL) and the other for long-lived (LL) waste.

The SL store will be capable of containing approximately 2500 m^3 of processed SL-waste (net, without containers, grout, crane space, etc) and allow the waste packages to be stored for a period of 50 years. The store will be designed so that it can be extended by the addition of up to three similar modules, so that a total storage volume of 10000 m^3 can be provided.

The LL store will be capable of containing approximately 2000 m^3 of LL-waste (net, without containers, crane space, etc) and allow the waste packages to be stored for a period of 50 years. The store is also designed so that it can be extended in modules.

The necessity to extend SL or LL waste interim stores will depend on overall implementation of the INPP decommissioning process (i.e. availability of waste disposal facilities, waste properties and amounts which will be generated during dismantling and decommissioning etc.).

1.4 Stages of Activity

The proposed economic activity could be subdivided into three main stages, cf. Figure 1.4:

- Design, construction and commissioning;
- Operation;
- Decommissioning.

It is planned to put the SWMSF into operation by 2010. The construction of the SWMSF will be held in parallel with the construction of the ISFSF.

The operation phase could be subdivided into waste treatment/storage and only waste storage phases.

During the waste treatment and storage phase the radioactive waste will be retrieved from the existing INPP solid waste storage facilities, and transferred to and treated in the SWTF. The INPP operational and decommissioning waste will be transferred to and treated in the SWTF as well. The treated waste will be stored in the SWSF.

Treatment of the INPP operational waste is expected to last until 2020. After 2020, and up to the end of the SWTF's 30 years design life, the facilities will be used to process only decommissioning waste.

The design lifetime of the SWSF will be 50 years. If appropriate disposal facilities for LILW-SL and LILW-LL are available the decommissioning of the SWSF can start earlier than 2060.

1.5 Production

It is estimated [8] that by the time of the planned shutdown (i.e. until year 2010) the INPP will collect 22300 m^3 of G1 and 5000 m^3 of G2 waste. The estimated volume of unconditioned G3 waste (collected until year 2008) is 930 m^3.

The facilities of the SWMSF are designed to ensure average processing rates as follows:

- 11.2 m^3/day for G1 waste;
- 2.8 m^3/day for G2 waste;
- 0.9 m^3/day for G3 waste.

The average processing rates are based on an annual operation time (i.e. operating period for waste retrieval and treatment facilities, excluding maintenance activities) of 245 days per year and one shift operation schedule. The average design processing rates enable to process the whole inventories (accumulated till 2010) of G1 and G2 within 10 years and of G3 within 5 years after SWMSF commissioning.

1.6 Demand for Resources and Materials

The annual demand for resources and materials during the construction and operation of the SWMSF are presented in Table 1.1, Table 1.2 and Table 1.3.

1.7 Site Status and Territory Planning Documents

The proposed SWMSF sites are within an industrial land area allocated for the State Enterprise Ignalina NPP (land parcel No. 453500020005) [9]. In accordance with the land usage specialty Nr. PN 45/03-0071 from July 2, 2003 [10], the State Enterprise Ignalina NPP uses the land 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 a defined land usage purpose. The special land usage conditions will be considered also. The preliminary location of SWTSF and ISFSF sites has been coordinated with the Ministry of Economy on 26 March 2004 [11].

Presently the State Enterprise Ignalina NPP is in the process of preparation and coordination of a new revision of a detailed plan for the land parcel No. 453500020005. The main goal is to optimize land usage. The planned changes in the new revision of the detailed plan do not affect the status of the proposed SWMSF sites.

The selection of sites for the SWMSF and available alternatives are discussed in chapter 6.3 Location Alternatives.

1.8 Connection to Existing Infrastructure

In accordance with special designing conditions issued by the municipality of Visaginas [12], the engineering service for the SWTSF site will be provided by the existing INPP infrastructure.

Supplies include cold water supply, hot water supply, electricity supply and connection to the telecommunication system. Storm water drainage and sewage water drainage systems will be connected to the appropriate INPP site infrastructure.

The SWTSF and ISFSF sites will have common external infrastructure connection points. Connection details will be developed during preparation of the Technical Design.

1.9 Tables and Drawings of the Chapter "General Information"

The following Tables are attached to the chapter "General Information":

Table 1.1 Annual average demand for utilities during SWMSF construction *);

Table 1.2 Annual average demand for utilities during SWMSF operation *);

Table 1.3 Annual average demand for consumables during SWMSF operation *).

The following Figures are attached to the chapter "General Information":

Figure 1.1 Location of Ignalina NPP;

Figure 1.2 INPP south-west region;

Figure 1.3 Structure of the new Solid Waste Management and Storage Facilities (SWMSF) at Ignalina NPP;

Figure 1.4 Stages of decommissioning of INPP Reactor Units, of spent nuclear fuel storage at ISFSF and of proposed economic activity (SWMSF).

Table 1.1 Annual average demand for utilities during SWMSF construction *)

Utility	SWRF	SWTSF	Total	Source, remark
Electricity, kVA	40	230	270	"Rytų skirstomieji tinklai"
Potable water, m^3/day (max)	8	42	50	"Visagino energija"

*) Preliminary estimation, data will be better estimated during the design phase

Table 1.2 Annual average demand for utilities during SWMSF operation *)

Utility	SWRF	SWTSF	Total	Source, remark
Electricity, MWh	410	2580	2990	"Rytų skirstomieji tinklai"
Potable water, m^3	100	4000	4100	"Visagino energija"
Service water, m^3	200	13300	13500	
Hot water, m^3		128600	128600	For heat supply
De-mineralized water, m^3		50	50	
Process steam, Mg		250	250	
Compressed air, Mg	17.7	1380	1398	

*) Preliminary estimation, data will be better estimated during the design phase

Table 1.3 Annual average demand for consumables during SWMSF operation *)

Consumables	SWRF	SWTSF	Total	Remarks
Lubrication, Mg	0.2	3.15	3.35	
Big bags, pieces	700		700	
Fuel (standard diesel), m^3	12		12	For the fork lifter
Foil, Mg	4	4	8	For the Bale Press
Metal bands, Mg	1	1	2	For the Bale Press
Filters, pieces	15	78	93	For the ventilation systems, including HEPA filters
Liquid nitrogen, Mg		5	5	For the cooling of monitoring equipment
200 liter drums, pieces		1400	1400	Sacrificial drums for the High Force Compaction
Light oil, Mg	0.05	30	30	
Bags, pieces		20400	20400	For incineration waste packing
Activated char coal, Mg		4	4	For the dioxin filters of Incineration Facility
Caustic soda (20%), Mg		37	37	For the neutralization of scrubber effluent of Incineration Facility
Ammonium carbamate, Mg		0.4	0.4	For the NO_X reduction
Cement, Mg		100	100	Grouting of Short-Lived waste
Grouting additives, Mg		8	8	Grouting of Short-Lived waste

*) Preliminary estimation, data will be better estimated during the design phase

Figure 1.1 Location of Ignalina NPP

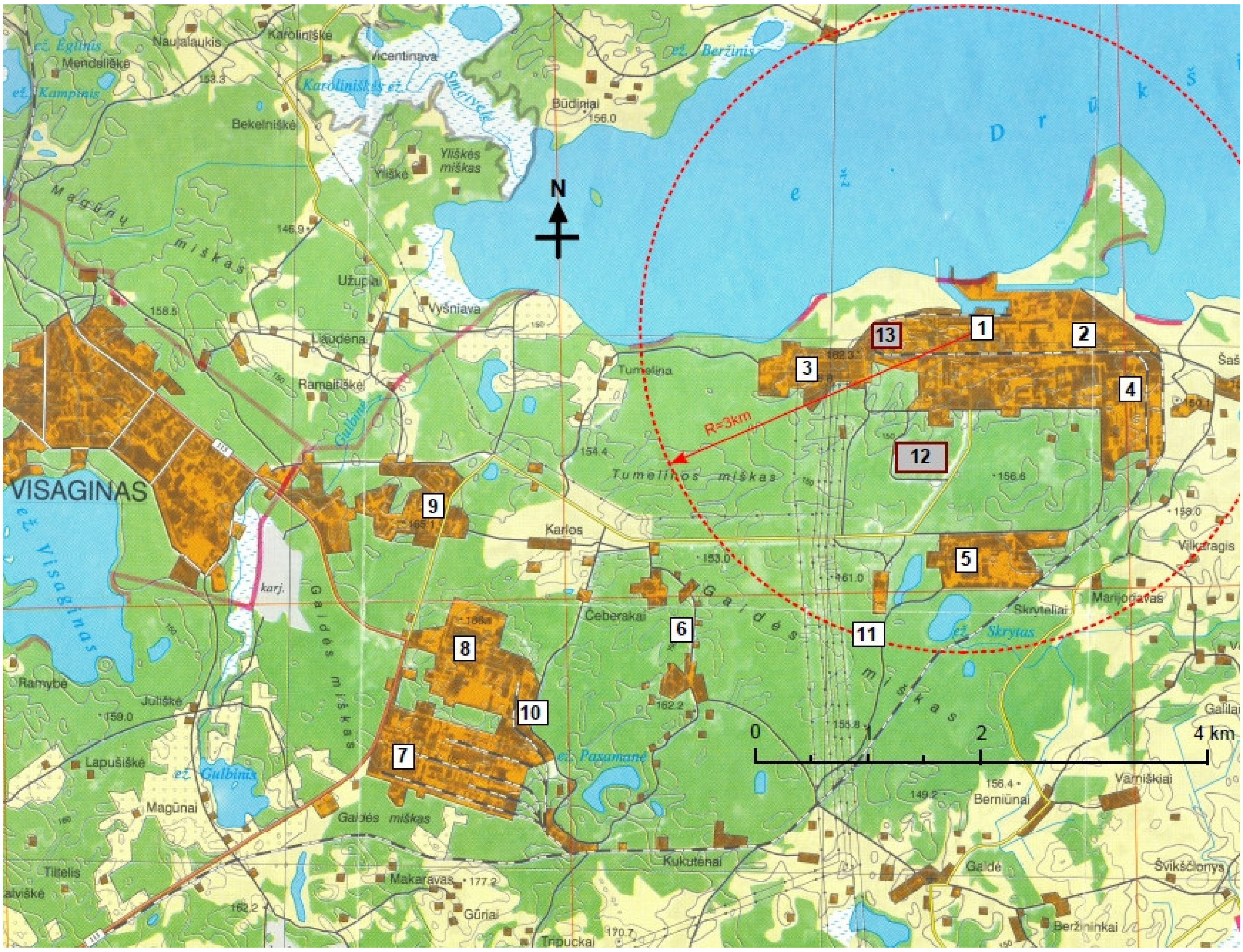


Figure 1.2 INPP south-west region

1 – 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 - military base, health clinic, 10 - heat boiler station, 11 - Visaginas dump site, 12 – SWTSF and ISFSF site, 13 – SWRF site. The existing 3 km radius Sanitary Protected Zone of INPP is also indicated.

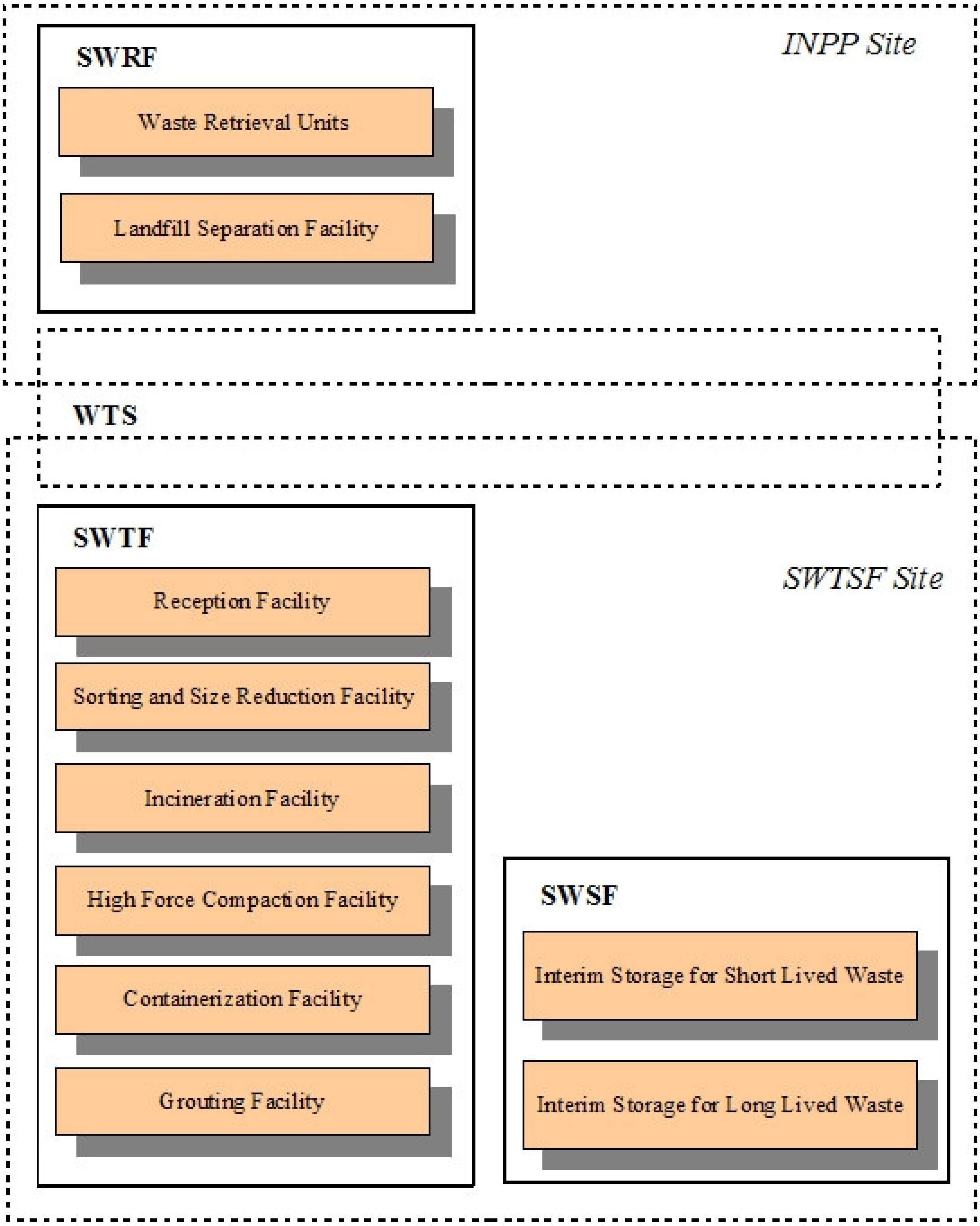


Figure 1.3 Structure of the new Solid Waste Management and Storage Facilities (SWMSF) at Ignalina NPP

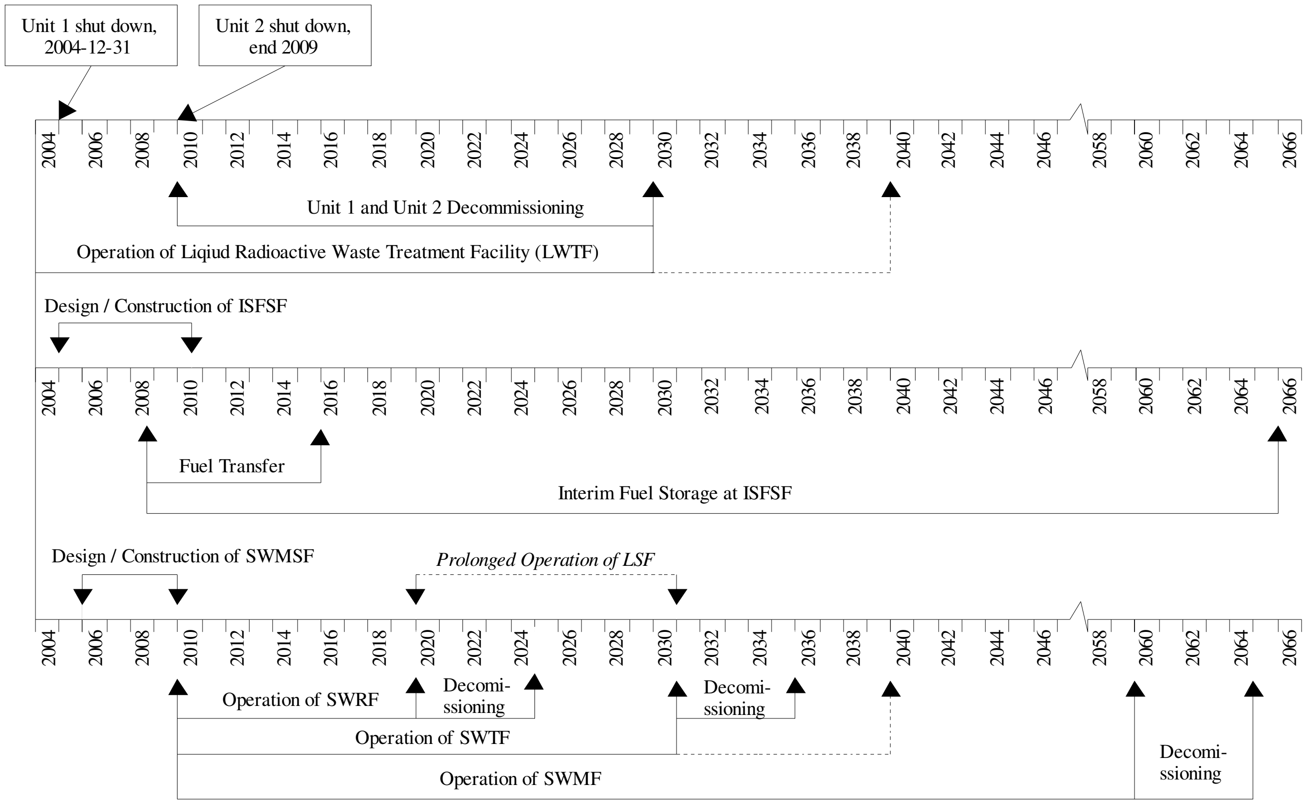


Figure 1.4 Stages of decommissioning of INPP Reactor Units, of spent nuclear fuel storage at ISFSF and of proposed economic activity (SWMSF)

2 TECHNOLOGICAL PROCESSES

The new solid radioactive waste management and interim storage facilities are required for the Ignalina Nuclear Power Plant (INPP) to support ongoing decommissioning work, including removal of waste from the existing storage buildings. These new facilities are known as the solid waste management and storage facilities (SWMSF).

The main objectives of the SWMSF will be to:

- Retrieve waste from the existing storage buildings 155, 155/1, 157 and 157/1;
- Sort and condition waste from both the storage buildings and the INPP;
- Reduce the waste volumes by compaction and incineration, where possible;
- Package the presorted landfill waste in an appropriate way for landfill disposal;
- Containerize the conditioned waste for interim storage, depending on its class;
- Provide interim storage facilities with a lifetime of 50 years, by which time a final disposal route is planned to be available.

The new facilities will be located on two separate sites. The solid waste retrieval facilities (SWRF) will be built in connection with the existing storage buildings inside the perimeter of the INPP. The solid waste treatment and storage facility (SWTSF) will be built on a new site close to the INPP. The SWTSF will be a building combining solid waste treatment facilities (SWTF) with the new solid waste storage facility (SWSF).

The solid radioactive waste management within the SWMSF is summarized in Figure 2.1. The radioactive waste specificity, waste management technologies and facilities are described and explained in sub-chapters below. The description of the SWMSF is mainly based on two documents, the Ignalina NPP issued “Technical Specification for New Solid Waste Management and Storage Facilities” [8] and NUKEM Technologies GmbH developed technical proposals for “Lot 1 – New Solid Waste Retrieval Facility” [13] and “Lot 2 – New Solid Waste Treatment and Storage Facilities” [14].

2.1 Radioactive Waste

2.1.1 Waste Classification and Segregation

The INPP generated and/or accepted for storage solid radioactive waste is presently classified according to:

- Radiological properties that are divided into three groups: G1 (low active waste), G2 (intermediate active waste) and G3 (high active waste), cf. Table 2.1.
- Combustibility properties that are divided into two groups: combustible and non-combustible.

This existing (so-called “old”) waste classification system is used for waste segregation and selection of the appropriate waste storage compartment in the existing INPP storage buildings.

VATESI has introduced a new classification [15], cf. Table 2.2, which is to be used as the basis for the future waste classification and management system at INPP. The waste segregated originally according to the existing (old) INPP classification must be re-segregated and treated in the SWMSF according to its ultimate destination:

- Class A waste: very low level waste for landfill disposal;
- Class B and C waste: low and intermediate level for short-lived intermediate storage;
- Class D waste: low level graphite waste for long-lived intermediate storage;
- Class E waste: intermediate level waste for long-lived intermediate storage;

- Class F waste: SSS waste for long-lived intermediate storage.

Figure 2.2 clarifies the relation between the old and the new classification if only the waste surface dose rate is considered. To comply fully with the new classification also the nuclide composition must be considered, cf. remarks to/below Table 2.2.

2.1.2 Waste Characteristic

G1 waste is produced during normal operational and service functions of INPP.

Combustible G1 waste, cf. Figure 2.3 and Figure 2.4, includes:

- Paper, textile and plastic generated during the normal operation and service of the plant. These materials are used for cleaning purposes, as protective clothing, covers to protect equipment and surfaces against contamination, etc.;
- Wood and wooden constructions which have been used inside the controlled area;
- Filters, which have been used inside the controlled area for different purposes. These filters include various filter cartridges, HEPA filters, respiratory filter cartridges etc.;
- PVC waste which consist of rolls of floor cover material and miscellaneous items like gloves, films, sheets, baskets etc.

Filter cartridges (potential activity concentration) and PVC waste (which incineration creates hazardous chlorine compounds) will not be incinerated and therefore are to be re-sorted and appropriately treated as non-combustible waste.

Non-combustible G1 waste, cf. Figure 2.5, includes:

- Wide range of different metal items. The most common metals are stainless steel and carbon steel;
- Construction materials like bricks, concrete, gypsum sheets and asbestos;
- Thermal insulation materials consisting mainly of glass wool material in the form of sheets and heat insulation coating for pipe works;
- Cables and casings, which include various types of electrical wires and cables with different kinds of coating materials (rubber, PVC, textile, etc.), casings of electrical and process equipment (paronite, metal, plastics, etc.). Some casing materials contain asbestos (e.g., paronite) which must be taken into consideration in the waste treatment;
- Dry sediments, sands and other kinds of fine materials collected at different points inside the controlled area and also loaded in the storage compartments of the waste storage facility.

G2 waste consists mainly of replaced equipment, parts, components and elements, and maintenance service material originating from various locations.

Composition and structure of the G2 combustible waste do not differ much from G1 combustible waste. The waste is regarded as G2 waste because of its higher activity or contamination level.

Composition of G2 non-combustible waste differs to some extent from G1 non-combustible waste, cf. Figure 2.6. The proportion of metal items in G2 as well as insulation materials is higher. Graphite is present in G2 waste while sediments or cables are not generally present in Group 2 waste.

G3 waste, which is in general metallic (~90 %-w) cf. Figure 2.7, is produced in the existing INPP Hot Cells and Cutting Facilities. G3 waste includes a certain amount of PVC baskets, which are used as a liner for the transport casks for the Cutting Facilities. This waste also contains filters from the Hot Cell ventilation chamber.

Spent sealed sources can be found in compartments of non-combustible G1, G2 and G3 waste. Since year 2000 spent sealed sources are collected and stored separately from other waste.

2.1.3 Waste Amounts

It is estimated [8] that by the time of the planned shutdown (until year 2010) INPP will collect 11900 m^3 of G1 and 2400 m^3 of G2 unconditioned combustible waste. Details on the amounts of specific combustible waste types are provided in Table 2.3.

The estimated volumes of non-combustible waste are similar. It is estimated that by the time of the planned shutdown INPP will collect 10400 m^3 of G1 and 2600 m^3 of G2 unconditioned non-combustible waste. Details on the amounts of specific non-combustible waste types are provided in Table 2.4.

The estimated volume of unconditioned G3 waste (collected until year 2008) is 930 m^3, cf. Table 2.4.

2.1.4 Waste Properties

The Technical Specification [8] Appendix 4 provides data on quantities and characteristics of the solid radioactive waste stored in the existing waste storage facilities for the date 2001-12-31. The average waste density and the specific activity of particular waste groups are summarized in Table 2.5. Waste specific activity is recalculated for the date 2010-01-01 (planned startup of operation of the SWMSF, cf. chapter 1.4).

It shall be noted that uncertainties of the reported waste characteristics (mass, activity etc.) might be very high. Only after 1993 waste loaded to the storages has been weighed regularly. Also the reliability of the waste activity data is limited as the nuclide content of the waste was defined by measurements of samples taken only a few times per year. The accuracy of the activity measurements until year 2001 is not known. Data collected with a new measuring system during year 2001 show limited reliability of the reported radionuclide inventory provided prior to the introduction of the new waste activity measurement system.

The Technical Specification [8] Appendix 4 provides data on quantities (mass) and characteristics (activities for the key radionuclides Co-60 and Cs-137) of the main solid radioactive waste streams produced by INPP during the year 2001. These data represent the characteristics of freshly generated operational waste.

Starting from the year 2001 a new waste activity measurement system is in operation at INPP. The activities of the key radionuclides for each waste container are measured. The uncertainty of the measurements is below ±30%. Evaluation of nuclides other than Co-60 and Cs-137 is based on a calculated nuclide spectrum defined for representative types of waste.

Calculated specific activities of key radionuclides in the freshly generated waste streams are presented in the Table 2.6. These activities do not include data on filters. Filters data were considered separately.

To calculate the activity for other radionuclides present in the waste scaling factors are used [16]. For the Ignalina NPP generated radioactive waste (and also presumably radioactive waste generated during decommissioning of INPP) representative radionuclide vectors for specific waste streams and scaling factors have been developed within the frame of preparation of the INPP final decommissioning plan. These vectors have been evaluated using calculation methods and now are going to be verified according to the results of the direct measurements. The scaling factors for the solid waste streams are presented in Table 2.7.

Specific activities of the freshly generated solid radioactive waste, calculated using directly measured activities of key radionuclides and appropriate scaling factors, are presented in Table 2.8. Average densities of INPP solid radioactive waste are provided in Table 2.9 and Table 2.10.

Data on graphite waste produced and expected at INPP by the year 2010 are presented in Table 2.11. Data are taken from the Technical Specification [8] Appendix 4.

Spent ventilation filters activity analysis is based on filters activity data collected after upgrading of the activity measuring system [17]. The main radionuclides average percentage content in the measured spent filters is provided in the Table 2.12.

The analysis of external dose rate values from filter packages [17] shows that most of the filter packages are classified as group G1 waste. 234 filter packages (from a total of 236 produced during years 2002 – 2005) have an external dose rate below 0.3 mSv/h. The average dose rate is 0.0632 mSv/h. Only two filter packages are classified as group G2 waste with external dose rates of 1.6 mSv/h and 1.8 mSv/h. Their average dose rate is 1.7 mSv/h.

The filter's specific activity was calculated from the average measured dose rate by means of a shielding calculation with QAD CGGP [75]. According to the Table 2.12 the following radionuclide activity contributors were considered:

- Co-60: 80.0%;
- Cs-137: 10.5%.

Calculation results are presented in Table 2.13. The radionuclides Cr-51 (decay half-life is 27.7 days), Fe-59 (decay half-life is 44.6 days), Nb-95 (decay half-life is 35.1 days) and Zr-95 (decay half-life is 64 days) are very short-lived. To give indication on long-lived radionuclides which potentially might be captured by the filters, the scaling factor S2, cf. Table 2.7, has been applied. The results are presented in Table 2.14. It can be expected that the filters of group G1 and G2 will be classified and treated as short-lived waste. However these results shall be considered as very preliminary indication. The real activity content of the filters will be measured during their characterization at the SWTF.

2.1.5 Waste Assaying, Tracking and Activity Determination

In order to provide an appropriate waste sorting and maintain necessary characteristic data (e.g., weight, material content, radiological data, etc.) of the specific waste streams a waste assaying, tracking and activity determination system will be established in the SWMSF.

The waste assaying and tracking process will start in the retrieval facilities and continues in more detail at the different waste sorting and product monitoring stations located at different places in the SWMSF. The waste will be sorted, treated and conditioned according to its radiological content and physical properties, and the characteristic data will be entered into the data base of the tracking system. The tracking system will assist the operators during the entire waste sorting, treating and conditioning process. The tracking system will also be used to support the assay systems for the waste characterization of the different packages which leave the SWRF and SWTF.

To assure appropriate waste sorting and to fulfill the regulation requirements the nuclide content of every waste package must be declared. This information will be gathered by measuring the waste gamma activity (e.g., using gamma spectrometry systems), considering the history of the retrieved waste, using the analysis of waste samples (if necessary) and the information from the installed assaying systems.

The waste characterization process will be made on the basis of gamma emission measurement (gamma spectrometry). Nuclides which cannot be directly measured will be determined using the key nuclide technology. This method requires a representative list of all nuclides in the related waste stream and is combined with results of direct measurements. This list can be different for some waste types, for example the graphite contains typically C-14 radioactivity which cannot be measured by non-destructive techniques. Only samples analyzed in a laboratory can be used in this case. Once this list is known, the nuclides that can not be directly measured will be correlated with those that can. This process can be further simplified by using the waste assay information to select a limited number of representative gamma emitting isotopes for measurements. The resulting gamma spectrum is used as a “fingerprint”, and the content of the other isotopes can be calculated.

Since no significant alpha activity in the waste is expected, no special monitors are planned. To verify this assumption different investigations can be performed. At first, for each waste stream samples can be taken and analyzed in a laboratory. Secondly, the contamination tests can be analyzed looking for a small trace of alpha activity. In the third check the gamma line of the Cs-137 isotope is used as an indication for alpha activity. Considering this isotope in the gamma spectrum analysis, a rough estimation is evaluated using the key nuclide method in which the isotope Cs-137 is correlated to the trans-uranium isotopes which are the main alpha emitters. The alpha activity determination procedure will be finally specified during the technical design.

2.2 Solid Waste Retrieval Facility (SWRF)

The purpose of the SWRF is to extract existing waste from its present storage location within the INPP solid radioactive waste storage facility, presort it, segregate adequate material for landfill disposal and package non landfill material for transfer to the SWTF.

The INPP solid radioactive waste storage facility consists of four buildings, namely buildings 155, 155/1, 157 and 157/1. This facility is a Soviet type facility designed for the interim storage of low and intermediate level radioactive waste arising as a consequence of operation of the NPP. The buildings of the storage facility are above the ground reinforced concrete structures. The buildings are located in the northwest side of the INPP supervised area, at about 500 m to the west from the first power unit.

The SWRF will mainly comprise the Retrieval Units (namely RU1, RU2 and RU3), the Landfill Separation Facility (LSF) and the Control Building. The Retrieval Units will be installations within which the waste retrieval, presorting and packaging for transfer to the SWTF will take place. The Landfill Separation Facility, attached to the Retrieval Unit 1, will house equipment to presort and pack the waste suitable for landfill disposal. The Control Building will be also situated close and will house common facilities like a changing room, sanitary facilities and the SWRF control room. The conceptual layout of the SWRF is given in Figure 2.8.

The SWRF will be constructed as a controlled area within the INPP supervised area. Access to the facility area is made from the Control Building.

All normal retrieval and presorting operations will be performed remotely, and only unusual waste, equipment failure, emergencies, and normal maintenance will require human intervention. Exception is the Landfill Separation Facility where due to low waste activity presorting mostly will be done manually.

2.2.1 Retrieval Unit 1 (RU1)

RU1 will be used to retrieve G1 waste from the buildings 155 and 155/1.

RU1 will be designed as a basically monolithic concrete structure with structural elements (slab, outer and inner walls) in order to provide the required radiological protection. RU1 will be constructed as an aside structure to the buildings 155 and 155/1. Appropriate containment will be provided for sealing RU1 against the waste buildings. Ventilation systems will maintain the operational area at a depression relative to the outside environment to prevent contamination escaping.

Waste retrieval will be achieved by using two remotely operated vehicles (ROV) which will enter the waste storage compartments via access apertures cut in the side of the waste buildings. The two

ROVs will have complimentary capabilities, one providing a bucket scoop for collecting loose waste, the other a multifunction arm which can pick up large items such as bales or scaffold poles. The ROVs will be able to retrieve each other in the event of an equipment failure, allowing repair work to be undertaken in a suitably shielded area (maintenance room).

Preliminary waste sorting will be undertaken in the RU1 presorting area, allowing SSS, filter or other special waste to be identified, directly separated, packed into a transport container and sent to the SWTF. Waste, which is too large for the transport containers will be cut using fitted tools (i.e. ROV, hydraulic shear and/or a saw). Other G1 waste will be routed to the Landfill Separation Facility.

G1 waste retrieved by RU2 (when operating on G1 waste) will be also transferred to and sorted in the RU1 presorting area.

2.2.2 Landfill Separation Facility

The Landfill Separation Facility will be built against the RU1 building. The G1 waste will be transferred from RU1 into the Landfill Separation Facility directly by a transport band and a roller conveyor without any need for road transport.

The main purpose of this facility is to separate class A waste (i.e. landfill waste) from the other G1 solid waste, then appropriately pack and load it into ISO standard containers for transfer to the Landfill repository. The type of container will be finally selected during Technical design stage. Preliminary it can be indicated that 20' ISO containers (6.10 × 2.44 × 2.59 m, (length × width × height), internal volume approximately 33 m^3) or lower capacity - half height 20' ISO containers (6.10 × 2.44 × 1.20 m, (length × width × height), internal volume approximately 15 m^3) may be used. Landfill disposal nonconforming G1 waste is placed into a G1 transport container and transferred to the SWTF for further treatment.

Within the sorting area most operations, i.e. sorting, handling, press and container filling, will be performed manually. The workers will wear safety overalls and masks with filters. Dose rate measurements and air monitoring is provided to assure that the requirements for workers in this area are within allowed limits. Input waste will also be monitored to prevent the waste with not acceptable dose rate from entering the sorting area. For safety interventions and decontamination purposes special safety overalls with pressurized air supply will be available. The activities within the sorting area will be supervised from the operation room.

In order to minimize the volume of solid waste, size reduction equipment will be installed in the Landfill Separation Facility:

- A bale press to compact the compactable waste;
- A scrap press to compact bulky metal items.

The Landfill Separation Facility will be a basically monolithic concrete structure.

2.2.3 Retrieval Unit 2 (RU2)

RU2 will be used to retrieve, presort and pack G1 and G2 waste from buildings 157 and 157/1.

RU2 will be a mobile unit located on the top of the building and appropriately fixed to the building structure. The unit will be designed as a framed metal structure and will be kept small and light enough to be handled by the existing 30-tons girder crane. RU2 will be sealed to the building, and a depression pressure to prevent spread out of airborne contamination will be maintained by the exhaust ventilation.

The waste from the storage compartments will be retrieved through existing waste loading apertures, c.f. Figure 2.9. Initial waste retrieval will be undertaken by a dedicated crane and grab. Once the crane has recovered all accessible waste, a ROV will be lowered into the compartment to load the remaining waste into a skip operated by the crane. Twin winches will be provided on the crane to allow redundancy and minimal risk of disruption.

In order to minimize the retrieved waste volume and to fit large objects into the transfer containers the oversized waste will be cut using fitted tools (i.e. hydraulic shear, a saw etc.).

2.2.4 Retrieval Unit 3 (RU3)

RU3 will be used to remove the G3 waste from compartments 1 and 4 of building 157.

Similar to RU2, the RU3 will be a mobile unit located on the top of the building and appropriately fixed to the building structure. The unit will be designed as a framed metal structure and will be kept small and light enough to be handled by the existing 30-tons girder crane. RU3 will be sealed to the building and a depression pressure to prevent spread out of airborne contamination will be maintained by the existing building 157 exhaust ventilation.

Due to the high G3 waste activity only appropriately shielded, automatic and remotely controlled waste retrieval and loading concept will be implemented, c.f. Figure 2.10. The G3 waste transfer container will be equipped with a basket (situated inside the container), which can be lowered into the waste compartment by means of a container mounted hoist gear. The waste pre-sorting and retrieval (i.e. waste loading into the basket of waste transfer container) will be performed using an inside compartment mounted (fixed in one of several existing waste loading apertures) hydraulic loading device. Oversized waste and PVC basket/sacks will be treated by means of attached tools. Once loaded, the basket with waste will be lifted up into waste transfer container. The container then will be closed and prepared for onward transport to the SWTF.

2.2.5 Control Building

The retrieval operation will be managed from a central Control Building, which will use displays to provide the ROV pilots with perception of the recovery area operations. The control room will also liaise with the SWTF to coordinate the dispatch and return of the waste containers and will have radio contact with the transport drivers, ensuring safe, efficient and controlled transfer operations.

The Control Building will house also common facilities like personnel access control, changing rooms, sanitary facilities, and interfaces with other INPP supplies like electricity, compressed air, telephone, etc.

The Control Building will be built adjacent to the Landfill Separation Facility, in a position where it allows easy access to the RU. The building will be erected in a conventional way, with brickwork and reinforced concrete or with the help of prefabricated modules, designed for the purposes to be met.

2.3 Radioactive Waste Transfer

Solid and liquid waste transfer systems will be required throughout the operation of the SWMSF. Some of the waste transfer systems (like solid waste transfer from the INPP waste generating facilities to the waste storage facility etc.) are already established and licensed, and operate for years.

All existing and new transportation will be performed within the supervised area and without entering public roads. A fenced road connection will be constructed to connect INPP and SWMSF /

ISFSF sites. The road connection will be constructed aside the new railroad connection (which will be used for spent nuclear fuel transfer from INPP to the ISFSF sites), cf. Figure 2.11.

To provide flexibility and allow efficient use of equipment, the transport vehicles will be of a similar design (anticipated to be 10-tons trucks), with appropriate flatbed trailers, c.f. Figure 2.12. All transportations will be controlled and coordinated by the SWMSF Control Room, which will have communication links to the other facilities.

2.3.1 Waste Transfer within INPP Supervised Area

Radioactive waste transfer within the existing INPP supervised area will include:

- Solid G1 waste transfer from RU2 to RU1 for segregation of class A waste suitable for Landfill disposal. This waste transfer will be performed internally within the SWRF site and will be short distant, cf. Figure 2.8;
- Liquid waste transfer from the SWRF to the INPP Liquid radioactive Waste Treatment Facility (LWTF). Waste stored in the existing INPP storage facility may contain liquids. The water may have ingressed during storage; some liquids may result from waste management practice. The existing building drainage and liquid waste transfer facilities will be used to transfer liquids from the G1 and G2 waste compartments to the LWTF;
- Solid class A waste transfer from the SWRF to the Landfill repository site. The waste packages are loaded into a standard 20´ ISO container at the Landfill Separation Facility and will be transported to the landfill repository site using a standard trailer.

2.3.2 Waste Transfer in between INPP to SWTF Sites

Radioactive waste transfer in between INPP and the SWTF sites includes:

- Solid G1, G2, G3 waste transfer from the SWRF to the SWTF;
- Solid B, C, D, E waste transfer from INPP to the SWTF;
- Liquid waste oil transfer from INPP to the SWTF;
- Liquid waste transfer from the SWTF and ISFSF to the INPP LWTF.

It is planned to use three types of containers for the transfer of solid waste from the SWRF to the SWTF:

- Containers for G1 waste;
- Containers for G2 (B, C) waste;
- Containers for G3 (D, E) waste.

The waste transfer containers G1, G2 and G3 will be designed following the IP2 standard. The containers can withstand a drop from 1.2 m height.

G1 and G2 containers are of a similar design. They will have the same envelope (global size and shape) and will carry the same basket (G1/G2 basket) inside. The outer envelope ensures the containment and radiological shielding. Containers will be made of iron steal covered by a decontaminable coat. The container’s lid will have a seal to ensure the air tightness during the transfer. The seal will be manually locked by a screw system.

The G3 container will be like a heavy bell made of iron steel ensuring the radiological protection and the containment during transport operations. Inside the G3 container will stand a stainless steel basket. The functions of the basket are the loading of waste during the retrieval phases and the unloading of waste in the SWTF. The bottom of the G3 container will be designed with a concept similar to the existing INPP containers. A drawer opens and closes the bottom of the container, allowing the passage of the basket during retrieval operations. The container will be equipped on the upper part with a hoist allowing the lowering and the lifting of the basket. The drawer will be equipped with a tightness plate allowing the closure of the inside of the container and thereby ensuring its tightness. The conceptual view of G3 container is given in Figure 2.13.

SSS, as a part of G1, G2, G3 waste, will be transferred to the SWTF together with G1 (non class A), G2, G3 waste using appropriate G1, G2, G3 waste transfer containers. A special procedure will be developed for collection and container loading of separately stored or SWRF presorted SSS.

The only liquid waste requiring transport from INPP to the SWTF will be waste oils consigned for incineration. In these circumstances the waste oils will be contained in 200-liter drums, which in turn will be loaded into an ISO container on the back of a 10-tons truck. The drums will be transported to the SWTF and emptied into the Waste Oil Storage Tank.

Liquid radioactive waste generated in the ISFSF and SWTF will be collected in liquid waste collection tanks. Collected liquid waste from the SWTF and the ISFSF will be transferred to a mobile doubly jacked tank lorry (truck or trailer). The tank then will be transported to the LWTF by road.

2.4 Solid Waste Treatment Facility (SWTF)

The SWTF will house equipment and facilities necessary for the treatment of the solid radioactive waste. The building will be designed as a several floors reinforced concrete structure with preliminary dimensions 80 × 50 m in plane. The conceptual view of SWTF design is provided in Figure 2.14, a more detailed facility layout of the site is provided in the chapter “Graphic Materials”.

In terms of functions the SWTF provides the following:
- Reception of solid radioactive waste from the SWRF as well as operational solid waste and waste oil from the INPP;
- Sorting and assaying of the incoming waste according to radiological and physical characteristics;
- Size reduction where necessary;
- Incineration where applicable;
- High force compaction where applicable;
- Containerization;
- Grouting;
- Waste product characterization;
- Waste transfer to the dedicated interim storage facilities of the SWSF.

The design of the SWTF is based on different sorting cells and subsequent waste processing facilities. In the sorting cells, named after the incoming waste type, the waste will be processed in parallel streams according to its respective radiological properties. Following on from sorting, size reduction and other preparations will take place prior to incineration, high force compaction, grouting and / or containerization.

Figure 2.1 gives an overview of the major waste streams being processed through the SWTF. In this Figure, waste streams that do not represent major volumes or special radiological challenges like waste oil, sand or secondary wastes are not shown.

2.4.1 Waste Reception

There will be three areas, within the SWTF, where waste enters the facility. The bulk of the waste will enter via the main reception area. Minor waste streams (e.g. waste oil), which do not require intensive processing, and pre-characterized waste packages from decommissioning will enter via side entrances. The side entrances will be used primarily for the delivery of empty drums, consumables and other materials (e.g. chemicals).

Waste to the main reception area will arrive in different containers, separated into G1 (non class A), G2 and G3 categories. The containers will be delivered on lorries. They will be picked up from the lorries and transferred to the unloading stations or - if necessary - to the respective buffer storage area in the SWTF building. Once emptied, and after the external surfaces have been decontaminated, if needed, the G1, G2 and G3 containers will be loaded back onto lorries. Due to the double door design of the unloading stations, no or only very low contamination of external container surfaces can be expected.

The waste reception areas are equipped with the appropriate registration equipment for receipt and identification of the waste (waste tracking system).

2.4.2 Waste Sorting and Size Reduction

Solid waste sorting and size reduction is carried out in two cells according to radiological waste characteristics:

- G2 sorting cell, for handling of combustible and for non-combustible G1 (non class A) and G2 waste (B, C, F classes);
- G3 sorting cell, for handling of high active G3 waste (D, E, F classes).

2.4.2.1 G2 Sorting Cell

The G2 sorting cell will be a sealed room connected to the active ventilation system to ensure that the cell is maintained at a lower pressure than the surrounding less active rooms.

All sorting operations that take place within the G2 sorting cell will be performed using a combination of the cell crane, manipulator arms and Remotely Operated Vehicles (ROVs). The operators will be able to view the equipment and waste within the G2 sorting cell through lead glass windows and by observing television monitors displaying in-cell camera images.

At the monitoring station the activity and weight will be measured, any identified “hot spots” will be removed before the remaining waste is sorted. Here operators separate SL-waste from LL-waste, SSS, filters, hazardous waste, graphite, and combustible waste from non-combustible waste using the ROV supported by manipulator arms.

The activity of the waste is measured by means of a gamma camera, mounted above the sorting table. The gamma camera takes a gamma image and a video image from the waste. Both pictures are superimposed and allow an easy identification of gamma emitting items. In the image a coordinate system is located.

To separate LL-waste from SL-waste, the key nuclide method is applied. With the built-in NaI spectrometer the gamma emission spectrum is measured. Using the characteristic line of Cs-137 at 661 keV, the Cs-137 content is measured (measuring time <= 20 min) and on this basis the content of long lived isotopes is estimated (the specific activity of 4000 Bq/g is the boundary between SL and LL waste). The long-lived items are taken out by means of the ROV and put into an ILW-LL container.

After removing the LL-waste items, the measurements can be repeated to check the result of the operation.

Waste suitable for high force compaction and waste that requires special treatment will also be removed and placed through corresponding ports into 200-liter drums. Large items will be size reduced using appropriate equipment within the G2 cell before being processed accordingly.

The graphite waste will be sent to the docked ILW-LL container.

All ventilation filters (metal and wooden framed) not acceptable for Landfill disposal will be transferred to the SWTF G2 Sorting Cell for further treatment. After characterization the filters will be moved without any other treatment to the charging device of the Filter Press. The Filter Press will pre-compact the filters so that they fit into a 200 l drum. The closed drum will be sent to the Drum Monitor and further to the High Force Compactor.

The rest of the waste, which is the non-compactable (i.e. thick walled tubes, metal bars etc.), will be collected in the docked LILW-SL container.

The G2 sorting cell will include the following size reduction facilities:

- A saw for cutting bulky items;
- Remotely Operated Vehicle cutting tools;
- Manipulator friendly cutting tools.

2.4.2.2 G3 Sorting Cell

The G3 sorting cell will be a sealed room connected to the active ventilation system to ensure that the cell is maintained at a lower pressure than the surrounding less active rooms so that the air flows into the more active G3 sorting cell.

All sorting operations that take place within the G3 sorting cell will be performed remotely using a combination of the cell crane and manipulator arms. The cell will include all equipment and devices required for G3 waste import, waste feed buffer storage, class E waste segregation and activity determination, SSS separation, volume reduction of PVC liners, as well as storage container and 200 liter sacrificial drum filling.

In order to minimize the waste volume a shredder for PVC liners from G3 waste containers will be installed in G3 sorting cell.

2.4.3 Incineration System

The incineration of waste has the advantage to achieve the highest volume reduction possible and convert the organic bulk material into ashes and residues that show higher stability and an inorganic nature which favors subsequent conditioning into waste forms suitable for storage, i.e. high force compacted ashes.

The incinerator proposed for the SWTF is typical of those NUKEM has installed at other nuclear waste processing facilities, i.e. Karlsruhe in Germany (which it is more than 20 years in operation), Bohunice in Slovakia and Balakovo in Russia. The incinerator's waste feed system and ash management system is adapted to non-manual work sequences for class B & C waste handling. The design of the incineration plant will include features to deal with all normal industrial hazards (i.e. hot surfaces) as well as radiological hazards (i.e. radiation dose rates). The conceptual view of the incineration facility design is presented in Figure 2.15.

The design and operation of the Incineration Facility shall take into account the safety guidance provided by the IAEA Safety Series No. 108 [18].

Although plants treating only radioactive waste are excluded (Article 2 (2) (a) (vi)) from the scope of the European Union Directive [19] the incineration system of the SWMSF shall comply with the air emission limits values given in Annex V as well as with the measurement requirements given in Article 11 of this Directive. Analogous requirements are included into the Lithuanian environmental requirements on the incineration of waste [20].

The general concept of incineration system operation, required consumables and potential releases becomes evident from the block flow diagram given in Figure 2.16. The key points are described below.

The solid waste for incineration is delivered to the reception box of incineration facility loaded into skeleton containers. The waste in the container is already pre-sorted, shredded and packed into plastic bags, each weighing approximately 5 kg. The bags are reloaded onto incinerator feeding conveyor of transfer box, transferred into the incinerator feed box and fall by gravity into the feed slide which will then be started, to automatically feed the incinerator. The feed slide is part of the safety lock between the incinerator atmosphere and the reception box atmosphere. Depending on the calorific value of the waste packages, the feeding into the incinerator has to be performed in time intervals of 2 to 4 minutes.

The liquid combustible waste (spent oil etc.) can also be incinerated. The liquid waste for incineration is delivered into SWTF in 200 liter drums. The liquid waste at the SWTF is pumped into the receiving tank. Once the receiving tank is full, the radioactive liquid waste is transferred by the feed pump to the supporting burner of the incinerator where the waste is burned. The incineration of liquid waste occurs together with the incineration of solid waste. During this simultaneous incineration, the normal throughput of solid waste has to be reduced in the proportion with the heat throughput of the liquid waste.

The average design capacity of incineration facility will be incineration of 100 kg/h of solid waste and 40 kg/h of liquid waste.

The incinerator is of the shaft type, without any internals. Internal surface of the shaft is lined with multilayered refractory liner. The feeding of solid waste is performed from the top of the incinerator. The waste falls to the bottom. The bottom of the incinerator is equipped with a heat-resistant butterfly valve in order to discharge the ash.

A fan supplies the incinerator with the necessary combustion air. The combustion air is filtered through a HEPA-filter (no shown in Figure 2.16). This filter serves as a protection of the surroundings in case of a possible over-pressure condition in the incineration system.

Incineration of the waste takes place in two zones; each supplied separately with combustion air. The solid waste is burned in the lower zone, just above the bottom of the incinerator and supported by a steam-air mixture. About one fourth of the total combustion air flow is used for the lower incineration zone. It is heated to 130°C in an electric heater and is mixed with steam before entering the incinerator. The steam flow is controlled in order to maintain an oxygen concentration of about 16 % in the steam-air mixture. An endothermic reaction between steam and carbon ensures an upper temperature limit of approximately 900°C in the burning material. As a consequence, the formation of slag is excluded and the settling of slag on the walls of the incinerator is avoided to a large extent.

The rest of the combustion air flow is fed into the second zone directly above the burning zone of the solid waste. This air flow is calculated to provide an excess of oxygen to ensure complete combustion and is adjusted in order to reach an incineration temperature in the range of 1000°C and 1100°C.

The flue-gas leaving the incinerator still contains combustible gaseous components and solid particles. These are combusted and destroyed in the upper section of the afterburner chamber (c.f. Figure 2.16, post-combustion). The oxygen concentration in the upper section of the afterburner chamber is controlled and maintained to exceed 6% by volume by additional compressed air as required. The fuel oil fired maintains the temperature in the afterburner chamber between 1100°C and 1150°C, This temperature range together with a residence time of the flue-gas in the afterburner zone of more than two seconds ensures the destruction of all of the organic compounds. The temperature of the flue-gas leaving the afterburner zone is lowered to 850°C by injection of process water into the lower section of the afterburner chamber. This treatment ensures that parts of the ash which might have been liquefied in the upper part of the chamber, will settle in the solid state on the bottom of the afterburner chamber. The NO_X reducing agent can be added to the process water if the NO_X concentration in the off-gas discharged into the stack reaches the upper permitted limit.

The flue-gas contains hazardous constituents that have to be removed. Among them are HCl, HF, SO_2, NO_X, heavy metals and radionuclides. They will be eliminated in successive steps of flue-gas cleaning process.

The hot flue-gas leaving the afterburner chamber is rapidly cooled down to 250°C in a static mixer. In this way the formation of dioxins and furans is excluded, as the temperature range between 250 to 450°C in which their formation occurs is passed rapidly. Further cooling is then performed in the reverse jet scrubbers I and II where cooled flue-gas is washed in two successive steps.

In the scrubber I the flue-gas is washed to reduce the amount of hazardous constituents such as HCl and HF. The pH-value of the scrubbing solution is maintained between 0.5 and 1.5 by means of the addition of caustic soda. The flue-gas is then washed in the scrubber II to reduce the amount of hazardous constituents such as SO_2. The pH-value of the scrubbing solution is maintained between 7 and 9 by metering with caustic soda. This pH-range is selected as being the best for SO_2 absorption from the off-gas and simultaneously minimizing the absorption of CO_2.

For both scrubbers, the scrubbing solutions are circulated in closed loops by means of special pumps. The spent scrubbing solution will be discharged in batches for further conditioning.

The off-gas from the second reverse jet scrubber, already cleaned of most of the hazardous constituents, passes a particle-filter (HEPA-filter), where remaining small particles are retained.

After the HEPA the off-gas has to pass the dioxin removal filter for the compliance of the emission limits for dioxins and furans. The dioxin removal filter is formed from an adsorptive material like activated charcoal.

The negative pressure inside the incineration plant is maintained by two blowers. The main blower holds the negative pressure during normal operation. The smaller auxiliary blower is used during an interruption of the incineration process or in the stand-by mode at weekends when the gas flow rate in the system is low.

The ash from the incinerator is removed once a day and the ash from the afterburner chamber once a week. The ash is discharged into 200 liter drums which afterwards are compacted by means of high force compactor, c.f. chapter 2.4.4.

The monitoring of potentially hazardous chemical emissions is performed before discharging off the flue gas into the main stack. The radiological monitoring is performed in the main stack and considers radioactivity discharged from the whole SWTF.

2.4.4 High Force Compaction of Waste

A high force compactor with a proven track record will provide high force waste compaction within the SWTF. It will be easily maintained and decontaminated. NUKEM has successfully utilized this equipment in a number of other waste treatment facilities. The conceptual view of the high force compactor design is provided in Figure 2.17.

The high force compactor will apply a force of approximately 15 000 kN to minimize the volume of pretreated waste, which is filled in sacrificial 200-liter drums. Expected volume reduction rates are in the order of 3 to 7, depending on waste characteristics, c.f. Figure 2.18.

Any residual liquids displaced during the drum compaction process are collected by a drain system. When a defined amount is reached the liquid waste is discharged to one of the buffer storage tanks of the SWTF. Air or gas with particulates displaced during the compaction process is handled by a filter system.

In order to optimize the efficient filling of the LILW-SL containers, a tracking system will select drums in the buffer store according to their radiation levels and the height of the resulting pellet after compression. This ensures best use of the container capacity, ensuring that the container's radiation limit will never be reached. The number of disposal containers will therefore be greatly reduced and minimize the required disposal space.

2.4.5 Containerization of Waste

Waste will be filled into containers for disposal and interim storage at several containerization stations inside the SWMSF, e g. at the Landfill Separation Facility, the G2 and G3 sorting cells and the high force compactor. The waste route and its containerization will depend on the waste class.

In order not to mix up different waste streams there is one container filling system for landfill waste at the Landfill Separation Facility and container filling systems located in different areas inside the SWTF.

Before packing the waste into containers the waste is characterized (weight, nuclide content, dose rate, physical and chemical condition) as necessary. A waste tracking system will allow the exact data to be assigned to each container in which the waste is to be filled. If a container needs to be inspected or exported to a final disposal site, the database will allow all necessary information to be quickly retrieved. The database will support operations for the 50-year life of the store.

An approximate 3.5 m^3 internal volume concrete shielded container (external volume of conditioned waste package is approximately 6.4 m^3) will be used as storage, transport and final disposal container for SL waste.

The LL waste container will be an unshielded steel design of rectangular shape and an approximate internal volume of 2.5 m^3 (external volume of container is approximately 4 m^3), which is a design with the aim to minimize the size of the interim storage for LL waste. Since the container is unshielded, the Long-Lived Waste Storage building walls will be designed to provide the required shielding.

Before filled and conditioned waste containers are transported into the SWSF their external surfaces will be monitored for contamination. If necessary, decontamination measures are available within the SWTF.

2.4.6 Grouting of Short-Lived Waste

The purpose of the grouting facility will be to encapsulate solid waste in disposable containers. The waste to be grouted will either be pretreated in the high force compaction facility, or directly put into container (i.e. bulky items). The pellets resulting from high force compaction, or loose scrap material, will be delivered in SL waste containers to the grouting facility.

The grouting facility will be divided into two main sections, the grout preparation system and the grout delivery and container filling system. Each grout batch will be individually prepared. The recipe of grout will be designed so that it will easily flow and fill-up the container volume with a minimum of voids.

The general concept of the grouting system operation and the required consumables become evident from the block flow diagram given in Figure 2.19.

2.4.7 Liquid waste collection system

There will be two liquid waste collection sub-systems at SWTF, each for a separate liquid waste stream.

The first sub-system will collect potentially non radioactive (personnel showers) or low radioactive liquid effluents from:

- Decontamination effluent from treatment areas, container washing and decontamination;
- Area cleaning / floor washing effluent;
- Personnel decontamination (showers water).

The sub-system will consist of four 5 m^3 volume tanks. Personnel shower water will be collected separately (two tanks will be used) from other waste water (will be collected in another two tanks). Each tank pair will have:

- One tank in operation for filling;
- One tank empty as spare tank.

The second sub-system will collect potentially higher radioactive liquid effluents:

- Neutralized scrubber solution from the flue gas treatment of the incineration facility;
- Liquid released during compaction operation at the high force compactor;
- Liquid waste from floor cleaning at ground level.

The system will consist of three 2 m^3 volume tanks:

- One tank in operation for filling,
- One filled tank under quarantine for controlling the activity,
- One tank empty as spare tank.

The all liquid waste collection tanks will be designed with a safety margin to contain all the liquid effluent generated from the plant for a period of several days. The tanks will be equipped with level control instrumentation (with a high-level pre-alarm, an over level alarm as safeguard against overfilling etc.). Safeguards will be installed to protect the tank lorry against overfilling, the liquid waste transfer pump against running dry and spilling of liquids.

The liquid waste collection tanks will be erected in a trough, which provides the secondary containment, and ensures that any liquid spillage is contained within the room. This secondary containment is designed to hold all the contents of one collection tank plus an additional volume as a safety factor. The liquid waste transfer pump will be also located in the trough.

2.5 Solid Waste Storage Facility (SWSF)

The SWSF will comprise two intermediate stores, which will be directly connected to the SWTF: one store for Short-Lived (SL) and the other for Long-Lived (LL) waste. Both facilities will be designed as reinforced concrete structures. The conceptual view of the SWSF design is provided in Figure 2.14, a more detailed facility layout on the site is provided in the chapter “Graphic Materials”.

2.5.1 Short-Lived Waste Storage

Waste packages containing class B or C waste will be stored in the SL waste store. This store will be capable of containing approximately 2500 m^3 of processed SL-waste (net, without containers, grout, crane space, etc) and allow the waste packages to be stored for a period of 50 years.

The building will be designed as one floor reinforced concrete structure with preliminary dimensions of 90 × 20 m in plane. The building will be able to accommodate about 1200 disposal containers (cf. chapter 2.4.5) with conditioned SL-waste.

It will not be necessary to shield the whole store building as the SL waste containers are individually shielded.

Waste packages are transported to the SL store by a conveyer. A remotely operated store crane, equipped with a suitable grab, will then pick up the waste packages from the conveyer and transport them to their allocated storage position.

A maintenance and repair area for the store crane and grab will be provided. A recovery mechanism will be installed to lower and release the load, and to pull the crane into the maintenance and repair area remotely should the crane fail during operation.

During storage, waste packages may be visually inspected to confirm the integrity of the container and its external condition. A dedicated inspection area is proposed for this activity.

The store's air supply will be dehumidified to maintain a dry environment within the store building, and minimize container corrosion.

The SL store will be designed so that it can be extended by the addition of up to three similar modules, so that a total storage volume of 10000 m³ can be provided. The extension modules would be built parallel to the SL store at the west side of the SWTF.

Retrieval and export of the SL waste containers after the lifetime of the store can be achieved by the provision of an export bay. The retrievability of waste packages after storage for 50 years will be assured by concrete Technical design solutions and will be justified in SAR.

2.5.2 Long-Lived Waste Storage

Waste packages containing Class D (graphite), E (highly active scrap) and F (SSS) waste will be stored in the LL waste store. The LL store will be capable of containing approximately 2000 m^3 of LL-waste (net, without containers, crane space, etc) and allow the waste packages to be stored for a period of 50 years. The store will be provided with separate compartments for spent sealed sources and graphite waste.

The building will be designed as one floor reinforced concrete structure with preliminary dimensions of 60 × 20 m in plane. The building will be able to accommodate about 1000 storage containers (cf. chapter 2.4.5) with LL-waste.

Since the LL waste container is unshielded, the shielding function for the waste is fulfilled by the building structure of the store (i.e. substantial shielding walls). Access into the main storage area will therefore not be permitted, and any maintenance be undertaken by staff in a specific area of the reception/inspection area, protected by a shielding wall.

Waste packages are transferred to the LL store by a conveyor. A remotely operated store crane, equipped with a suitable grab, will then collect the waste packages from the conveyor and transport them to their allocated storage position. A recovery mechanism will be installed to lower and release the load, and to pull the crane into the maintenance area remotely should the crane fail during operation.

During storage, waste packages may be visually inspected to confirm the integrity of the container and its external condition. Inspection will be carried out through CCTV in a special position inside the store where single containers can be transported to using the store crane.

An active ventilation system will be installed to provide heat removal and air exchange. The air supply will be dehumidified to maintain a dry environment within the store building and minimize container corrosion.

The LL store will be designed so that it can be extended. The same store crane together with its maintenance, import and export facility could be used to serve the extended store (only the crane rails of the store crane need to be extended). The interface to the extension will be considered in design and erection of the first stage. As possible alternative, a construction, which already includes the extension, could be performed.

Retrieval and export of waste packages after the store lifetime can be achieved by the provision of an export bay. The retrievability of waste packages after storage for 50 years will be assured by concrete Technical design solutions and will be justified in SAR.

2.6 Tables and Drawings of the Chapter "Technological Processes"

The following Tables are attached to the chapter "Technological Processes":

Table 2.1 Existing ("old") INPP radiological classification for solid radioactive waste, used for waste segregation and storage at INPP. Whichever parameter is applicable, [21];

Table 2.2 New radiological classification for solid radioactive waste to be used as criteria for waste segregation and treatment in SWMSF, [15];

Table 2.3 Expected combustible solid radioactive waste quantity at INPP by the year 2010;

Table 2.4 Expected non-combustible solid radioactive waste quantity at INPP by the year 2010;

Table 2.5 Characteristics (specific activities are recalculated for the date 2010-01-01) of the solid radioactive waste stored (2001-12-31) in the existing buildings;

Table 2.6 Specific activities of key radionuclides for the year 2001 generated solid radioactive waste (without filters);

Table 2.7 Scaling factors for different types of radioactive wastes;

Table 2.8 Specific activities of radionuclides for the year 2001 generated solid radioactive waste (without filters);

Table 2.9 Average waste densities of INPP solid radioactive waste (calculated on data provided in Table 2.3 and Table 2.4);

Table 2.10 Average densities of filters (calculated on data provided in Table 2.3 and Table 2.4);

Table 2.11 Characteristics of graphite waste produced and expected at INPP by the year 2010;

Table 2.12 Main radionuclides average percentage content in the measured spent filters [17];

Table 2.13 Specific activities of radionuclides in the filters calculated basing on external dose rate from the filter packages;

Table 2.14 Specific activities of radionuclides in the filters calculated basing on external dose rate from the filter packages and scaling factor S2, cf. Table 2.7.

The following Figures are attached to the chapter "Technological Processes":

Figure 2.1 Major solid radioactive waste streams within SWMSF;

Figure 2.2 Comparison between old and new SRW classification systems if only surface dose rate is considered (spent sealed sources are not included);

Table 2.1 Existing ("old") INPP radiological classification for solid radioactive waste, used for waste segregation and storage at INPP. Whichever parameter is applicable, [21]

Waste group	Equivalent dose rate at the distance of 10 cm from surface, mSv/h	Surface contamination, Bq/cm^2	
		Beta activity	Alpha activity
G1 (low active waste)	0.0006 – 0.3	8 - 333	0.017 - 33
G2 (intermediate active waste)	> 0.3 - 10	> 333 – 330 000	> 33 – 33 000
G3 (high active waste)	> 10	> 330 000	> 33 000

Table 2.2 New radiological classification for solid radioactive waste to be used as criteria for waste segregation and treatment in SWMSF, [15]

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 [22]
Short-Lived low and intermediate level waste *)				
A	Very low level waste (VLLV)	≤ 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 waste (ILW-SL)	> 2	Required	Near surface repository
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 Cs137, 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 Cs137, 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 sealed sources.

Table 2.3 Expected combustible solid radioactive waste quantity at INPP by the year 2010 [8]

Waste type	G1	G2
Paper, textile and plastic	3500 – 4600 m^3 690 – 930 Mg	480 – 640 m^3 80 – 100 Mg
Bales (compacted waste)	700 pieces 680 m^3 410 Mg	
Wood	2300 – 3050 m^3 690 – 915 Mg	850 – 1150 m^3 420 Mg
Filters	1600 m^3 330 Mg	200 m^3 40 Mg
PVC	2300 – 3050 m^3 690 – 914 Mg	270 – 370 m^3 100 Mg
Total	**11900 m^3 3100 Mg**	**2400 m^3 660 Mg**

Table 2.4 Expected non-combustible solid radioactive waste quantity at INPP by the year 2010 [8]

Waste type	G1	G2	G3 ****)
Metals *)	2500 m^3 1400 Mg	1500 m^3 870 Mg	891 m^3 916 Mg
Construction material	2500 m^3 2400 Mg	500 m^3 480 Mg	
Thermal insulation materials	1500 m^3 150 Mg	550 m^3 55 Mg	
Cables and casings	2900 m^3 900 Mg		
Graphite		~ 46 m^3 55 Mg	
Sediments **)	900 m^3 1000 Mg		
Spent sealed sources ***)	35334 pieces		
Depleted uranium	< 1m^3 2 Mg		
Other	100 m^3 30 Mg		Filters: 25 m^3; 7.5 Mg PVC: 14 m^3; 18 Mg
Total	**10400 m^3 6000 Mg**	**2600 m^3 1500 Mg**	**930 m^3 940 Mg**

*) Includes pipes from emergency cooling system (200 m^3, 25 Mg) stored with combustible waste

**) Includes sand (685 m^3, 960 Mg) in storage building 155

***) Spent sealed sources can be found from storages of all waste categories

****) Projected only until the year 2008

Table 2.5 Characteristics (specific activities are recalculated for the date 2010-01-01) of the solid radioactive waste stored (2001-12-31) in the existing buildings

Waste type	G1 Combustible	G1 Non-combustible	G2 Combustible	G2 Non-combustible	G3 Non-combustible
Waste volume, m^3	9905	5580	1806	1858	632
Waste mass, Mg	3201	3472	452	922	672
Waste density, kg/m^3 *)	323.2	622.2	250.3	496.2	1063
Radionuclide	**Specific activity, Bq/kg**				
H-3	0	0	0	0	1.04E+02
C-14	5.75E+04	2.40E+04	3.29E+05	9.70E+04	3.83E+07
Fe-55	0	0	0	0	4.65E+08
Ni-59	1.21E+04	5.10E+03	6.99E+04	2.06E+04	4.01E+07
Ni-63	2.58E+06	1.08E+06	1.47E+07	4.22E+06	4.11E+09
Co-60	1.02E+06	5.58E+05	6.33E+06	1.03E+06	1.53E+09
Sr-90	1.04E+05	2.03E+04	3.22E+05	1.22E+05	0
Nb-94	2.32E+04	9.77E+03	1.32E+05	3.90E+04	2.72E+07
Zr-93	0	0	0	0	3.45E+05
Cs-137	1.79E+07	3.44E+06	5.45E+07	2.09E+07	0
I-129	1.01E+02	1.88E+01	3.08E+02	1.21E+02	0
Pu-238	4.18E+02	7.80E+01	1.25E+03	4.90E+02	0
Pu-239	1.27E+02	2.37E+01	3.86E+02	1.52E+02	0
Pu-240	2.84E+02	5.32E+01	8.79E+02	3.52E+02	0
Pu-241	1.70E+04	3.41E+03	5.15E+04	1.92E+04	0
Am-241	9.36E+02	1.79E+02	2.83E+03	1.10E+03	0
Cm-244	6.04E+01	1.19E+01	1.83E+02	6.80E+01	0
Total	**2.17E+07**	**5.14E+06**	**7.65E+07**	**2.65E+07**	**6.21E+09**

*) Calculated from waste mass and volume data.

Table 2.6 Specific activities of key radionuclides for the year 2001 generated solid radioactive waste (without filters)

Waste type	G1 Combustible	G1 Non-combustible	G2 Combustible	G2 Non-combustible	G3 Non-combustible
Radionuclide	**Specific activity, Bq/kg**				
Co-60	2.34E+05	6.53E+05	9.99E+06	6.42E+06	9.48E+10
Cs-137	2.13E+04	1.01E+06	1.85E+05	2.18E+05	6.80E+04 *)

*) In the absence of measurement the Cs-137 specific activity in spectrum S4 (cf., Table below) type of waste is assumed to be equal to 68 Bq/g, corresponding to a surface contamination of 2.14E+02 Bq/cm^2 [16].

Table 2.7 Scaling factors for different types of radioactive wastes

Radionuclide/ Scaling radionuclide	**S2 *)**	**S4 **)**
C-14/Co-60	4.7E-03	3.9E-03
Mn-54/Co-60	1.7E+00	–
Fe-55/Co-60	4.7E+00	6.1E+00
Co-58/Co-60	1.4E+00	–
Ni-59/Co-60	1.0E-03	4.2E-03
Ni-63/Co-60	2.4E-01	4.8E-01
Nb-94/Co-60	1.9E-03	8.0E-03
Sr-90/Cs-137	6.0E-03	6.0E-02
Tc-99/Cs-137	4.0E-04	4.0E-03
I-129/Cs-137	3.6E-06	3.6E-06
Cs-134/Cs-137	1.4E+00	1.2E+00
U-235/Cs-137	2.7E-10	1.6E-06
U-238/Cs-137	8.0E-09	4.9E-05
Pu-238/Cs-137	1.7E-05	1.0E-01
Pu-239/Cs-137	4.4E-06	2.7E-02
Pu-240/Cs-137	1.1E-05	6.4E-02
Pu-241/Cs-137	1.6E-03	9.5E+00
Am-241/Cs-137	2.4E-05	1.5E-01
Cm-244/Cs-137	4.7E-06	2.8E-02

*) Scaling factor S2 is used to characterize: the spent ion-exchange resins, perlite and sediments; the G1 and G2 combustible/non-combustible operational and decommissioning waste; the thermal insulation materials; the concrete structures contaminated by leaking and spilled fluids; the secondary waste generated during the conditioning of the above operational and decommissioning waste.

**) Scaling factor S4 is used to characterize the G3 waste - metallic waste other than Zr-alloys.

Table 2.8 Specific activities of radionuclides for the year 2001 generated solid radioactive waste (without filters)

Waste type	G1 Combustible	G1 Non-Combustible	G2 Combustible	G2 Non-Combustible	G3 Non-combustible
Radionuclide	**Specific activity, Bq/kg**				
C-14	1.10E+03	3.07E+03	4.70E+04	3.02E+04	3.70E+08
Mn-54	3.98E+05	1.11E+06	1.70E+07	1.09E+07	0
Fe-55	1.10E+06	3.07E+06	4.70E+07	3.02E+07	5.78E+11
Co-58	3.28E+05	9.14E+05	1.40E+07	8.99E+06	0
Co-60	2.34E+05	6.53E+05	9.99E+06	6.42E+06	9.48E+10
Ni-59	2.34E+02	6.53E+02	9.99E+03	6.42E+03	3.98E+08
Ni-63	5.62E+04	1.57E+05	2.40E+06	1.54E+06	4.55E+10
Nb-94	4.45E+02	1.24E+03	1.90E+04	1.22E+04	7.58E+08
Sr-90	1.28E+02	6.06E+03	1.11E+03	1.31E+03	4.08E+03
Tc-99	8.52E+00	4.04E+02	7.40E+01	8.72E+01	2.72E+02
I-129	7.67E-02	3.64E+00	6.66E-01	7.85E-01	2.45E-01
Cs-134	2.98E+04	1.41E+06	2.59E+05	3.05E+05	8.16E+04
Cs-137	2.13E+04	1.01E+06	1.85E+05	2.18E+05	6.80E+04
U-235	5.75E-06	2.73E-04	5.00E-05	5.89E-05	1.09E-01
U-238	1.70E-04	8.08E-03	1.48E-03	1.74E-03	3.33E+00
Pu-238	3.62E-01	1.72E+01	3.15E+00	3.71E+00	6.80E+03
Pu-239	9.37E-02	4.44E+00	8.14E-01	9.59E-01	1.84E+03
Pu-240	2.34E-01	1.11E+01	2.04E+00	2.40E+00	4.35E+03
Pu-241	3.41E+01	1.62E+03	2.96E+02	3.49E+02	6.46E+05
Am-241	5.11E-01	2.42E+01	4.44E+00	5.23E+00	1.02E+04
Cm-244	1.00E-01	4.75E+00	8.70E-01	1.02E+00	1.90E+03
Total	**2.17E+06**	**8.34E+06**	**9.08E+07**	**5.86E+07**	**7.20E+11**
Total alpha *)	1.3	61.7	11.3	13.3	2.51E+04

*) Radionuclides U-235, U-238, Pu-238, Pu-239, Pu-240, Am-241 and Cm-244.

Table 2.9 Average waste densities of INPP solid radioactive waste (calculated on data provided in Table 2.3 and Table 2.4)

Waste type	G1 Combustible *)	G1 Non-combustible **)	G2 Combustible *)	G2 Non-combustible	G3 Non-combustible *)
Waste volume (average), m^3	10800	9716	1880	2596	905
Waste mass (average), Mg	2828	4922	610	1460	934
Waste density, kg/m^3 *)	280	507	324	562	1032

*) Without filters

**) Without sand in storage building 155

Table 2.10 Average densities of filters (calculated on data provided in Table 2.3 and Table 2.4)

Waste type	G1	G2	G3
Volume, m^3	1600	200	25
Mass, Mg	330	40	7.5
Density, kg/m^3	206	200	300

Table 2.11 Characteristics of graphite waste produced and expected at INPP by the year 2010

Waste type	Graphite
Waste volume, m^3 *)	46
Waste mass, Mg	54.5
Waste density, kg/m^3	1185
Radionuclide	**Specific activity, Bq/kg**
H-3	1.83E+10
C-14	3.20E+07
Cl-36	5.10E+05
Fe-55	7.70E+06
Co-60	1.50E+07
Ni-59	1.20E+04
Ni-63	2.10E+06
Total	**1.84E+10**

*) Data from Table 2.4.

Table 2.12 Main radionuclides average percentage content in the measured spent filters [17]

Radionuclide	Radionuclide content from total activity, %	Value dispersion, %
Cr-51	0.5	± 60
Mn-54	2	± 60
Fe-59	1.5	± 50
Co-60	80	± 40
Nb-95	1.5	± 60
Zr-95	1	± 60
Cs-134	3	± 60
Cs-137	10.5	± 50

Table 2.13 Specific activities of radionuclides in the filters calculated basing on external dose rate from the filter packages

Filter type	G1	G2
Average dose rate from filter package, mSv/h	0.0632	1.7
Radionuclide	**Specific activity, Bq/kg**	
Cr-51	3.37E+03	9.05E+04
Mn-54	1.35E+04	3.62E+05
Fe-59	1.01E+04	2.72E+05
Co-60	5.38E+05	1.45E+07
Nb-95	1.01E+04	2.72E+05
Zr-95	6.73E+03	1.81E+05
Cs-134	2.02E+04	5.43E+05
Cs-137	7.07E+04	1.90E+06
Total	**6.73E+05**	**1.81E+07**

Table 2.14 Specific activities of radionuclides in the filters calculated basing on external dose rate from the filter packages and scaling factor S2, cf. Table 2.7

Filter type	G1	G2
Radionuclide	**Specific activity, Bq/kg**	
C-14	2.53E+03	6.81E+04
Mn-54	1.35E+04	3.62E+05
Fe-55	2.53E+06	6.81E+07
Co-58	7.54E+05	2.03E+07
Co-60	5.38E+05	1.45E+07
Ni-59	5.38E+02	1.45E+04
Ni-63	1.29E+05	3.48E+06
Nb-94	1.02E+03	2.75E+04
Sr-90	4.24E+02	1.14E+04
Tc-99	2.83E+01	7.60E+02
I-129	2.54E-01	6.84E+00
Cs-134	2.02E+04	5.43E+05
Cs-137	7.07E+04	1.90E+06
U-235	1.91E-05	5.13E-04
U-238	5.65E-04	1.52E-02
Pu-238	1.20E+00	3.23E+01
Pu-239	3.11E-01	8.36E+00
Pu-240	7.77E-01	2.09E+01
Pu-241	1.13E+02	3.04E+03
Am-241	1.70E+00	4.56E+01
Cm-244	3.32E-01	8.93E+00
Total	**4.06E+06**	**1.09E+08**
Total alpha *)	4.3	116.1

*) Radionuclides U-235, U-238, Pu-238, Pu-239, Pu-240, Am-241 and Cm-244.

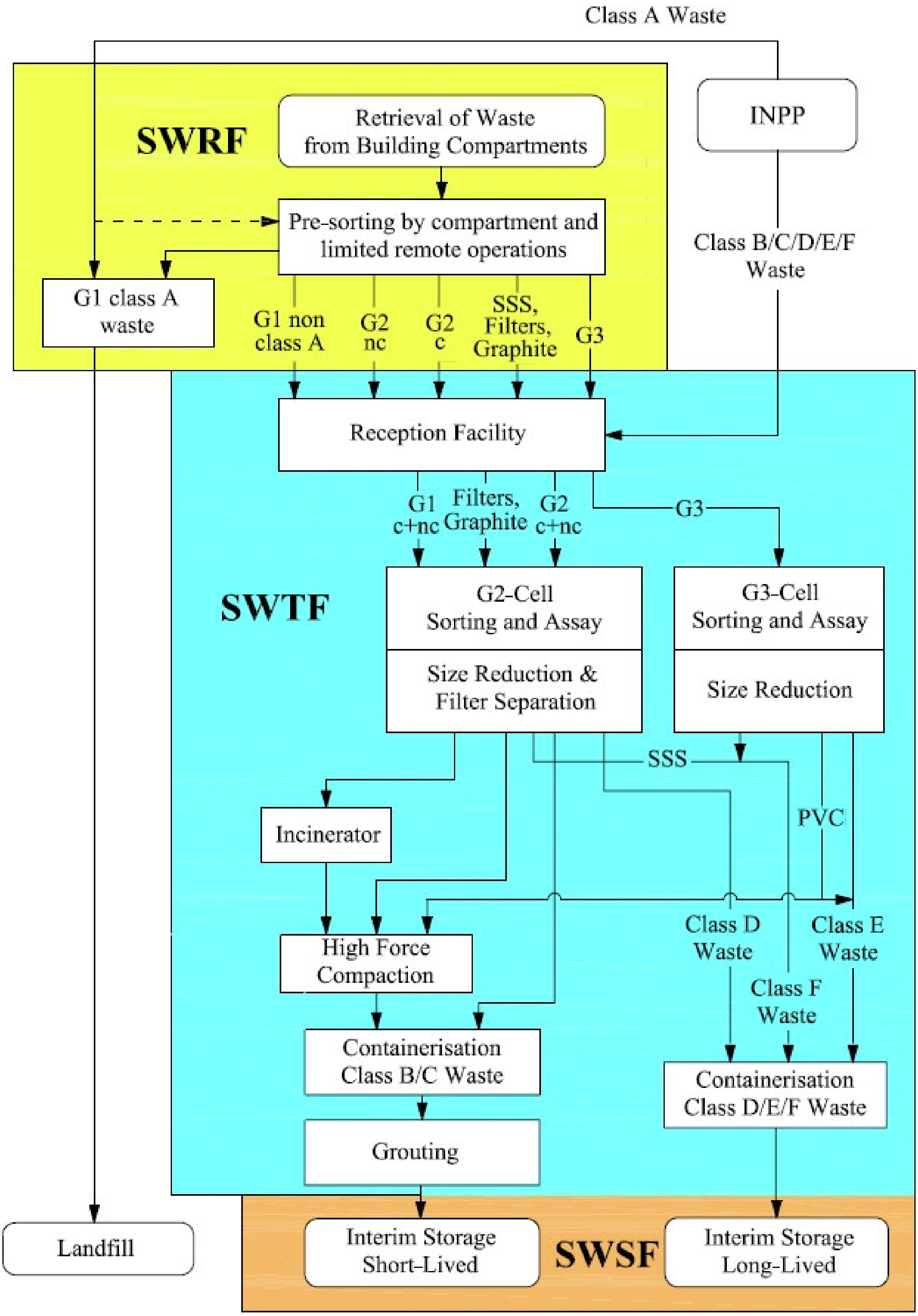


Figure 2.1 Major solid radioactive waste streams within SWMSF. Class A waste going to Landfill repository shall meet Waste Acceptance Criteria for a Landfill repository

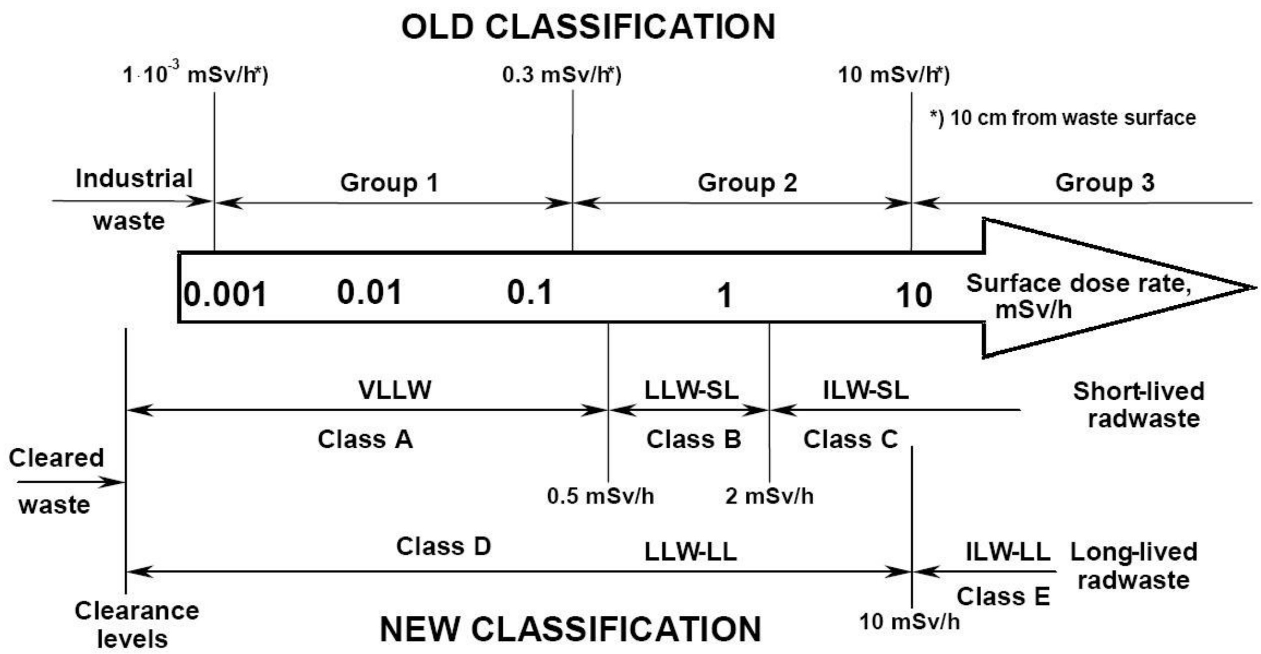


Figure 2.2 Comparison between old and new SRW classification systems if only surface dose rate is considered (spent sealed sources are not included)

Figure 2.3 Storage compartment in operation with group G1 combustible waste

Figure 2.4 Filters in group G1 combustible waste

Figure 2.5 Waste collection container with group G1 non combustible waste

Figure 2.6 Group G2 non combustible waste with graphite waste on top

Figure 2.7 Group G3 waste stored in the building 157

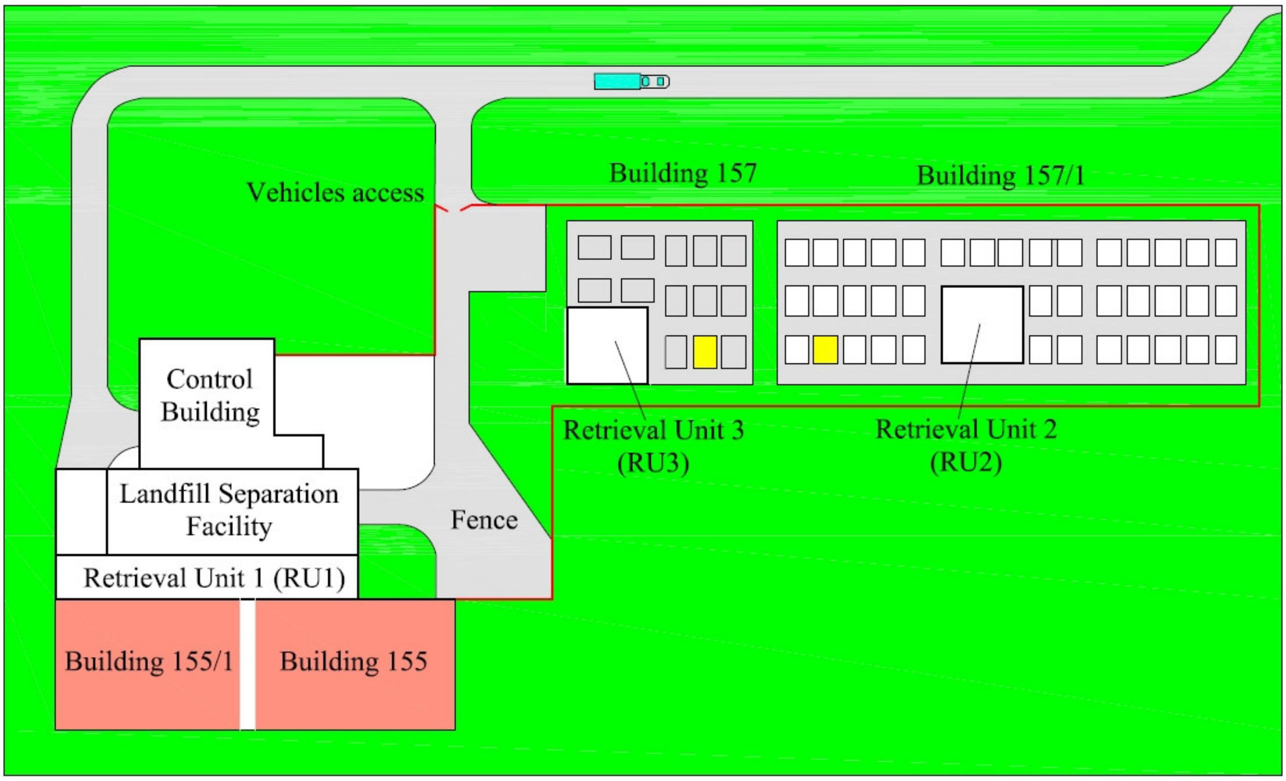


Figure 2.8 Conceptual layout of SWRF

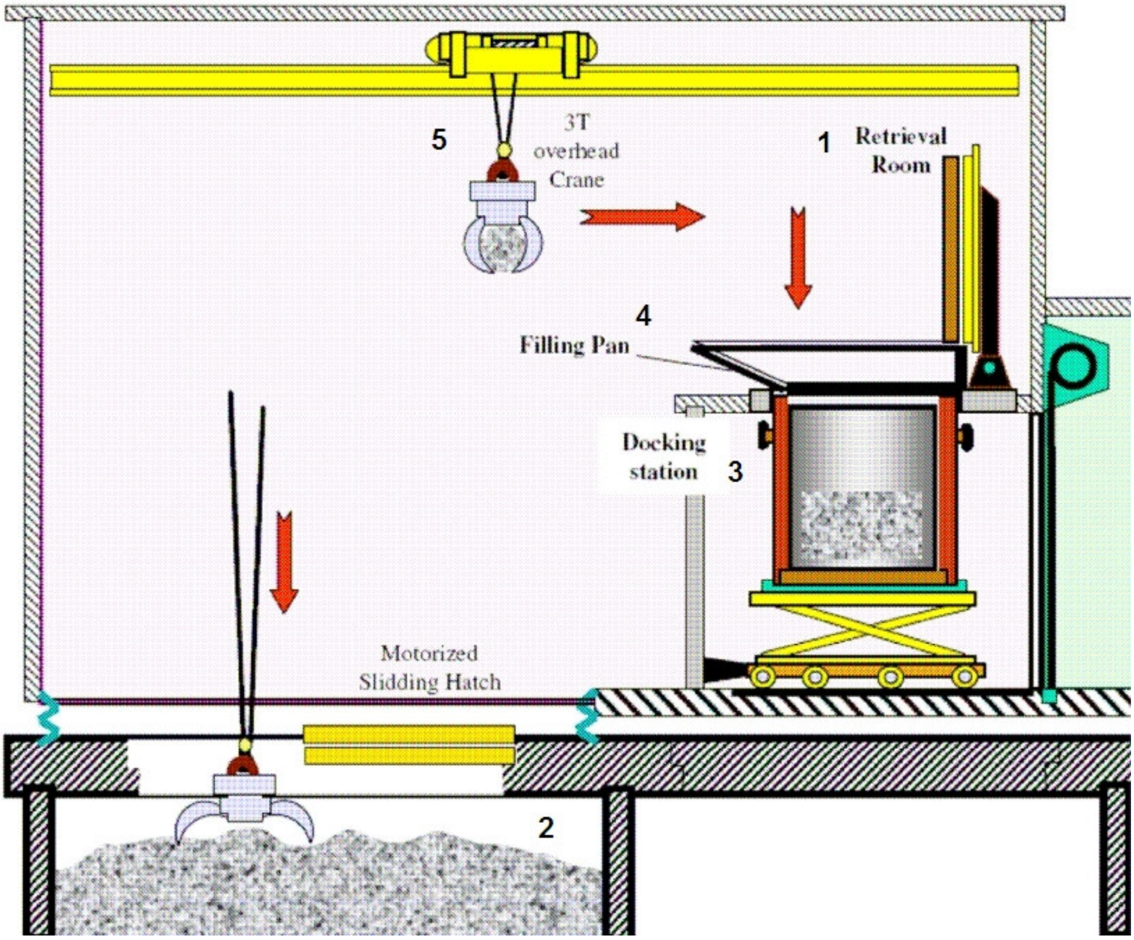


Figure 2.9 RU2, G1 and G2 waste retrieval concept. 1 – Retrieval room of RU2; 2 – Waste compartment; 3 – Container docking station with double lid system; 4 – Waste filling pan; 5 – Overhead crane with waste grab

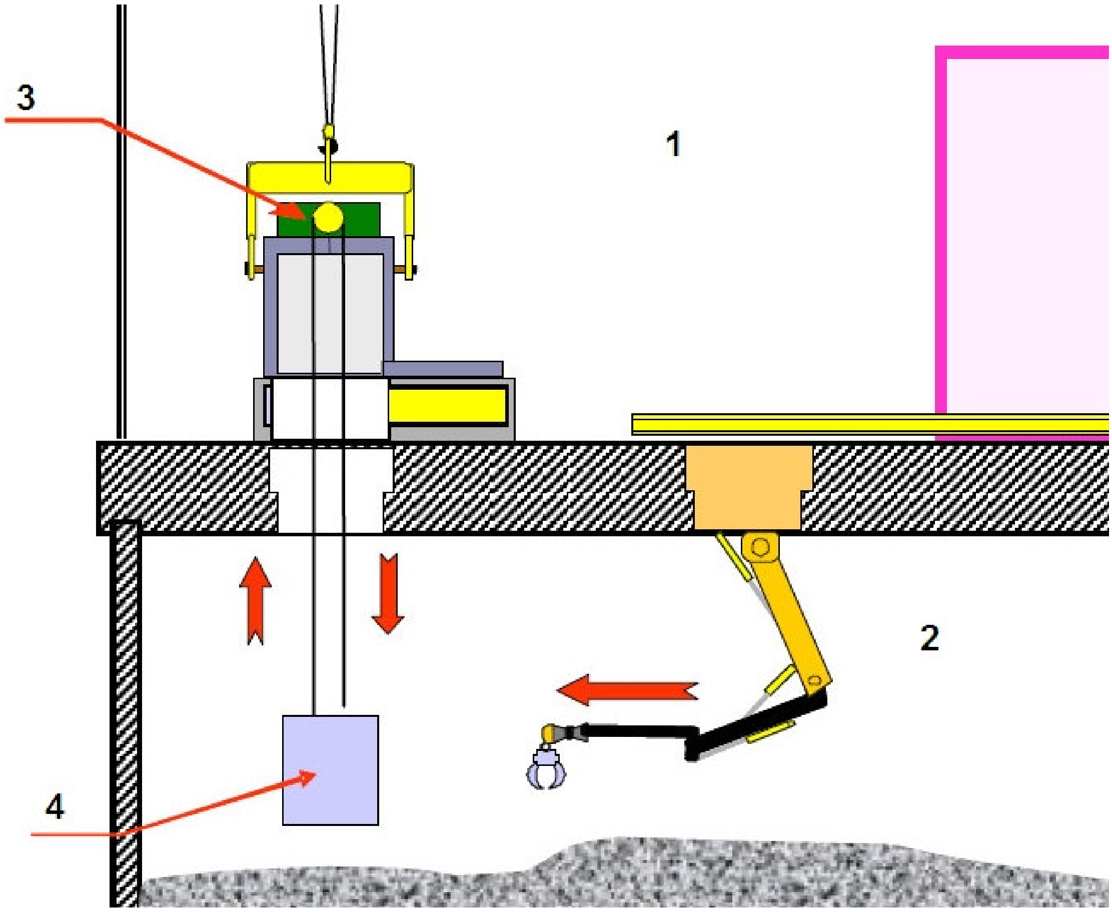


Figure 2.10 RU3, G3 waste retrieval concept. 1 – Retrieval room of RU3; 2 – G3 waste compartment with installed hydraulic waste loading device; 3 – Basket lowering, loading and lifting; 4 – G3 waste container hoist

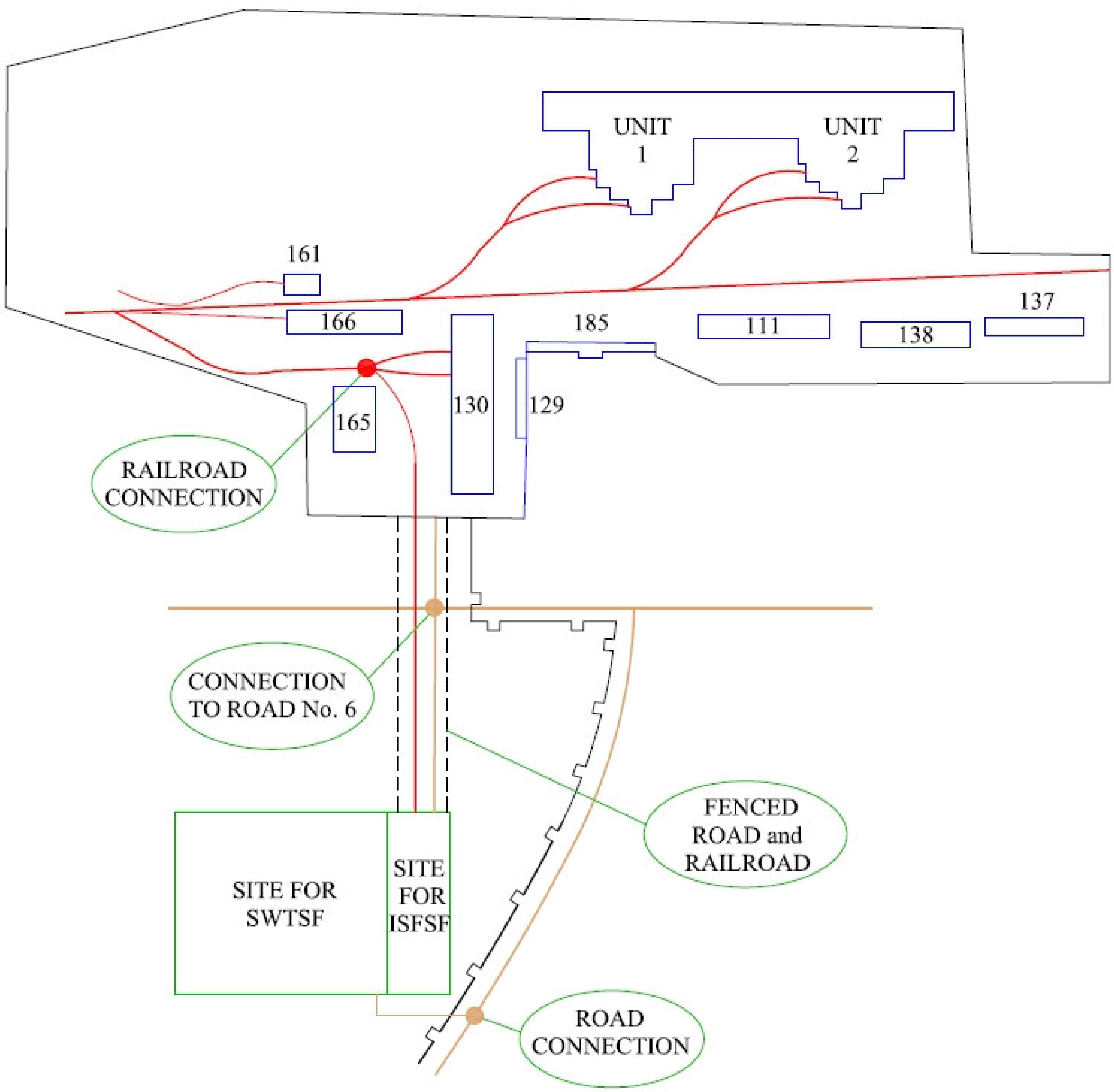


Figure 2.11 Scheme of the railroad and road connections with the existing INPP infrastructure

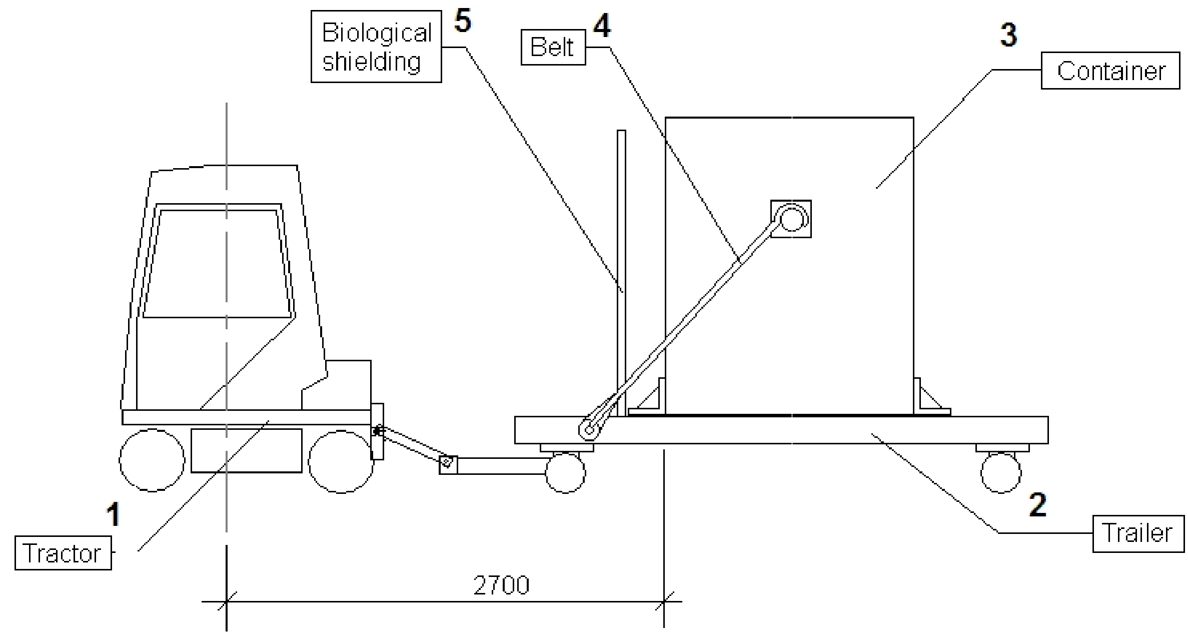


Figure 2.12 Conceptual view of waste transfer truck (tractor) with waste container on trailer

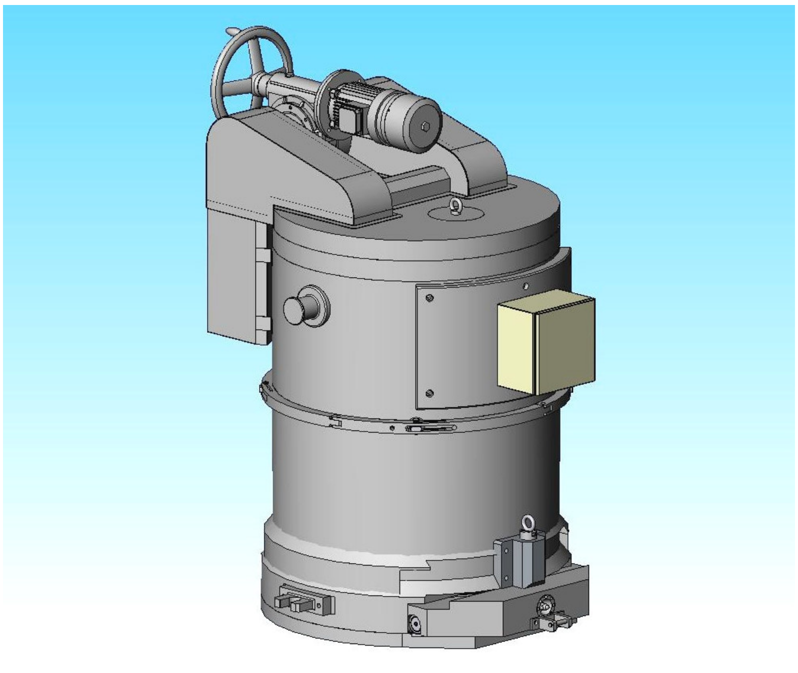


Figure 2.13 Conceptual view of G3 waste transfer container

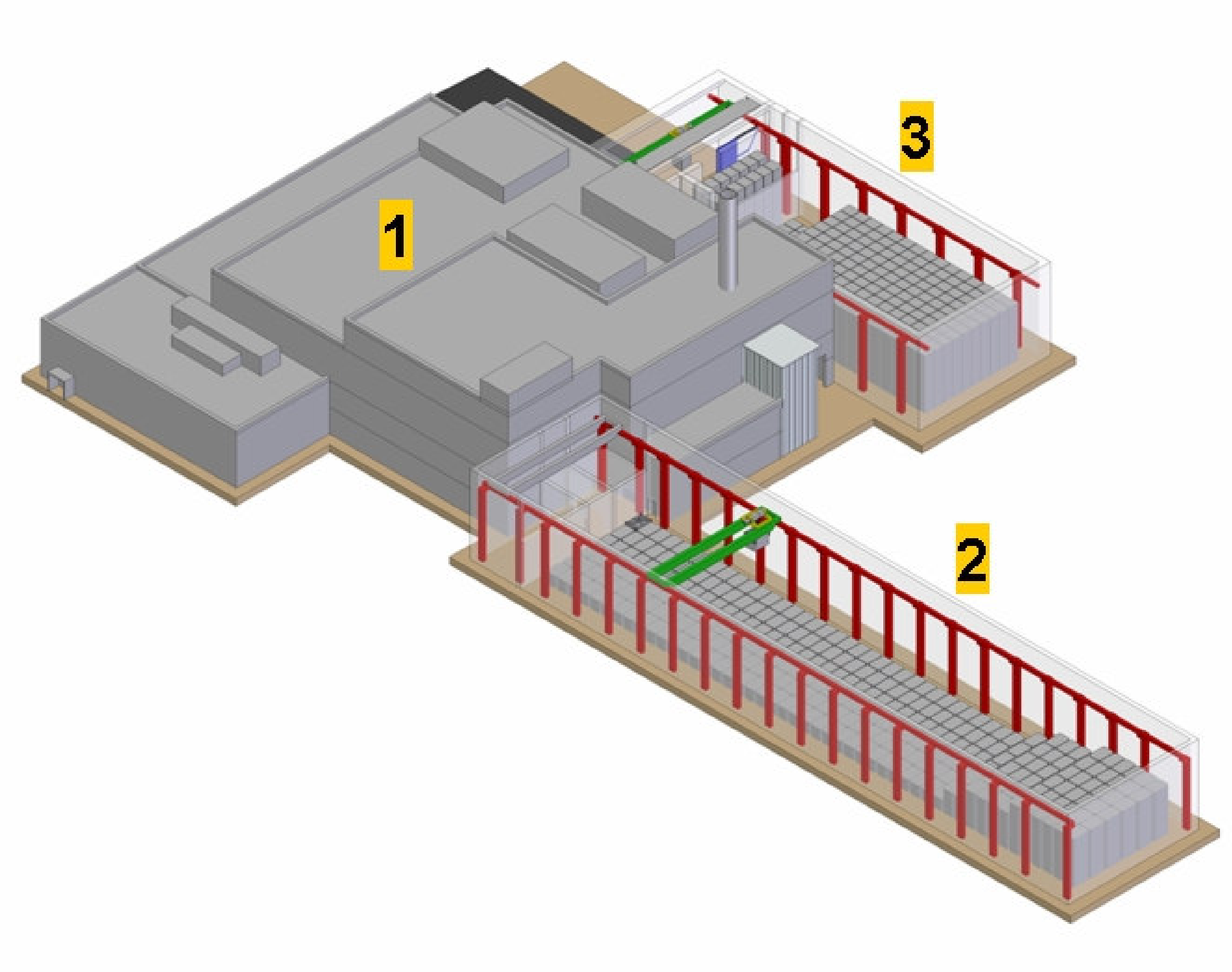


Figure 2.14 Conceptual view of SWTSF. 1 – SWTF, 2 – SWSF, SLW store; 3 – SWSF, LLW store. External walls of SWSF are shown transparent, inside stored waste containers can be seen. Extensions of SWSF are not shown

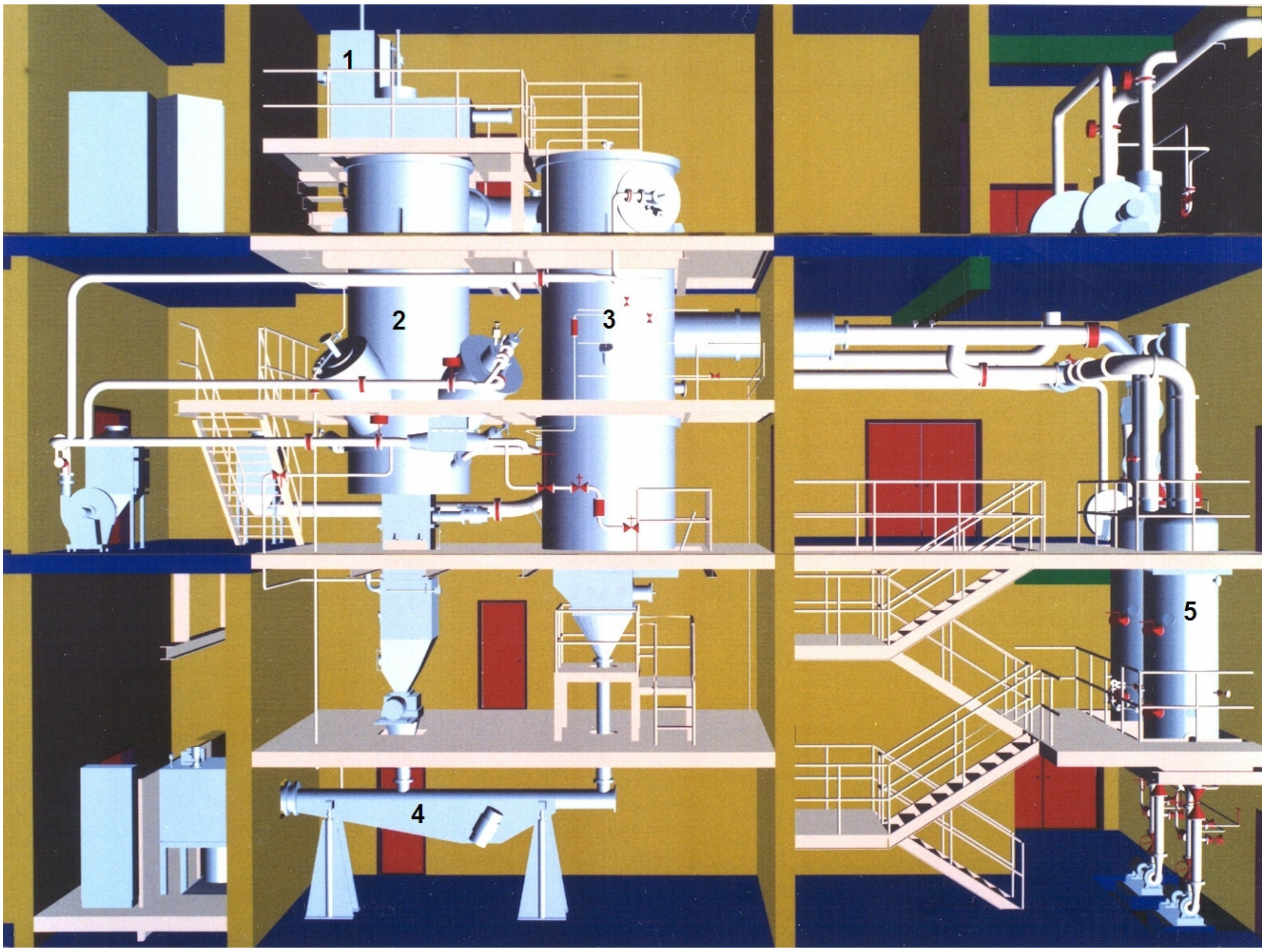


Figure 2.15 Conceptual view of incineration facility design. 1 – Waste feeding system; 2 – Incinerator; 3 – After burner; 4 – Ash discharge unit; 5 – Scrubber system

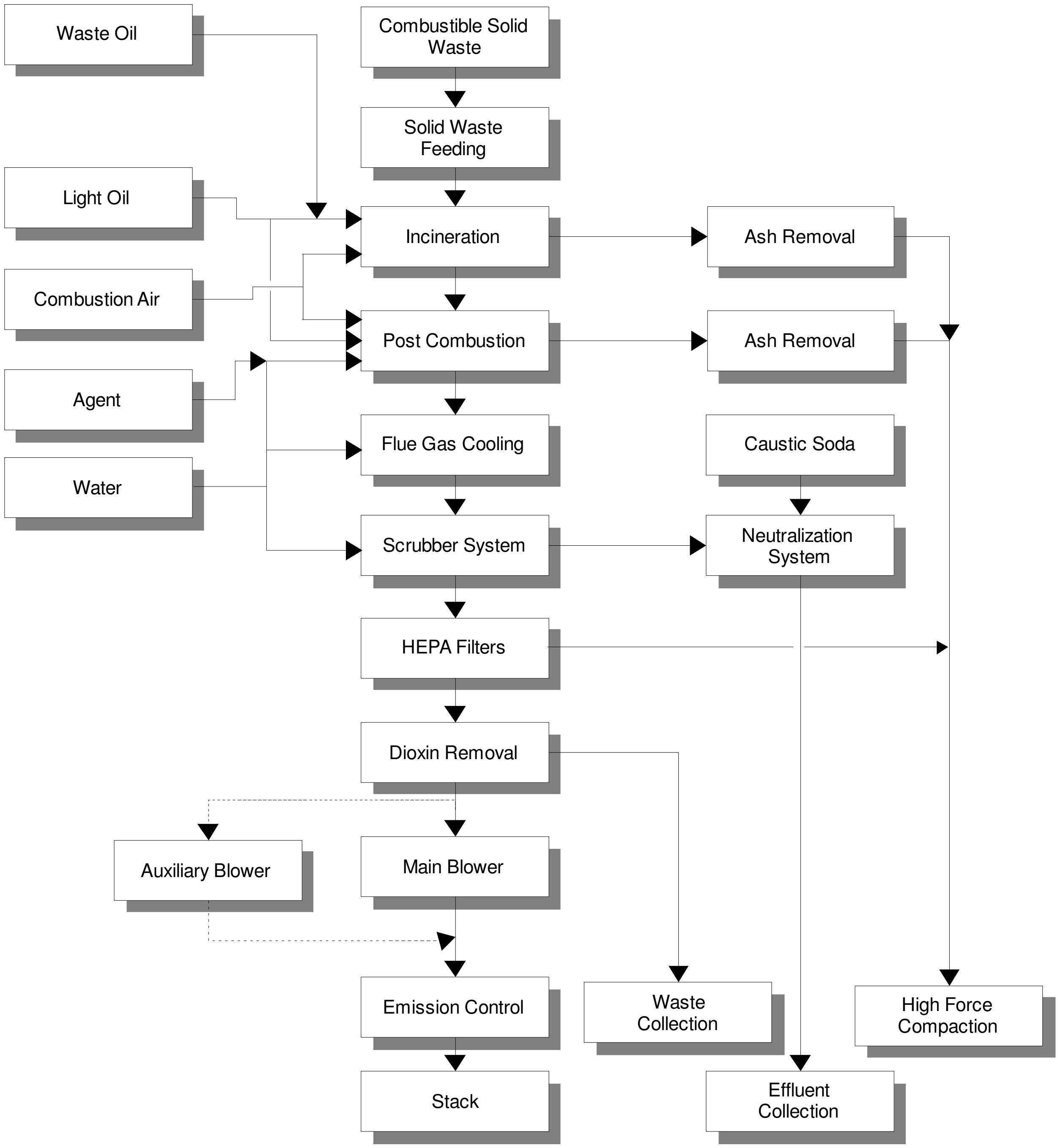


Figure 2.16 Incineration system block flow diagram

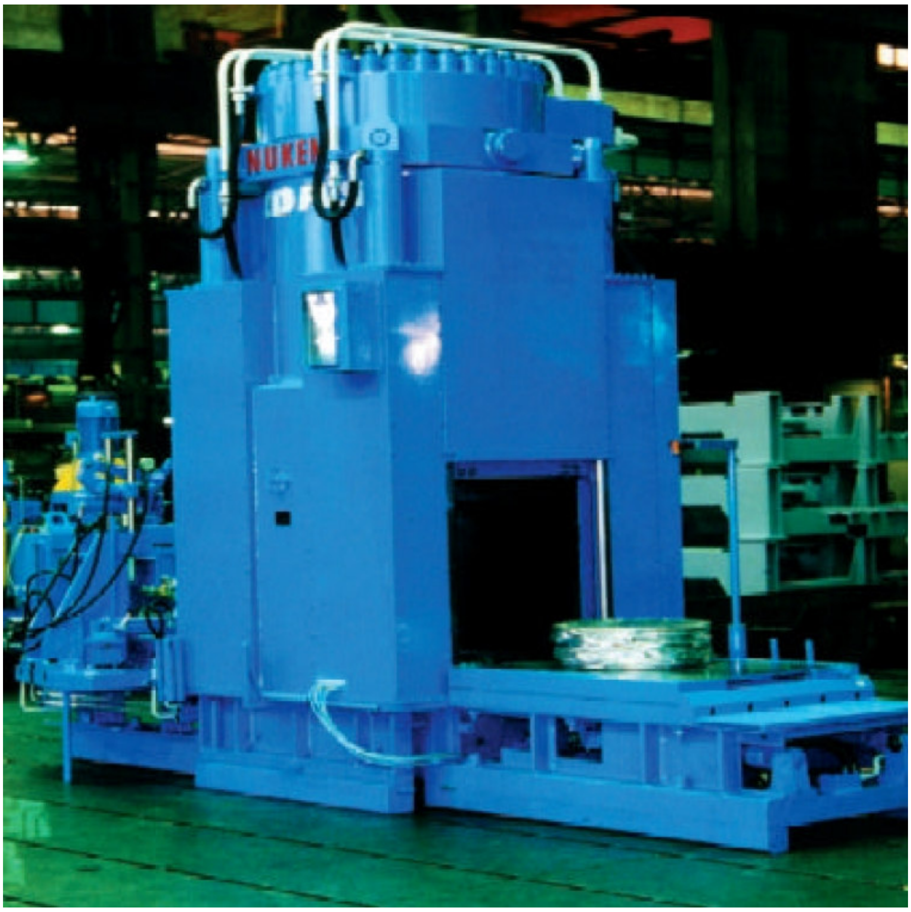


Figure 2.17 Conceptual view of NUKEM high force compactor design

Figure 2.18 Compacted waste drums (pellets)

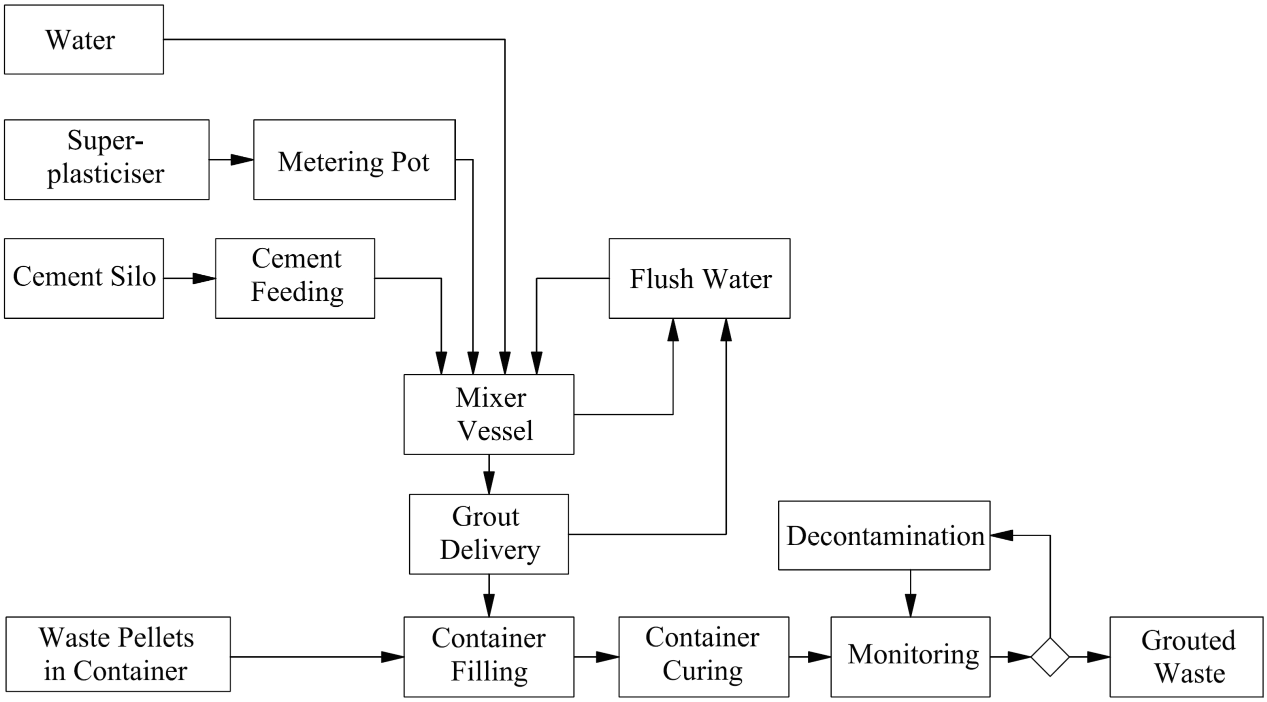


Figure 2.19 Grouting system block flow diagram

3 WASTE

3.1 Construction

At present, there are no constructions on the SWTSF site. There are no underground and over ground communications. The concrete Heliport is situated close to the site. During the SWTSF site preparation works the concrete Heliport (720 m^2) could be dismantled. The SWTSF site will be cleared off trees, roots, shrubs and construction waste.

After deforestation and trees sorting the timber will be used for INPP needs. Worthless shrubs, roots and branches will be burnt up on the site. The concrete pieces of the Heliport and other different construction waste will be transported off site for appropriate disposal.

The waste produced during construction of the SWMSF will be typical civil industry waste resulting from erection of reinforced concrete structures, mounting of equipment and organizing of working activity (i.e. construction debris, packaging material waste, personnel sanitary waste etc.). No toxic or chemically hazardous waste will be produced. The following measures to minimize construction waste generation shall be implemented: materials that can be reused will be segregated and stored separately; biological waste will be collected into metal drums or cans; paper, cardboard, wood and similar waste may used for incineration in boiler-house, if it is determined as effective pricewise.

The waste produced during construction of the SWMSF will be collected in on site holding tanks (for liquids) or containers (for solids) and will be transported off site for appropriate treatment and disposal, according to Construction Waste Management Regulations [24]. The contractor is obliged to manage all waste material from the construction site and storage areas, and to provide any remediation work required to leave these areas in a neat and clean condition.

The estimated overall production quantity of solid construction waste during the construction phase of the SWMSF is as follows (waste classification according to the requirements of Regulation on Waste Management [25] is indicated in brackets):

- Construction waste: metal structures (non-hazardous, code 17 04 02) – 4000 kg, insulation (non-hazardous, code 17 01 02) – 1000 kg, brickwork (non-hazardous, code 17 01 02) – 2000 kg, screed (non-hazardous, code 17 02 01) – 2000 kg, sand (non-hazardous, code 17 07 01) – 1000 kg, gravel (non-hazardous, code 17 05 01) – 2000 kg and other construction waste, total about 15 tons;
- Packaging material: paper and cardboard (non-hazardous, code 20 01 01) – 2000 kg, wood (non-hazardous, code 20 01 07) – 3000 kg, plastic foils (non-hazardous, code 20 01 04) – 500 kg and other packaging waste, total about 7 tons.

During the construction the personnel on the site will vary between 30 and 90 people, reaching a statistical average of 70 employees. A construction workforce of as many as 70 people could generate as much as 7 m^3 of sanitary waste water each day. Construction phase sanitary waste water will be collected in on-site holding tanks and transported off-site for appropriate treatment and disposal. No direct discharge of untreated liquid waste will be allowed.

No radioactive waste will be generated during the SWMSF construction phase.

3.2 Operation

3.2.1 Non-radioactive Waste

Solid waste generated during operation of the SWMSF will be of utility type: daily waste and similar constructional and maintenance waste. It is foreseen that likely amounts of these wastes will be small. The estimated production quantity per month of utility type solid waste during the operation of the SWMSF is as follows (waste classification according to requirements of Regulation on Waste Management [25] is indicated in brackets):

- Mixed utility type waste: personnel protection means (non hazardous, code 15 02 01) – 500 kg, paper and cardboard (non hazardous, code 15 01 01) – 2000 kg, textile (non hazardous, code 15 02 01) – 1000 kg, wood (non hazardous, code 15 01 03) – 2000 kg, plastic foils (non hazardous, code 15 01 02) – 500 kg, tins (non hazardous, code 15 01 04) – 500 kg and other similar waste, in total about 7 tons;
- Organic kitchen-stuff for compost (non hazardous, code 20 02 01) - about 10 tons.

Non-radioactive solid waste will be managed in accordance with the requirements of the waste management legislation and regulations in force [22], [25], 26], INPP instruction [27] and the new Permission on Integrated Prevention and Control of Pollution which will be granted for the SWMSF.

Household waste water will be collected from showers and toilets of supervised area. Less than 100 employees will work during the operation of the SWMSF. The estimated household waste water discharge will be about 245 m^3 per year. Household waste water will be discharged into the existing INPP household waste water drainage system from where it is pumped to the household waste water treatment plant outside of the INPP territory. The household waste water from the INPP is transferred to the state enterprise “Visagino energija” under the agreement.

Storm drainage water refers to the rain water collected from non-controlled areas, ground run-off, drainage from building roofs, and other sources with no potential radioactive contamination. Estimated storm drain water discharge is about 15 000 m^3 per year. The storm water will be derived with external down pipes at the outer perimeter of the site, collected with underground sewers and connected to the new storm water drainage system.

Management of the household waste water and storm drain water are described in chapter 4.1.4 “Waste water management”.

3.2.2 Radioactive Waste

Most of the SWMSF operations will be undertaken remotely, and the generation of secondary solid wastes will be limited. The activity of the secondary waste will generally remain low (with the possible exception for filters from the exhaust system, and any redundant tooling from the G3 sorting cell). Therefore, it is not necessary to introduce specific secondary waste handling methods and means, which depart from those used at INPP. Solid radioactive waste produced during operation of the SWMSF will be managed by the SWMSF. The Table 3.1 presents an initial assessment of the secondary solid waste generation. The existing buildings of the storage facility remaining unused after retrieval are not in the scope of the proposed economic activity. It will be considered a INPP decommissioning waste.

The liquid radioactive waste generated during the operation of the SWMSF will include:

- Drainage from existing INPP waste storage buildings;
- Decontamination effluents from existing INPP waste storage building's compartment decontamination;

- Neutralized scrubber solution from the flue gas treatment of the incineration facility;
- Decontamination effluent from treatment areas, container washing and decontamination;
- Personnel decontamination (showers) water;
- Area cleaning / floor washing effluent;
- Liquid released during compaction operation at the bale press and the high force compactor.

All liquid radioactive waste arising from the operation of the SWMSF will be collected in liquid waste collection tanks and then will be transferred to the existing INPP Liquid radioactive waste treatment facility (LWTF), cf. chapter 2.3.2. The LWTF is designed for storage and treatment of all liquid radioactive waste produced during the operation of INPP. The facility is planned to operate till 2022 with possibility (reconstruction would be necessary) to prolong its operation for approximately 10 years. The Table 3.2 presents an initial assessment of liquid waste generation.

In the liquid waste the highest radioactive content is expected in the scrubber solution. This liquid is used to wash radioactive particles out of the flue gas coming from incineration and afterburner. In the worst case only G2 group waste would be incinerated. This will lead to a Co-60 activity of about 5.4×10^5 Bq/kg and to a Cs-137 activity of about 8×10^3 Bq/kg for the scrubber solution. Without any special calculations the nuclide vector of this liquid can be assumed to be identical to the nuclide vector of the ash. This one is directly derived from the nuclide vector of combustible waste, c.f. Table 2.7. The activity content of scrubber solution is summarized in Table 3.3.

3.3 Decommissioning Options

3.3.1 General

The SWRF can be decommissioned when all waste stored inside the storage buildings have been retrieved and the storage cells have been decommissioned, and when the operation of the two units of the Ignalina NPP has been completed (only decommissioning waste will be produced which will be sent either directly to the Landfill repository or to the SWTF). The solid waste resulting from those decommissioning activities can further be treated in the SWTF in the same way as its previous retrieved waste inventory, with following interim storage of the conditioned waste inside the SWSF.

The SWTF will be used, beyond its use for the treatment of retrieved waste from the SWRF and the INPP operational waste, for the treatment of the decommissioning waste from the INPP, and therefore will be decommissioned only when all solid waste resulting from the decommissioning activities has been finally treated and temporarily stored inside the SWSF.

The SWSF will be decommissioned when all radioactive waste stored inside the Storage Facility is transferred to final disposal or to other long time storage facilities. As all waste stored inside the SWSF is packaged inside the storage containers with contamination free external surfaces it can be assumed that only small amounts of radioactive waste will result from this decommissioning activities.

3.3.2 Outline Decommissioning Plan

3.3.2.1 Licensing Framework

During the design phase NUKEM will develop a Decommissioning Plan as part of the Preliminary Safety Analysis Report (PSAR). This Plan, which will be provided to the Employer for approval, and which will be an essential part of the Employer's application for the SWMSF Construction License.

The Decommissioning Plan will be updated by NUKEM for the Final Safety Analysis Report (FSAR) submission which will be part of the Employers SWMSF Operating License application.

A detailed decommissioning program will be required before the start of decommissioning activities.

3.3.2.2 Overall Decommissioning Plan

The main objectives of the Decommissioning Plan are to identify the decommissioning principles as well as the proposed approach to decommissioning. This will be developed in the Decommissioning Plan itself as part of PSAR and FSAR.

Details of the decommissioning process, such as decommissioning management structure, work breakdown structure, detailed decommissioning program, etc., will not be included in the Decommissioning Plan.

Operating experience and its impact on decommissioning activities will be a further and particularly important element to be taken into account in the development of the detailed decommissioning program.

The key principles for the decommissioning are:

- To ensure low risk to workers and the environment;
- To minimize waste generation throughout decommissioning;
- To keep costs as low as achievable.

These principles will be taken into account in the Facility design, for example, to facilitate easy decontamination of structures and equipment and simplify the removal of radioactive waste and contaminated equipment when the SWMSF is finally decommissioned.

3.3.2.3 Procedures and Methods

When waste processing has ceased, all inventories that will not be used in decommissioning will be removed from the facility. Process piping and vessels will be emptied and flushed with appropriate decontamination solutions until radioactivity is reduced to such level where further flushing is not justifiable. Sorting cells may also be washed down using an appropriate decontamination solution. With appropriate planning, waste solutions generated may be largely processed through the existing process facilities including solidification.

3.3.2.3.1 Deactivation

All equipment not needed for decommissioning or for safety purposes will be shut down. Systems such as ventilation, heating and monitoring instrumentation may be maintained during decommissioning. All unnecessary electrical systems may be deactivated. Non-contaminated materials and equipment, including materials that may be recycled, may then be stripped out of the building.

3.3.2.3.2 Decontamination

Any equipment that would cause excessive radiation exposure to the personnel will be decontaminated and removed early (for special decontamination if necessary) to reduce risk. The sorting cell areas may be expected to be the most contaminated areas. Cleaning may, for example, take the form of a remote jet spray for cell interiors and equipment.

The decontamination and dismantling steps need to be coordinated to keep the required facilities operable for processing the waste materials from decommissioning operations.

The decontamination of the retrieval equipment prior to re-use for another silo is part of the routine operation for silo emptying purposes. The final decontamination of the equipment will be a repeat of previous decontamination operations.

Additional specialized decontamination may be justified, for example, to decontaminate equipment to the levels that allow it to be recycled or released for refurbishment and further unrestricted use.

The final decontamination of the process areas begins with ceilings and walls, and ends with floors. Only proved techniques shall be used for decontamination, for instance steel shot blasting technology. In this technique, steel shot is blasted against the contaminated surface. The steel particles and eroded contaminated material are continuously extracted by a vacuum system. The steel is separated and the eroded material collected in drums for disposal as radioactive waste. Cell floors and walls may require removal of some concrete to eliminate all radioactivity.

3.3.2.3.3 Dismantling

Dismantling or demolition is essentially the reverse of Facility construction. Decontaminated equipment will be dismantled and removed from the Facility. In the event of any equipment remaining at high levels of radiation, dismantling may be performed using remote controlled systems thus protecting personnel from dose uptake. Due to the earlier decontamination steps described above, this is not expected to be necessary.

After all internal equipment is dismantled, the facility building structure may be dismantled. The characterization of concrete structures by core sampling will reveal whether the concrete is suitable for unrestricted disposal. The concrete can then be broken into pieces and disposed as landfill waste.

Dismantled material is characterized and evaluated to determine the benefit of additional decontamination to reduce waste volumes and disposal costs. Size reduction can be used to minimize waste volume and optimize the size and type of waste containers used.

3.3.2.3.4 Site Closure

The soil and rock excavated for the foundations will remain on the site and be contoured and seeded to prevent any significant surface water runoff. Following facility demolition, this material may be redistributed as backfill to return the site to its original contours.

The final condition of the decommissioned SWTSF site must be characterized and documented.

3.3.2.3.5 Radiation Protection

The key concepts to be included in the Decommissioning Plan are:

- As Low As Reasonably Achievable (ALARA);
- Administrative matters, including radiological control organization and respective records management;
- Self-assessments and internal audits;
- Monitoring of individuals and medical surveillance;
- Workplace monitoring;
- Works controls e.g. entry and exit controls for radiation areas, work permits;
- Training.

3.3.2.3.6 Radioactive Waste Production

Waste minimization is an important issue to reduce the decommissioning costs due to the cost of disposal. Therefore, waste minimization has to be considered in the decommissioning planning. Examples of waste minimization measures are:

- Volume reduction of liquid decontamination waste streams;
- Decontamination of vessels and structures to allow unrestricted disposal or re-use;
- Segregation of radioactive material and eroded material in the case of jet-blasting.

The following assumptions have been made to estimate the waste volumes arising from the decommissioning of the SWMSF:

- The design of the SWTF and the operating procedures will result in all significant contamination being contained in the cell interiors;
- The equipment outside the cells will remain uncontaminated or can easily be decontaminated for unrestricted re-use or disposal;
- 50% of metal wastes are decontaminated to allow unrestricted re-use.

The Table 3.4 presents the initial assessment of waste generated by decommissioning of the SWMSF.

3.4 Tables and Drawings of the Chapter "Waste"

The following Tables are attached to the Chapter "Waste":

Table 3.1 Secondary solid radioactive waste generation *);

Table 3.2 Liquid radioactive waste generation *);

Table 3.3 Specific activities of radionuclides in scrubber solution (assuming that only most active G2 group waste is incinerated);

Table 3.4 Decommissioning waste generation.

*Table 3.1 Secondary solid radioactive waste generation *)*

Waste category	Description	Waste amounts per year (m^3/y) and disposal route		
		Landfill repository	Near surface repository	Long-lived waste storage
VLLW, class A	Meets Landfill repository WAC	100		
LLW-SL, class B	Low-level waste		20	
ILW-SL, class C	Filters from the extract system		2	
LLW-LL, class D	Redundant tooling from the G3 sorting cell			1
Total		**100**	**22**	**1**

*) Preliminary estimation, data will be better estimated during the design phase

*Table 3.2 Liquid radioactive waste generation *)*

Waste description	Waste amounts per year (m^3/y) and generation place	
	SWRF	SWTF
Drainage from existing INPP waste storage buildings	50	
Decontamination effluents from existing INPP waste storage building's compartment decontamination	100	
Personnel decontamination (showers water)	45	200
Area cleaning / floor washing effluent	5	10
Decontamination effluent from treatment areas, container washing and decontamination		60
Neutralized scrubber solution from the flue gas treatment of the incineration facility		20
Liquid released during high force compaction		10
Total	**200**	**300**

*) Preliminary estimation, data will be better estimated during the design phase

Table 3.3 Specific activities of radionuclides in scrubber solution (assuming that only most active G2 group waste is incinerated)

Waste type	Scrubber solution
Waste density, kg/m^3	1100
Radionuclide	**Specific activity, Bq/kg**
C-14	2.52E+03
Mn-54	9.11E+05
Fe-55	2.52E+06
Co-58	7.51E+05
Co-60	5.36E+05
Ni-59	5.36E+02
Ni-63	1.29E+05
Nb-94	1.02E+03
Sr-90	4.77E+01
Tc-99	3.18E+00
I-129	2.86E-02
Cs-134	1.11E+04
Cs-137	7.95E+03
U-235	2.15E-06
U-238	6.36E-05
Pu-238	1.35E-01
Pu-239	3.50E-02
Pu-240	8.75E-02
Pu-241	1.27E+01
Am-241	1.91E-01
Cm-244	3.74E-02
Total	**4.87E+06**
Total alpha *)	0.5

*) Radionuclides U-235, U-238, Pu-238, Pu-239, Pu-240, Am-241 and Cm-244.

Table 3.4 Decommissioning waste generation

Waste source	Original material, m^3	LLW-SL, m^3	Landfill repository or re-use, m^3
Waste treatment controlled areas	6900	340	6560
Waste treatment uncontrolled areas	1875	-	1875
Storage for LILW-LL	3700	170	3530
Storage for LILW-SL	2280	120	2160
Waste retrieval	630	80	550

4 POTENTIAL IMPACTS OF THE PROPOSED ECONOMIC ACTIVITY ON THE COMPONENTS OF THE ENVIRONMENT AND IMPACT MITIGATION MEASURES

This chapter of EIA addresses the potential impacts on the components of the environment which could be expected during normal operation of the proposed economical activity. Emergency situations are investigated in chapter 8 “Risk Analysis and Assessment”.

4.1 Water

4.1.1 Overview of Hydrological Conditions

The INPP site is located on the southern shoreline of Lake Druksiai. The distance from the existing INPP solid radioactive waste storage buildings to the lake is about 600 m. The distance from the SWTSF site to the lake is about 1600 m. The existing and planned facilities are in the lake catchment (inflow) area.

Lake Druksiai serves as the INPP cooling water source. The waste water (if it meets established quality requirements) and storm drainage water from the plant are released into the lake.

Lake Druksiai is the largest lake in Lithuania. The total volume of water is about 369×10^6 m^3 for normal affluent levels (water level altitude of 141.6 m). The total area of the lake, including nine islands, is nowadays about 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 is 5.3 km, and the perimeter is 60.5 km [30], [31], [32].

The water regime of Lake Druksiai is formed by a combination of natural and anthropogenic factors.

The main natural factors are surface inflow (73%) and outflow (77%). Due to the large surface area precipitation (24%) and lake surface evaporation (23%) are also significant. The inflow of shallow and semi-confined groundwater is insignificant (less than 3%). Outflow to the deeper laying water horizons is considered to be very low due to the permeability properties of bed sediments and deposits [30].

The anthropogenic factors affecting the water regime are the control of the outflow by the hydro-engineering complex and water circulation in the lake of the water used for power plant cooling. The hydro-engineering complex (dam) was constructed in 1953 on the River Prorva before the entrance to Lake Abaliai. This has raised the water level in Lake Druksiai by 0.3 m to the present level of 141.6 m.

According to long-term observations (1953-1984) the natural water level fluctuation in Lake Druksiai is 0.8 m. The highest recorded water level was 142.35 m and the lowest was 140.85 m [30], [33]. According to the Ignalina NPP Unit 2 Safety Analysis study [34] the probability of Lake Druksiai water level rising higher than 143.5 m is below 2.1×10^{-8} per year. The altitude of the existing waste storage facility site is at the level of about 150 m. The altitude of the SWTSF site (not smoothed) varies from 153 to 159 m. The flooding of the SWRF or SWTSF sites due to water rise in Lake Druksiai is not probable.

The INPP region is drained into watersheds of the rivers Nemunas (Sventoji) and Daugava. The Sventoji watershed is represented by the laky upper course until the Antaliepte water reservoir. The small territory in the northeastern 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), c.f. Table 4.1.

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 1 river that outflows it (the Prorva). The main rivers which flow in 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).

The catchment basin of Lake Druksiai, cf. Figure 4.1, is small, only 564 km^2. The greatest length of the catchments basin (from south-west to north-east) is 40 km; maximum width is 30 km, 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 [33]. The outflow from Lake Druksiai reaches the Gulf of Riga of the Baltic Sea through a long and complex pathway of approximately 550 km length.

The INPP region is predominated by clay, loamy and sandy loam soils, which determine variation of water filtration conditions in different parts of the region. The percentage of the forestland in the region is also widely varying and is highest in the basin of Lake Druksiai. 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 total evaporation from the surface is about 500 mm. The groundwater drainage is 2–3 l/s/km^2. The average annual runoff is 6.5–7.0 l/s/km^2. The average spring runoff (March–May) is 120 mm. The average runoff of a dry season (June–February) is 100–140 mm. The minimal runoff of a warm season is 2 l/s/km^2; and of a cold season – 3 l/s/km^2 [33].

4.1.2 Overview of Hydrogeological Conditions

4.1.2.1 Aquifers and their Interconnections

The areas of the INPP and the SWTSF are located in the recharge area of the eastern part of the Baltic artesian basin. The hydrogeological cross-section data indicates presence of hydrodynamical zones of the active, slower and slow water exchange. Active water exchange zone is separated from the slower water exchange zone by 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 [35].

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 [35].

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 [35].

The aquifers in the intertill deposits are composed of sand, gravel, and in some paleovalleys – cobble and pebble deposits. The thicknesses of different aquifers vary from 0.3–2 m to 20–40 m, and in paleovalleys – 100 m and higher [35].

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 [35].

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. The water of the Sventoji–Upninkai aquifer system is used for the water supply for Visaginas town and INPP. The Visaginas town waterworks are located in about 2.5 km to the southwest from the SWTSF site.

According to the field investigations performed in 1978 cf. [36] and later in 1981 – 1982 cf. [37], [38] the shallow unconfined groundwater aquifer at the industrial INPP site was found mainly at the depths 1.0–4.0 m below the soil surface. Locally the aquifer 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.

The latest geotechnical investigations [39] in the SWRF site provide additional information on local groundwater characteristics. Groundwater was found at the depths 0.8–14 m below the soil surface. The water can be considered as non-aggressive to concrete and low aggressive to metal constructions.

The similar hydrological characteristics are identified in the SWTSF site [40], [41], [42].

The shallow groundwater was found locally in the descent areas in the mound, wetlands and till sediments. The shallow groundwater in the borings has settled at the depth of 0.3–4.5 m and in some cases it provides barely higher pressure than atmospheric.

The first confined intertill aquifer is located in fluvioglacial sediments. Below the uplifted parts of the site, the groundwater is partially drained away. Below the descent areas, the water is confined (the hydraulic pressure head is 0.7–4.2 m). The aquifer contains lenses and interlayers of 1.1–7.2 m thick consisting of water resistant sediments, which are fissured outside the site and therefore can be considered as a local aquitards. The regional aquitard consists of till sediments. Hydraulic conductivity of water bearing sediments is 0.8–63.5 m/d.

The recharge of shallow groundwater is from atmospheric precipitation while there could be a very low infiltration from the lake Druksiai when the Visaginas town waterworks are operated in intensive mode. The recharge of the confined intertill aquifer comes from several sources. Groundwater is calcium bicarbonate and can be considered as medium aggressive to concrete.

The shallow groundwater from the site is drained by the water pool located in the north of site, cf. Figure 4.12. The first confined intertill aquifer is mostly drained by Lake Druksiai.

The current radiological situation is described in chapter 7.3.

4.1.2.2 Quality of Groundwater

The Sventoji–Upninkai aquifer system D_{3+2}sv-up rich in groundwater is exploited by the waterworks of Visaginas town. The quality of the groundwater of the exploited aquifer system is good not only in the waterworks but also in the entire region, and only minimal changes are made in the waterworks [51].

4.1.3 Water Demand

The planned water demand is given in chapter 1.6 “Demand for Resources and Materials”.

Water supply to the SWRF and the SWTSF will be organized by connecting to the existing water supply system of INPP. The planned water demand is to be managed by the existing equipment and technologies of INPP.

4.1.4 Waste Water Management

The management of all liquid radioactive waste arising from the operation of the SWMSF is described in chapter 3.2.2 “Radioactive Waste”.

Only the non-radioactive liquid waste can be released to the household waste water sewerage. Furthermore, the chemical evaluation shall confirm that it meets the requirements [28].

The household waste water of the SWMSF will be discharged into the INPP existing sanitary-household waste water system from where it is transferred into the State Enterprise “Visagino Energija” waste water treatment plant. The SWMSF household waste water system shall follow the requirements of the normative document [28]. According to clause 6 of [28], the discharge of sewage water into the environment may be performed only through a discharger for installation of which a permission for construction is issued or a construction works project is coordinated by the order established in regulations, and only then when the order is established, the conditions for the sewerage water discharge are approved (the condition are established in the approved construction works project (according to which the permission for construction is issued) or in the permission for sewage water discharge).

Surface water will consist of the precipitation and irrigation water collected from supervised areas of SWTSF, water from drainage systems of building roofs and other sources, not contaminated by radionuclides. New SWTSF surface water drainage system will be connected to the INPP existing underground storm drain and sewage water system. Radionuclides concentration in the storm drain water and in the groundwater of new observation boreholes, which will be installed around the SWTSF and ISFSF sites (see chapter 7.4.5 “Groundwater Monitoring”), as well as the chemical content of storm drain water and groundwater will be monitored. The INPP environmental monitoring program will be updated before obtaining Permission on Integrated Prevention and Control of Pollution for the SWMSF. The SWTSF surface water drainage system shall follow the requirements of the normative document [29].

4.1.5 Potential Impact

There will be no uncontrolled releases into the environment from the SWRF and SWTSF sites under normal operation conditions. The SWMSF structures (bottom slabs) will be adequately designed to isolate technological systems and components from any potential interaction with an environment water component. Flooding by water rise in Lake Druksiai is not expected. Flooding of the facilities by surface water will be prevented by the construction and maintenance of the site storm water drainage system.

There will be no uncontrolled waste water release from the SWMSF. Prior to release waste water will be collected and the necessary parameters will be measured. The waste water will be released into the INPP existing waste water system in a controlled manner from where waste water is transferred into the centralized waste water system of State Enterprise “Visagino Energija”.

The waterworks for the supply of Visaginas town are in a distance of about 2.5 km to the southwest from the SWTSF / ISFSF sites cf. Figure 1.2. The SWRF site consequently is more distant.

In the site evaluation for nuclear power plants and activities in the field of nuclear energy a detailed investigation of the hydrosphere in the region should be carried out. The IAEA Safety Guide No NS-G-3.2 [49] recommends assessing the potential impact on the drinking water sources in the vicinity. For this purpose the study [51] was prepared by request of INPP, aiming to identify the compatibility of the sanitary protection zone (SPZ – defined protected area around the waterworks, where economic activity is limited [50]) of the waterworks of Visaginas town with the ISFSF and the SWTSF. The results of detailed investigations and modeling carried out by the Joint-Stock Company “Vilniaus hidrologija” [51] have shown that the ISFSF and the SWTSF sites are outside the SPZ of the waterworks of Visaginas town (in the case where the yield of the waterworks does not exceed the approved amount of groundwater exploitation resources which is 31 000 m^3 per day).

The study for justification of the groundwater monitoring structure for the ISFSF and SWTSF site [52] includes an additional assessment of hypothetic contamination propagation by the water path, where possible directions of contamination spread and contamination migration velocities have been evaluated. An extremely conservative approach has been used in the model. It is assumed that the contaminant concentration is present in the entire volume of the ground water layer below the ISFSF / SWTSF site area, and that this situation remains during the time frame considered by the calculations (i.e. 150 years). In the remaining part of the ground water aquifer, and also in aquifers stratified below, the initial relative value of contaminant concentration in the model is set to be zero. During the migration calculations, sorption and decay processes reducing the concentration of contamination have not been considered, i.e. only advection processes have been taken into account. The maximal yield of waterworks was assumed, i.e. 31 000 m^3 per day.

The modeling results show that the flow of fresh groundwater within the aquifers stratified below the ISFSF / SWTSF site significantly dilutes the migrating contamination. During the considered period at the most 40–45% to the Medininkai-Zemaitija aquifer, 3–4 %, to the Zemaitija-Dainava and 0.15–0.2 % to Sventoji-Upininkai aquifer complex of the initial contaminant concentration could be observed. Only one hundredth of one percent of the contamination could actually reach the aquifer of the waterworks. Thus, the results of conservatively performed modeling of hypothetic contamination migration show that ISFSF and SWTSF, as local and relatively small objects (in comparison to the waterworks catchment area) can not substantially affect the quality of groundwater of the Visaginas town waterworks.

No release of activity into the water component of the environment from the proposed economical activity under normal operation conditions is planned. All liquid radioactive waste generated during the operation of the SWMSF will be collected and transferred into the existing liquid radioactive waste treatment facility, cf. chapters 2.3.1 and 2.3.2. The technological systems and their separate components used for the collection and storage of potentially radioactive liquids will be designed to isolate the liquids from the environment.

The radiological impact on the “water” component of the environment from the proposed economical activity under normal operation conditions therefore is not expected. Accidental situations potentially resulting in the release of radioactive material into the water component of the environment are addressed in chapter 8.

4.1.6 Impact Mitigation Measures

The INPP radioactive waste storage facility and the planned SWRF site are surrounded by the existing network of ground water monitoring boreholes. A new net of monitoring boreholes will be established in the SWTSF site. The ground water level and parameters will be monitored in accordance with the regulatory approved monitoring program. Emergency activity release, if any, will be detected and appropriate mitigation measures can be taken.

The description of the existing and planned ground water and storm drain water monitoring systems is provided in chapter 7 “Monitoring”.

Minor short-term lowering of the groundwater table may occur in the vicinity of the SWTSF site during dewatering of foundation excavations. The water from dewatering activities could contain suspended solids. Measures will be taken to remove settleable solids prior to discharging water from the site, including the use of sediment sumps or other sediment control structures. The limited drawdown from a dewatering activity is not expected to have a significant impact.

Accidental spills of combustive-lubricating materials, paints or other materials during the construction phase could contaminate coastal or inland waters. A written emergency response plan will be prepared and retained on the site, and the workers will be trained to follow specific procedures in the event of an accidental spill.

4.1.7 Tables and Drawings of the Chapter "Water"

The following table is attached to the chapter "Water":

Table 4.1 The main river watersheds of the Ignalina NPP region.

The following scheme is attached to the chapter "Water":

Figure 4.1 Scheme of Lake Druksiai catchment basin.

Table 4.1 The main river watersheds of the Ignalina NPP region

River	Main watershed	The length of river till the Ignalina NPP region, km	The distance from the mouth, km	Watershed area, km²	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

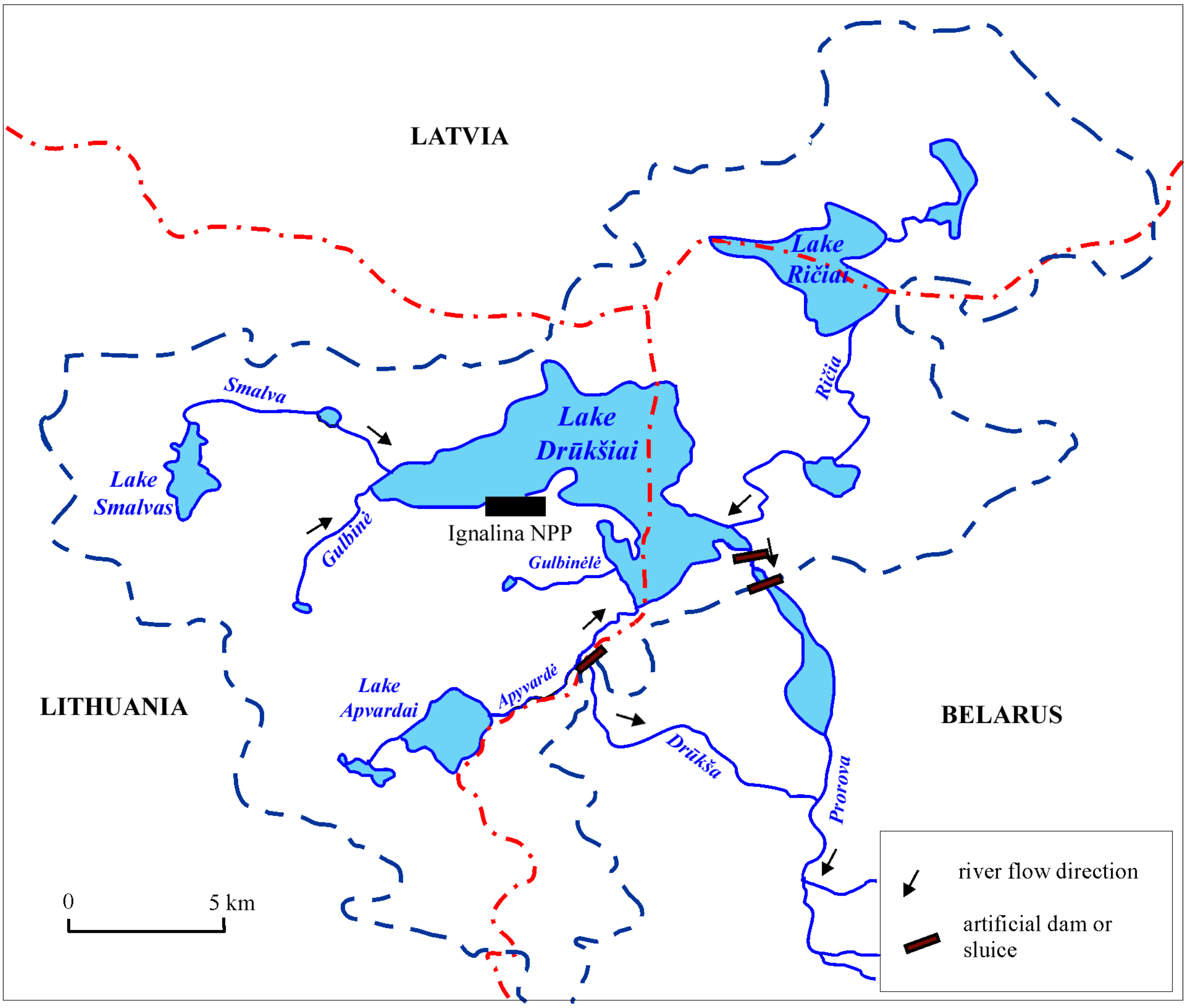


Figure 4.1 Scheme of Lake Druksiai catchment basin

4.2 Environmental Air (Atmosphere)

4.2.1 Overview of Atmosphere

The Lithuanian climate depends mainly on the circulation of air masses from the Atlantic and air masses from the continental parts of Europe and Asia. The influence of Lithuanian territory on the formation of new air masses or on significant transformation of existing ones is negligible. On a global scale the Lithuanian climate can be considered as homogeneous, cf. [53].

On a regional scale climatic conditions depend on the region proximity to the Baltic Sea because of the prevalent intrusion of air flows from the adjacent geographical zones. The eastern regions of Lithuania (i.e. INPP region) as compared to the western parts are marked by a larger variation of the temperature over the year, colder and longer winters with abundant snow cover and warmer but shorter summers, cf. [53].

The configurations of the relief and the diversity of underlying surfaces also influence local climatic conditions, cf. [53], [30].

The main meteorological parameters representing Lithuanian climate in the second half of the 20th century (averaged values for observation period 1961-1990) are presented in Table 4.2, cf. [54].

The meteorological characteristics of Ignalina region, as given by Utena Regional Department of Environment Protection in 2006 [55], are presented in Table 4.3.

The current radiological situation with respect to environment air component is described in chapter 7.3.

4.2.2 Potential Air Pollution Sources

During the construction of the SWMSF the main air pollutant sources will be mobile sources (like trucks etc.) used for the transport of constructional material and for the civil engineering construction works.

During the operation of the SWMSF mobile pollutant sources will be the trucks performing radioactive waste transfer and supplying necessary deliverables.

Airborne emissions arising from stationary SWMSF sources result mainly from the operation of the ventilation systems and from the operation of the incineration facility.

4.2.3 Environmental Air Pollution Forecast

4.2.3.1 Non-radioactive Airborne Emissions

4.2.3.1.1 Mobile Sources

The environmental air pollution from mobile pollution sources will be time limited (by relatively short construction phase) and/or location limited (radioactive waste transport will be performed within the INPP industrial site and fenced road connecting INPP and the SWTSF sites), and therefore will not cause significant atmospheric emissions. The ambient air quality will be directly affected by the emissions of NO_X, SO_2, dusts, CO, CO_2 and unburnt carbohydrates C_XH_X generated by the road transfer of construction materials and containers with radioactive waste, and by the operation of road construction equipment. The affected area includes the construction route and their direct environment in a range of about 100 m.

4.2.3.1.2 Non-radioactive Airborne Emissions from the Incineration Facility

The non-radioactive pollutants will be released via the stationary SWTSF ventilation stack. The stack coordinates according to the LKS-94 system are X = 6165076.12, Y = 660874.20, height 50 m over the ground, diameter 2.5 m. The flow rate of the combustion products from the incineration facility is 3000 m^3/h (2600 nm^3/h), the total flow of exhaust ventilation air is 63200 m^3/h, and the average exhaust gas temperature is 35ºC. The annual releases via the stack due to the incinerator operation are estimated to occur during 1536 h including start-up, operation and shutdown.

The Contractor declares that the emission limit values set out in the Lithuanian regulations in force [20] and in the Directive 2000/76/EC of the European Parliament and of the Council [19] (the same emission limit values are set out in both documents [20] and [19]) will not be exceeded in the exhaust gas. For modeling of the air pollutants dispersion it is assumed that the air pollutants concentration in the exhaust gas from the incineration facility is maximal and equal to the emission limit values set out in the documents [20] and [19] Annex V (half-hourly average values) as presented in Table 4.4.

The Utena Regional Department of Environment Protection has provided the meteorological data for Ignalina region (Table 4.3).

The binary PC code VARSA v3.01 was used for the atmospheric dispersion analysis of non-radioactive pollutants. VARSA is one of the models for the environmental impact assessment recommended by the Ministry of Environment of Lithuania. It is included in the "List of models that can be used for EIA" [123]. VARSA is being intensively used for the dispersion modeling of the pollutants from industrial power plants and other objects in Lithuania (as an example, EIA reports of oil refinery Joint-Stock Company "Mazeikiu Nafta", biggest power plant in Lithuania State Enterprise "Lietuvos elektrine", waste oil combustion facility at State Enterprise "Radviliskio siluma" and many other industrial objects).

The code VARSA complies with the OND-86 non-Gaussian multiple-source regulatory dispersion model based on the advection-diffusion equation for point and area sources. The intended field of application is the calculation of the dispersion of pollutants from industrial pollution sources with the worst-case (98-percentile) concentration fields at the local and local-to-regional scale (domain dimension – up to 100 km from the sources). The following effects are included into the model: initial plume / jet rise, complex terrain, building downwash, sedimentation of heavy particles. The OND-86 methodology evaluates point concentrations for averaging range of 20-30 minutes. Therefore, in order to obtain reliable results, a 30 minutes averaging periods have been selected for the assessment.

The input information consists of the source parameters and coordinates, the terrain amplification factors for these sources (equal to 1.0 in flat terrain), building coordinates and heights (if necessary), and characteristics of the computational domain. Instead of the actual meteorological information, climatological data are used in the calculations which include the interval of variations of the wind speeds between 0.5 m/s and U95 (95-th percentile of PDF of the wind speeds), wind rose, and the climatological characteristic of the unfavorable dispersion conditions A.

The output quantities of the model are: the worst-case concentration field, critical wind speeds and wind directions at the receptor points, the source-receptor matrix. The output plot of the worst-case concentration field is based on the calculated critical wind speed U = (0.5 ... U_{max}), m/s. The actual wind rose is only used for defining the sanitary protection zone, in case if MPCs (Maximum Permissible Concentrations) are exceeded.

Data of wind and temperature profile measurements in the surface layer carried on the specialized network of the meteorological stations have been used to determine the values A over the territory of the former USSR; these values are varied between 140 and 250 (160 for Lithuania).

The maximum number of pollution sources is up to 2000, the number of pollutants is limited only by PC data storage capabilities. The number of pollutants with integrated effect within one group is up to 13; the number of groups with integrated effect is up to 60. The computer code is user-friendly and does have tools for handling data bases with input data, output tables and maps. Multiple custom scenarios of calculations can be made within the single run of the code. The reference description of the model is available at the European Topic Centre on Air and Climate Change [124].

The results of pollutant concentrations are to be compared with the short-term national ambient air quality standards called MPCs (Maximum Permissible Concentrations). They correspond to an averaging time of twenty to thirty minutes.

The code is based on the formula:

$$c_m = \frac{AMFmn\eta}{H^2\sqrt[3]{V_1\Delta T}}$$

where: A – stratification factor, A=160.
M – discharge intensity, g/s
F – factor estimating sedimentation of pollutant in atmosphere;
m, n – factor estimating flue gas outlet conditions;
η – relief factor. η=1, if terrain height difference less than 50 m in 1 km;
H – stack height, m;
V_1 – flow rate, m^3/s;
ΔT – ambient – flue gas temperature difference, ºC.

Integrated effect of two or more pollutants with the add-up impact was calculated:

$$\frac{C_1}{MPC_1} + \frac{C_2}{MPC_2} + \ldots + \frac{C_n}{MPC_n} \leq 1$$

where: C_n – actual concentration of individual pollutant;
MPC_n – maximum allowed concentrations of individual pollutant n.

The calculations were performed on the area of 5000 × 5000 m. The grid of the calculations is 100 m.

The background pollution data are derived from [122] by recommendation of Utena regional department of the Ministry of Environment.

The results of calculations of the maximum ground level concentrations of pollutants were compared with the maximum allowed short-term ground-level concentrations in ambient air (defined in Lithuanian Hygiene Standard HN 35:2002 [56]), Table 4.5 and Table 4.6. Some of the pollutants for which short-term averages are not defined in the regulation, were compared with stricter 24-hour average MPCs, Table 4.5 and Table 4.6.

The maximum worst-case calculated concentrations presented in Table 4.7. Figure 4.2 show the concentration distribution. The contour plots of the ground level concentration of pollutants are presented in Figure 4.3, Figure 4.4, Figure 4.5, Figure 4.6, Figure 4.7, Figure 4.8, and Figure 4.9.

The results of dispersion calculations show compliance with the limiting concentrations as defined in [56] what will enable to operate the incineration facility at the projected load with negligible impact on the environment. The concentrations of pollutants will not exceed the allowed values in case of the most adverse atmospheric conditions.

The release of dusts via the vent of the grouting concrete preparation unit is predicted to be lower due to a dust filter.

4.2.3.2 Radioactive Airborne Emissions

The calculation of the radioactive emissions from the ventilation systems of the SWMSF and the incineration facility of the SWTSF is based on:

- Production (waste throughput) of the SWRF and SWTF, cf. chapter 1.5;
- Waste characteristics, amounts and properties, cf. chapter 2.1;
- Specificity of the operation schedule of the SWRF and SWTF, cf. chapter 1.4;
- Specificity of technological processes at the SWRF and SWTF, cf. chapters 2.2 and 2.4;
- Bounding values for potential activity release fractions or activity release rates.

The results of calculations of radioactive emissions are also used for the assessment of public exposure, cf. chapter 4.9 “Public health”.

4.2.3.2.1 Airborne Activity Source Term

The amount of radioactive material released to the atmosphere is defined as the airborne activity source term. The airborne activity source term is typically estimated by the following linear equation:

Airborne activity source term = MAR × DR × ARF × RF × LPF;

Where:

MAR – is the Material at Risk. The MAR is the amount of radionuclides (in Bq for each radionuclide) available to be acted on by a given physical stress. For facilities, processes and activities, the MAR is a value representing some maximum quantity of radionuclide present or reasonably anticipated for the process or the structure being analyzed;

DR – is the Damage Ratio. The DR is the fraction of the MAR actually impacted by the event generated conditions. The engineering analysis of the response of the structural materials and the materials of the construction for the containment to the type and level of stress/force generated by the event is the basis for estimation of the DR. Standard engineering approximations are typically used. These approximations often include a degree of conservatism due to simplification of phenomena to obtain a useable model, but the purpose of the approximation is to obtain, to the degree possible, a realistic understanding of potential effects;

ARF – is the Airborne Release Fraction. For discrete or single events the ARF is the coefficient used to estimate the amount of radioactive material suspended in air as an aerosol and thus available for transport due to a physical stresses from a specific event. For the mechanisms that continuously act to suspend radionuclides (e.g., aerodynamic entrainment / re-suspension), the Activity Release Rate (ARR) and the activity release time (Δt) are required to estimate the potential airborne release fraction from the postulated event conditions. Generally, ARR’s are based upon measurements over some extended period to encompass most release situations for a particular mechanism. The ARF for continuous release is calculated as follows: ARF = ARR × Δt.

RF – is the Respirable fraction. The respirable airborne activity source term is a fraction of the airborne activity source term that is effectively inhalable. It is commonly assumed that respirable airborne activity includes particles of 10 µm Aerodynamic Equivalent Diameter (AED) and less.

LPF – is the Leakpath Factor. The LPF is the fraction of the radionuclides in the aerosol transported through some confinement deposition of a filtration mechanism. Where multiple leakpaths are involved, their cumulative effect is often expressed as one value that is the product of all leakpath multiples. The LPF is a calculated or standard value based upon (1) established relationships between the size of the particulate material, airborne transport mechanisms, and losses by deposition mechanisms, or (2) specified filtration efficiencies.

The design concept of the SWMSF off-gas filter units foresees "in-line" configured several filtration stages. The first stage in the line of the off-gas filters is a pre-filter (of F5 filter class according to EN779) for filtration of coarse dust. Minimal design filtering efficiency is 95%. The second and the main filter stage is the HEPA filter (of H13 filter class according to EN1822) for filtering of (radioactive) aerosols to protect the environment. Minimal filtering efficiency is 99.95% (or minimal decontamination factor DF = 2000). At the third position in the line a second HEPA filter (of the same H13 filter class) is installed. Its function is a safety task for cases of accidents, damages or staff failures at the main (second stage) of the filter unit. The increase of the DF can be considered as a positive side-effect. In estimation of the overall DF for the filter unit, the efficiency of the first filter is neglected. The second filter is assumed to provide the minimal design decontamination factor DF = 2000. The third filter (if relevant) will also increase the overall filtration efficiency. Only a factor DF = 5 is set for the last stage. The total DF of the filter unit therefore is estimated to be 10000. Without the second HEPA, the total unit DF is assumed to provide the minimal design DF = 2000.

The data on the ARF / ARR and RF are selected basing on recommendations of the U.S. Department of Energy Handbook [57]. The data in this handbook can be used in a variety of applications, such as safety and environmental analyses, and to provide information relevant to system and experiment design. This handbook contains (1) a systematic compilation of airborne release and respirable fraction experimental data for nonreactor nuclear facilities, (2) assessments of the data, and (3) values derived from assessing the data that may be used in safety analyses when the data are applicable. To assist in consistent and effective use of this information, the handbook provides:

- Identification of a consequence determination methodology in which the information can be used;
- Discussion of the applicability of the information and its general technical limits;
- Identification of specific accident phenomena of interest for which the information is applicable;
- Examples of use of the consequence determination methodology and airborne release and respirable fraction information.

As a conservative approach bounding values of the ARF / ARR and RF are used in this environment impact assessment. The recommended [57] bounding values for this proposed economic activity relevant impacts are presented in Table 4.8 and Table 4.9.

A special consideration was made regarding the G3 waste activity that potentially may become airborne under these proposed economic activity relevant physical stress conditions. The G3 waste activity mostly comes from metal elements (parts from fuel assemblies, sensors, tubes etc.), which are irradiated by neutron flux within a reactor core and surface contaminated by deposits (fission products, activated corrosion products) present in the coolant water of the main circulation contour. The G3 waste activity as provided in the chapter 2.1.4 represents the total activity resulting from both activity-generating mechanisms.

The consideration that all activity of the G3 waste activation products can become airborne is not realistic because the foreseen waste treatment technology (in general - mechanical waste handling and reloading) will not lead to such physical stresses that may affect the internal metal structure (as metal shredding or melting). Activation products, which theoretically may be affected and therefore potentially may become airborne, are surface deposits and a thin layer of the metallic waste surface. Therefore it was conservatively assumed that up to 10% from the total activity of activation products might be affected by the physical stresses imposed by the proposed G3 waste handling technologies. Only this part of the activity may become airborne. However no credits are taken with respect to the G3 waste activity, which comes from fission products – it is considered that all activity may become airborne. The same concerns the activation product C-14, whose origin comes from the elements present in coolant water. The potentially airborne group G3 waste activity is summarized in Table 4.10.

4.2.3.2.2 Waste Flow within Specific Waste Management Streams and Potential Airborne Releases

The waste flow within specific waste management streams of the SWRF, the sources of the generation of airborne activity and the airborne activity release pathways are summarized in Figure 4.10. The airborne activity is generated during waste retrieval and waste treatment steps. The airborne activity is collected by the ventilation systems of the RU and LSF. After the filtration a certain amount of airborne activity could be released through the ventilation stacks of the SWRF.

No airborne activity release during waste transfer under normal operation conditions is assumed. The waste will be transferred in tightly closed containers. The lid of the containers will be appropriately fixed. The contamination of the external surfaces of the containers will be checked before each transfer. If necessary, the external surfaces of the containers will be decontaminated.

The waste flow within specific waste management streams of the SWTF, the sources of the generation of airborne activity and the airborne activity release pathways are summarized in Figure 4.11. The airborne activity is generated during various waste processing and treatment steps, is collected by the ventilation system. After the filtration a certain amount of airborne activity could be released through the main ventilation stack of the SWTF.

No airborne activity release during waste storage under normal operation conditions is assumed. The waste either will be stored in closed metal containers (LL-waste) or will be grouted and stored in concrete containers (SL-waste). The contamination of the external surfaces of the waste storage containers during waste loading will be prevented by the design (by the use of double lid lock systems). Also, external surfaces of containers will be checked for contamination before waste transfer to the storage positions. If necessary, the external surfaces of the containers will be decontaminated.

4.2.3.2.3 Annual Airborne Emissions from SWRF and SWTF during Retrieval and Processing Existing and Operational INPP Waste

The estimation of the annual airborne releases during normal operation of the SWRF is provided in Table 4.11. The estimations are based on the annual RU1/LSF, RU2, RU3 waste throughputs, therefore the results provide the annual activity release values for each of the specific waste streams on the assumption that only this specific waste stream is processed during the whole year. For the RU2 a group G2 waste stream is considered as the group G2 waste activity is higher than the group G1 waste. Therefore the RU2 operating on G2 waste may result in higher values of airborne emissions. As facilities RU1/LSF, RU2 and RU3 may operate independently, the annual releases from these facilities are to be summed. The results, considering only the highest releases produced waste streams, are presented in Table 4.12.

The estimation of the annual airborne releases during normal operation of the SWTF while operating on the existing and operational INPP groups G2 and G3 waste (during the first 10 years after startup) is provided in Table 4.13. The estimations are based on the annual SWTF waste throughput, therefore the results provide the annual activity release values for each of the specific waste streams on the assumption that only this specific waste stream is processed during the whole year. Analyzing group G2 waste stream airborne release data it can be observed, that airborne activity release is highest in case of processing of G2 combustible waste. In reality, various types of waste (i.e. G1 non class A, G2 combustible, G2 non-combustible etc.) will be processed during a single year. However, airborne release will be lower than in the indicated case because processing of other waste streams results in lower airborne activities. For the assessment of the bounding case of airborne emissions it is assumed that during a whole year the SWTF treats G2 combustible waste only. G3 waste is processed independently from G2 waste, therefore the annual releases from both G2 and G3 waste streams shall be summed. The results are presented in Table 4.14.

A special consideration is made regarding to the release of C-14 during incineration of combustible waste. The airborne release fraction equal to 1.0 was used respect to C-14 activity annual throughput thus assuming that all radioactive carbon during waste incineration is transformed into gaseous carbon oxides and is released into atmosphere without retention in ash, scrubbers solution and HEPA filters.

4.2.3.2.4 Annual Airborne Emissions from SWTF during Processing of INPP Decommissioning Waste

The retrieval and treatment of the INPP existing and operational waste is expected to last about 10 years, cf. chapter 1.4. After that, and up to the end of the SWTF 30 year design life, the facilities of the SWTF will be used to process only decommissioning waste.

The waste from decommissioning of the nuclear installations will be delivered from INPP to the SWMSF presorted and pre-classified according to the categories A-E. The waste packages will carry a clear declaration of the origin and characterization of the waste. Therefore the waste will only be checked on arrival, and then will be treated according to the appropriate process lines for SL / LL waste.

The drums with decommissioning waste will be moved via a drum conveyer to the drum monitor station where they can be checked, then are compacted by the High Force Compactor, loaded into containers, grouted and sent to the ILW-SL storage facility.

LILW-SL and LILW-LL containers with non immobilized decommissioning waste will be moved via a container conveyor to the processing lines for ILW-SL Storage and ILW-LL Storage. The LILW-SL containers with decommissioning waste will be checked for the dose rate at the Delivery of Empty Containers at SWTF. In case of wrong loading - when the dose rate check of the container declared as class B waste shows an excess of the dose rate limit at surface (hot spot inside) - two correction measures are possible:

- The container will be reclassified from B to C and will be moved to the grouting and storage without any other treatment;
- The container will be moved onto the container transfer line, will be transferred to the loading position in the G2 sorting cell, and the wrong piece will be taken out of the container.

This case of an incorrectly filled and declared waste package will be assumed to be very exceptional, and the actions caused by this event have to be performed as an abnormal, exceptional operation with a special procedure.

The LILW-SL containers will be moved to the grouting station where they will be grouted and then moved via the ILW-SL Monitoring (final monitoring) to the ILW-SL Storage.

The LILW-LL containers with decommissioning waste cannot be repacked or re-inspected at the SWMSF with exception of the surface dose rate measurements before being directed to the respective processing lines. The LILW-LL containers will be directed as delivered and will pass through the facility as they are. The LILW-LL containers will be moved to the ILW-LL container monitoring station (final monitoring) and then to the ILW-LL Storage.

It can be stated, that during the processing of decommissioning waste at the SWTF a considerably smaller amount of open waste handling operations will be performed. The maximal design activity load of the LILW – SL containers is the same for operational and decommissioning waste. Therefore no considerable increase in decommissioning waste activity within a waste package can be expected. There will be no waste processing in the G3 sorting cell, which forms a major part (fraction higher by two orders of magnitude as compared to fractions from other waste streams, cf. chapter 4.2.3.2.3) of the potential airborne releases during the treatment of operational INPP waste. Also, there will be no releases from the existing waste retrieval at the SWRF. Therefore it can be concluded that airborne emissions during the processing of decommissioning waste at the SWTF will be lower than in case of retrieval and processing of the existing and operational INPP waste.

4.2.3.2.5 Summary of Radioactive Annual Airborne Emissions

Radioactive emissions into the atmosphere under normal operation conditions are summarized in Table 4.15. The maximally expected annual releases are calculated to be about 1.3×10^{10} Bq/a. The real annual radioactive emissions will be lower than these which are provided by calculations of the bounding release cases.

The radioactive emissions from the INPP site are limited by the conditions of the Permission for the Releases of Radioactive Material into the Environment [58]. The document includes information on planned annual INPP radioactive releases and provides the annual limits for specific radionuclides that could be released into the atmosphere.

A comparison of the calculated SWMSF emissions and the permissible INPP site radioactive emissions are presented in Table 4.16. It can be observed that the conservatively assessed SWMSF emissions are considerably below permissible limits.

Also, a new economic activity in relation with the decommissioning of INPP is planned. The spent nuclear fuel retrieval (from spent nuclear fuel storage pools at the reactor units of INPP) and storage at ISFSF will be held in parallel to the SWMSF project, cf. chapter 1.4. The airborne emissions from the SWMSF are compared with the permissible values also considering the planned INPP and projected ISFSF releases, Table 4.16. It can be observed that the assessed radioactive emissions due to the proposed economic activities together with the planned emissions for the INPP site are below the permissible limits.

Together it should be noted that implementation of the proposed economic activity foresee release of radionuclides which are not covered by conditions of the actual Permission [58]. Therefore, the Permission for the Releases of Radioactive Material into the Environment will have to be reviewed and updated before issuing operation license for the SWMSF.

4.2.4 Impact Mitigation Measures

4.2.4.1 Non Radiological

Due to low forecasted traffic levels the impact level of the emissions of the mobile sources (vehicles and construction equipment) will be acceptable both in the construction and operation phases. Most of the works will be carried out in open air so that the natural air circulation will prevent the accumulation of significant concentrations of such substances.

Electric driven trucks are planned for the transfer of radioactive waste containers in-between the SWRF and the SWTSF.

4.2.4.2 Radiological

The radiological impact mitigation measures include:

- Safety of design:
  - Multi-barrier design;
  - Safety SSC preferred over Administrative Controls;
  - Passive SSC preferred over active SSC;

  - Preventive controls preferred over mitigate controls. Controls that are effective for multiple hazards can be resource effective;
  - Optimal design of incineration process assuring minimization of generation of potential airborne pollutants (e.g. dioxins etc.);
  - Air flow from lower to higher activity / contamination zones (cascaded pressure concept in design of ventilation system);
  - Minimize possibilities for spread out of confined radioactive contamination (e.g. use of double lid lock systems);
- Safety of operation:
  - Supervision of work by radiation protection staff;
  - Preventive maintenance and repair concept;
  - Preventive cleaning / decontamination concept;
  - Online monitoring and control of incineration process;
  - Online monitoring of airborne releases from stacks;
- Application of the ALARA principle;
- Monitoring of environment components on radioactive contamination.

4.2.5 Tables and Drawings of the Chapter "Environmental Air (Atmosphere)"

The following Tables are attached to the chapter "Environmental Air (Atmosphere)":

Table 4.2 Main parameters of Lithuanian climate, [54];

Table 4.3 Meteorological characteristics of the Ignalina region [55];

Table 4.4 Assumed peak amounts of discharged air pollutants;

Table 4.5 Maximum allowed concentrations of pollutants in ambient air, mg/m3 [56];

Table 4.6 Groups of pollutants with integrated effect [56];

Table 4.7 Peak ground-level concentrations in parts of MPC;

Table 4.8 Bounding values of Activity Release Fractions and Respirable Fractions for discrete events [57];

Table 4.9 Bounding values of Activity Release Rates and Respirable Fractions for continuous events [57];

Table 4.10 Specific activities of radionuclides for the year 2001 generated group G3 solid radioactive waste (without filters) and potentially to become airborne activity part;

Table 4.11 Assessment of airborne releases from processing of specific waste streams at SWRF under normal operation conditions;

Table 4.12 Maximal annual airborne emissions from SWRF under normal operation conditions;

Table 4.13 Assessment of airborne releases from processing of specific waste streams at SWTF under normal operation conditions;

Table 4.14 Maximal annual airborne emissions from SWTF under normal operation conditions;

Table 4.15 Maximal annual airborne emissions from SWMSF under normal operation conditions;

Table 4.16 Comparison of licensed conditions for radioactive emission into atmosphere from INPP site [58] and assessed emissions due to proposed economic activities (ISFSF and SWMSF).

The following Figures are attached to the chapter "Environmental Air (Atmosphere)":

Figure 4.2 Calculated ground-level concentrations of pollutants, when concentrations in exhaust gases are at emission limit values;

Figure 4.3 Contour plot of concentrations for pollutant code 250;

Figure 4.5 Contour plot of concentrations for pollutant code 6493;

Figure 4.6 Contour plot of concentrations for pollutant code G001;

Figure 4.7 Contour plot of concentrations for pollutant code 6493 with background;

Figure 4.8 Contour plot of concentrations for pollutant code G001 with background;

Figure 4.9 Contour plot of concentrations for pollutant code G002 with background;

Figure 4.10 Potential sources of generation of airborne activity and airborne activity release pathways during normal operation of SWRF;

Figure 4.11 Potential sources of generation of airborne activity and airborne activity release pathways during normal operation of SWTF.

Table 4.2 Main parameters of Lithuanian climate, [54]

Parameter	Dimension	Value
Amount of solar radiation	MJ/m^2	3690
Air temperature: Year average January April July October	°C	 5.5–7.0 from -6.5 to -2.8 4.5–6.2 16.1–17.5 6.3–9.0
Cloudiness (year average)	grade	6.7–7.2
Precipitation: Year average Warm season (April to October) Cold season (November to March)	mm	 550–900 375–525 175–350
Number of days with snow cover	days	70–105

Table 4.3 Meteorological characteristics of the Ignalina region [55]

Parameter	Dimension	Value
Coefficient characterizing an impact of the relief configurations on impurity distribution		1
Average maximal temperature of the hottest month	°C	21.5
Average temperature of the coldest month	°C	-7.0
Average annual air temperature	°C	5.4
Average annual recurrence of winds direction (average annual wind rose): north north east east south east south south west west north west	%	 7 8 8 14 15 22 14 12
Annual calm (recurrence of doldrums)	%	15
Average wind speed in January	m/s	4.1
Average wind speed in June	m/s	3.1
The upper limit of wind speed U*	m/s	8.5

Table 4.4 Assumed peak amounts of discharged air pollutants calculated basing on emission limit values*)

Pollutant	Emission limit values, mg/Nm^3 *)	Discharge intensity based on emission limit value	
		g/s	**Mg/year**
Total dust	30	0.022	0.120
Hydrogen chloride (HCl)	60	0.043	0.240
Hydrogen fluoride (HF)	4	0.003	0.016
Sulphur dioxide (SO_2)	200	0.144	0.800
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide	400	0.289	1.597
Carbon monoxide (CO)	100	0.072	0.399
Total organic carbon (TOC)	20	0.014	0.080
Cd + Tl	0.05	0.00004	0.0002
Hg	0.05	0.00004	0.0002
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V	0.5	0.0004	0.002
Dioxins and furans	1E-10	7E-11	4E-10

*) according to [20, 19]

Table 4.5 Maximum allowed concentrations of pollutants in ambient air, mg/m^3 [56]

Pollutant			Maximum allowed concentrations, mg/m^3	
Name	**CAS No**	**Code**	**Short-term 0.5 hour average**	**24 hour average**
Total dust	–	6493	0.05	0.02
Gaseous and vaporous organic substances, expressed as total organic carbon	–	308	0.2	–
Hydrogen chloride (HCl)	7647-01-0	440	0.2	0.2
Hydrogen fluoride (HF)	–	862	0.020	0.005
Sulphur dioxide (SO_2)	7446-09-5	1753	0.50	0.05
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide	10102-44-0	250	0.085	0.040
Cd + Tl	–	3211	–	0.0003
Hg	–	1024	–	0.0003
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V	–	2094	–	0.0003
Dioxins and furans	–	7866	–	5E-13
Carbon monoxide (CO)	63-08-0	177	5	3

Table 4.6 Groups of pollutants with integrated effect [56]

Pollutants	Code
NO_x, SO_2	G001
SO_2, HF	G002

Table 4.7 Peak ground-level concentrations in parts of MPC

Pollutant	Code	Max estimated ground level concentration, parts of MPC		
		Incineration unit	Incineration unit + background	Present background pollution
Total dust	6493	0.016	0.056	0.040
Gaseous and vaporous organic substances, expressed as total organic carbon	308	0.003	0.030	0.027
Hydrogen chloride (HCl)	440	0.003	0.003	–
Hydrogen fluoride (HF)	862	0.002	0.005	0.003
Sulphur dioxide (SO_2)	1753	0.004	0.042	0.039
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide	250	0.042	0.192	0.151
Cd + Tl	3211	0.005	0.005	–
Hg	1024	0.005	0.005	–
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V	2094	0.048	0.048	–
Dioxins and furans	7866	0.002	0.002	–
Carbon monoxide (CO)	177	0.0002	0.007	0.007
Integrated index (NO_2 + SO_2)	G001	0.045	0.077	0.032
Integrated index (SO_2 + HF)	G002	0.005	0.025	0.019

Table 4.8 Bounding values of Activity Release Fractions and Respirable Fractions for discrete events [57]

Impact	Material	ARF *)	RF **)
Free Fall Spill	Solutions, density near 1 g/cm^3	2.00E-04	0.5
Free Fall Spill	Powders (Sand)	2.00E-03	0.3
Falling Object Impact	Powders in can	1.00E-03	0.1
Thermal impact <800 ºC	Powders, non-reactive	6.00E-03	0.1

*) ARF – Activity Release Fraction

**) RF – Respirable Fraction

Table 4.9 Bounding values of Activity Release Rates and Respirable Fractions for continuous events [57]

Impact	Material	ARR [1/h] *)	RF **)
Re-suspension	Solutions, density near 1 g/cm^3	4.00E-07	1
Re-suspension	Powders (Sand)	4.00E-05	1
Re-suspension, covered by other material	Powders (Sand)	4.00E-06	1

*) ARR – Activity Release Rate

**) RF – Respirable Fraction

Table 4.10 Specific activities of radionuclides for the year 2001 generated group G3 solid radioactive waste (without filters) and potentially to become airborne activity part

Radionuclide	Total waste specific activity, Bq/kg	Potentially airborne fraction	Potentially airborne specific activity, Bq/kg
C-14	3.70E+08	1.0	3.70E+08
Mn-54	0	0.1	0
Fe-55	5.78E+11	0.1	5.78E+10
Co-58	0	0.1	0
Co-60	9.48E+10	0.1	9.48E+09
Ni-59	3.98E+08	0.1	3.98E+07
Ni-63	4.55E+10	0.1	4.55E+09
Nb-94	7.58E+08	0.1	7.58E+07
Sr-90	4.08E+03	1.0	4.08E+03
Tc-99	2.72E+02	1.0	2.72E+02
I-129	2.45E-01	1.0	2.45E-01
Cs-134	8.16E+04	1.0	8.16E+04
Cs-137	6.80E+04	1.0	6.80E+04
U-235	1.09E-01	1.0	1.09E-01
U-238	3.33E+00	1.0	3.33E+00
Pu-238	6.80E+03	1.0	6.80E+03
Pu-239	1.84E+03	1.0	1.84E+03
Pu-240	4.35E+03	1.0	4.35E+03
Pu-241	6.46E+05	1.0	6.46E+05
Am-241	1.02E+04	1.0	1.02E+04
Cm-244	1.90E+03	1.0	1.90E+03
Total	**7.20E+11**		**7.23E+10**
Total alpha *)	2.51E+04		2.51E+04

*) Radionuclides U-235, U-238, Pu-238, Pu-239, Pu-240, Am-241 and Cm-244.

Table 4.11 Assessment of airborne releases from processing of specific waste streams at SWRF under normal operation conditions

Abbreviations in the Table: MAR – material at the risk, DR – damage ratio, ARR – activity release rate, ARF – activity release fraction, RF – respirable fraction, DF – decontamination factor. Terms are explained in the chapter 4.2.3.2.1.

Assessment of airborne releases from processing of specific waste streams at SWRF under normal operation conditions

Step	Impacting Process	MAR relative	DR	ARR [1/h]	Time [h]	ARF	RF	DF	Airborne Release fraction	Waste Streams and Processes Performed: RU1 and LSF: G1 Combustible	RU1 and LSF: G1 Non-Combustible	RU2: G2 Combustible	RU2: G2 Non-Combustible
1	Waste Retrieval	2.0	0.5			2.00E-03	0.3	2.00E+03	3.00E-07	+	+	+	+
2	Waste Transfer	1.0	0.5	4.00E-05	24	9.60E-04	1.0	2.00E+03	2.40E-07	+	+		
3	Presorting	1.0	0.5	4.00E-05	24	9.60E-04	1.0	2.00E+03	2.40E-07	+	+	+	+
4	Filling in Drums / Containers	1.0	0.1			2.00E-03	0.3	2.00E+03	3.00E-08			+	+
5	Sorting and Conveyor Transfer	1.0	0.5	4.00E-05	24	9.60E-04	1.0	2.00E+03	2.40E-07	+	+		
6	Size Reduction and Packing	1.0	0.5			2.00E-03	0.3	2.00E+03	1.50E-07	+	+		

Notes:
1) DF – Overall decontamination factor of ventilation system HEPA filters
2) Leakpath Factor is calculated LPF=1/DF

	G1 Combustible	G1 Non-Combustible	G2 Combustible	G2 Non-Combustible
Airborne release fraction	1.17E-06	1.17E-06	5.70E-07	5.70E-07
Waste throughput [m³/d]	11.2	11.2	2.8	2.8
Waste density [kg/m³]	280	507	324	562
Waste activity [Bq/kg]	2.17E+06	8.34E+06	9.08E+07	5.86E+07
MAR – activity throughput [Bq/d]	6.81E+09	4.74E+10	8.24E+10	9.22E+10
Day average airborne release [Bq/d]	7.96E+03	5.54E+04	4.70E+04	5.26E+04
Annual operation time [d/a]	245	245	245	245
Annual airborne release [Bq/a]	1.95E+06	1.36E+07	1.15E+07	1.29E+07

Step	Impacting Process	MAR relative	DR	ARR [1/h]	Time [h]	ARF	RF	DF	Airborne Release fraction	RU3 G3
1	Waste Retrieval	2.0	0.5			2.00E-03	0.3	1.00E+04	6.00E-08	+
4	Filling in Containers	1.0	0.1			2.00E-03	0.3	1.00E+04	6.00E-09	+

	RU3 G3
Airborne release fraction	6.60E-08
Waste throughput [m³/d]	0.9
Waste density [kg/m³]	1032
Waste activity [Bq/kg]	7.23E+10
MAR – activity throughput [Bq/d]	6.72E+13
Day average airborne release [Bq/d]	4.43E+06
Annual operation time [d/a]	245
Annual airborne release [Bq/a]	1.09E+09

Table 4.12 Maximal annual airborne emissions from SWRF under normal operation conditions

Waste stream	G1 (Non-Combustible)	G2 (Non-Combustible)	G3 (Non-Combustible)	Total SWRF
Radionuclide	**Activity, Bq/a**			
C-14	5.00E+03	6.63E+03	5.55E+06	5.56E+06
Mn-54	1.81E+06	2.40E+06	0.00E+00	4.21E+06
Fe-55	5.00E+06	6.63E+06	8.69E+08	8.80E+08
Co-58	1.49E+06	1.98E+06	0.00E+00	3.46E+06
Co-60	1.06E+06	1.41E+06	1.42E+08	1.45E+08
Ni-59	1.06E+03	1.41E+03	5.98E+05	6.00E+05
Ni-63	2.55E+05	3.39E+05	6.83E+07	6.89E+07
Nb-94	2.02E+03	2.68E+03	1.14E+06	1.14E+06
Sr-90	9.86E+03	2.87E+02	6.13E+01	1.02E+04
Tc-99	6.58E+02	1.92E+01	4.09E+00	6.81E+02
I-129	5.92E+00	1.72E-01	3.68E-03	6.09E+00
Cs-134	2.30E+06	6.71E+04	1.23E+03	2.37E+06
Cs-137	1.64E+06	4.79E+04	1.02E+03	1.69E+06
U-235	4.44E-04	1.29E-05	1.63E-03	2.09E-03
U-238	1.32E-02	3.83E-04	5.00E-02	6.36E-02
Pu-238	2.79E+01	8.14E-01	1.02E+02	1.31E+02
Pu-239	7.23E+00	2.11E-01	2.76E+01	3.50E+01
Pu-240	1.81E+01	5.27E-01	6.54E+01	8.40E+01
Pu-241	2.63E+03	7.66E+01	9.70E+03	1.24E+04
Am-241	3.95E+01	1.15E+00	1.53E+02	1.94E+02
Cm-244	7.73E+00	2.25E-01	2.86E+01	3.65E+01
Total	**1.36E+07**	**1.29E+07**	**1.09E+09**	**1.11E+09**
Total alpha *)	100.5	2.93	376.9	480.3

*) Radionuclides U-235, U-238, Pu-238, Pu-239, Pu-240, Am-241 and Cm-244.

Table 4.13 Assessment of airborne releases from processing of specific waste streams at SWTF under normal operation conditions

Abbreviations in the Table: MAR – material at the risk, DR – damage ratio, ARR – activity release rate, ARF – activity release fraction, RF – respirable fraction, DF – decontamination factor. Terms are explained in the chapter 4.2.3.2.1.

Assessment of airborne releases from processing of specific waste streams at SWTF under normal operation conditions

Step	Impacting Process	MAR relative	DR	ARR [1/h]	Time [h]	ARF	RF	DF	Airborne Release fraction	Waste Streams and Processes Performed			
										G2	G2 Non-combustible		G3
										Combustible	compactable	Non-compactable	
1	Waste Emptying	1.0	0.5			2.00E-03	0.3	1.00E+04	3.00E-08	+	+	+	+
2	Sorting and Conveyor Transfer	1.0	0.5	4.00E-05	24	9.60E-04	1.0	1.00E+04	4.80E-08	+	+	+	+
3	Shredding (combustible waste)	1.0	0.5			2.00E-03	0.3	1.00E+04	3.00E-08	+			
4	Mixing (combustible waste)	1.0	0.5			2.00E-03	0.3	1.00E+04	3.00E-08	+			
5	Incineration (combustible waste)	1.0	1.0			1.0	1.0	1.50E+05	6.67E-06	+			
6	Filling in Drums / Containers	1.0	0.1			2.00E-03	0.3	1.00E+04	6.00E-09	+	+	+	+
7	High Force Compaction	1.0	0.5			2.00E-03	0.3	1.00E+04	3.00E-08	+	+		
8	Storage of Pellets	1.0	0.5	4.00E-06	24	9.60E-05	1.0	1.00E+04	4.80E-09	+	+		
9	Filling in Containers with Pellets	1.0	0.1			2.00E-03	0.3	1.00E+04	6.00E-09	+	+		
10	Transfer of Containers without Plugs	1.0	0.5	4.00E-06	24	9.60E-05	1.0	1.00E+04	4.80E-09	+	+	+	
11	Grouting of Containers	1.0	0.1			2.00E-03	0.3	1.00E+04	6.00E-09	+	+	+	

Airborne release fraction	6.86E-06	1.36E-07	9.48E-08	8.40E-08
Waste throughput [m³/d]	2.8	2.8	2.8	0.9
Waste density [kg/m³]	324	562	562	1032
Waste activity [Bq/kg]	9.08E+07	5.86E+07	5.86E+07	7.23E+10
MAR – activity throughput, [Bq/d]	8.24E+10	9.22E+10	9.22E+10	6.72E+13
Day average airborne release [Bq/d]	5.65E+05	1.25E+04	8.74E+03	5.64E+06
Annual operation time [d/a]	245	245	245	245
Annual airborne release [Bq/a]	1.38E+08	3.06E+06	2.14E+06	1.38E+09

Notes:

1) DF – Overall decontamination factor of ventilation system HEPA filters. Incinerator overall DF includes DF of afterburner, 2 Scrubbers and HEPA
2) Leakpath Factor is calculated LPF=1/DF

Table 4.14 Maximal annual airborne emissions from SWTF under normal operation conditions

Waste stream	G2 (Combustible)	G3 (Non-Combustible)	Total SWTF
Radionuclide	**Activity, Bq/a**		
C-14 **)	1.04E+10	7.07E+06	1.04E+10
Mn-54	2.59E+07	0.00E+00	2.59E+07
Fe-55	7.16E+07	1.11E+09	1.18E+09
Co-58	2.13E+07	0.00E+00	2.13E+07
Co-60	1.52E+07	1.81E+08	1.96E+08
Ni-59	1.52E+04	7.61E+05	7.76E+05
Ni-63	3.66E+06	8.70E+07	9.06E+07
Nb-94	2.89E+04	1.45E+06	1.48E+06
Sr-90	1.69E+03	7.80E+01	1.77E+03
Tc-99	1.13E+02	5.20E+00	1.18E+02
I-129	1.02E+00	4.68E-03	1.02E+00
Cs-134	3.95E+05	1.56E+03	3.96E+05
Cs-137	2.82E+05	1.30E+03	2.83E+05
U-235	7.62E-05	2.08E-03	2.16E-03
U-238	2.26E-03	6.37E-02	6.59E-02
Pu-238	4.80E+00	1.30E+02	1.35E+02
Pu-239	1.24E+00	3.51E+01	3.63E+01
Pu-240	3.10E+00	8.32E+01	8.63E+01
Pu-241	4.51E+02	1.23E+04	1.28E+04
Am-241	6.77E+00	1.95E+02	2.02E+02
Cm-244	1.33E+00	3.64E+01	3.77E+01
Total	**1.06E+10**	**1.38E+09**	**1.20E+10**
Total alpha *)	17.2	479.7	496.9

*) Radionuclides U-235, U-238, Pu-238, Pu-239, Pu-240, Am-241 and Cm-244.

**) In case of incineration of combustible waste the airborne release fraction equal to 1.0 was used respect to C-14 activity annual throughput thus assuming that all radioactive carbon during waste incineration is transformed to gaseous carbon oxides and is released into atmosphere without retention in ash, scrubbers solution and HEPA filters.

Table 4.15 Maximal annual airborne emissions from SWMSF under normal operation conditions

	Total SWRF	Total SWTF	Total SWMSF
Radionuclide	**Activity, Bq/a**		
C-14	5.56E+06	1.04E+10	1.04E+10
Mn-54	4.21E+06	2.59E+07	3.01E+07
Fe-55	8.80E+08	1.18E+09	2.06E+09
Co-58	3.46E+06	2.13E+07	2.48E+07
Co-60	1.45E+08	1.96E+08	3.41E+08
Ni-59	6.00E+05	7.76E+05	1.38E+06
Ni-63	6.89E+07	9.06E+07	1.60E+08
Nb-94	1.14E+06	1.48E+06	2.62E+06
Sr-90	1.02E+04	1.77E+03	1.20E+04
Tc-99	6.81E+02	1.18E+02	7.99E+02
I-129	6.09E+00	1.02E+00	7.11E+00
Cs-134	2.37E+06	3.96E+05	2.77E+06
Cs-137	1.69E+06	2.83E+05	1.98E+06
U-235	2.09E-03	2.16E-03	4.25E-03
U-238	6.36E-02	6.59E-02	1.30E-01
Pu-238	1.31E+02	1.35E+02	2.66E+02
Pu-239	3.50E+01	3.63E+01	7.14E+01
Pu-240	8.40E+01	8.63E+01	1.70E+02
Pu-241	1.24E+04	1.28E+04	2.52E+04
Am-241	1.94E+02	2.02E+02	3.96E+02
Cm-244	3.65E+01	3.77E+01	7.43E+01
Total	**1.11E+09**	**1.20E+10**	**1.31E+10**
Total alpha *)	480.3	496.9	977.2

*) Radionuclides U-235, U-238, Pu-238, Pu-239, Pu-240, Am-241 and Cm-244.

Table 4.16 Comparison of licensed conditions for radioactive emission into atmosphere from INPP site [58] and assessed emissions due to proposed economic activities (ISFSF and SWMSF)

Radionuclide	Licensed conditions		Assessed emissions	
	Limit	INPP planned emissions	ISFSF *)	SWMSF
	Bq/a	Bq/a	Bq/a	Bq/a
C-14	2.27E+11	1.27E+11	-	1.04E+10
Mn-54	9.05E+10	7.14E+08	-	3.01E+07
Co-58	7.34E+09	6.11E+07	-	2.48E+07
Co-60	2.88E+11	4.14E+09	-	3.41E+08
Sr-90	5.38E+09	4.44E+07	-	1.20E+04
Cs-134	1.33E+09	7.18E+07	2.39E+08	2.77E+06
Cs-137	1.39E+11	9.84E+08	1.03E+09	1.98E+06

*) Considers most conservative case, i.e. "One year maximal increase of radioactive emissions due to handling of all leaking fuel at Reactor Units" [59].

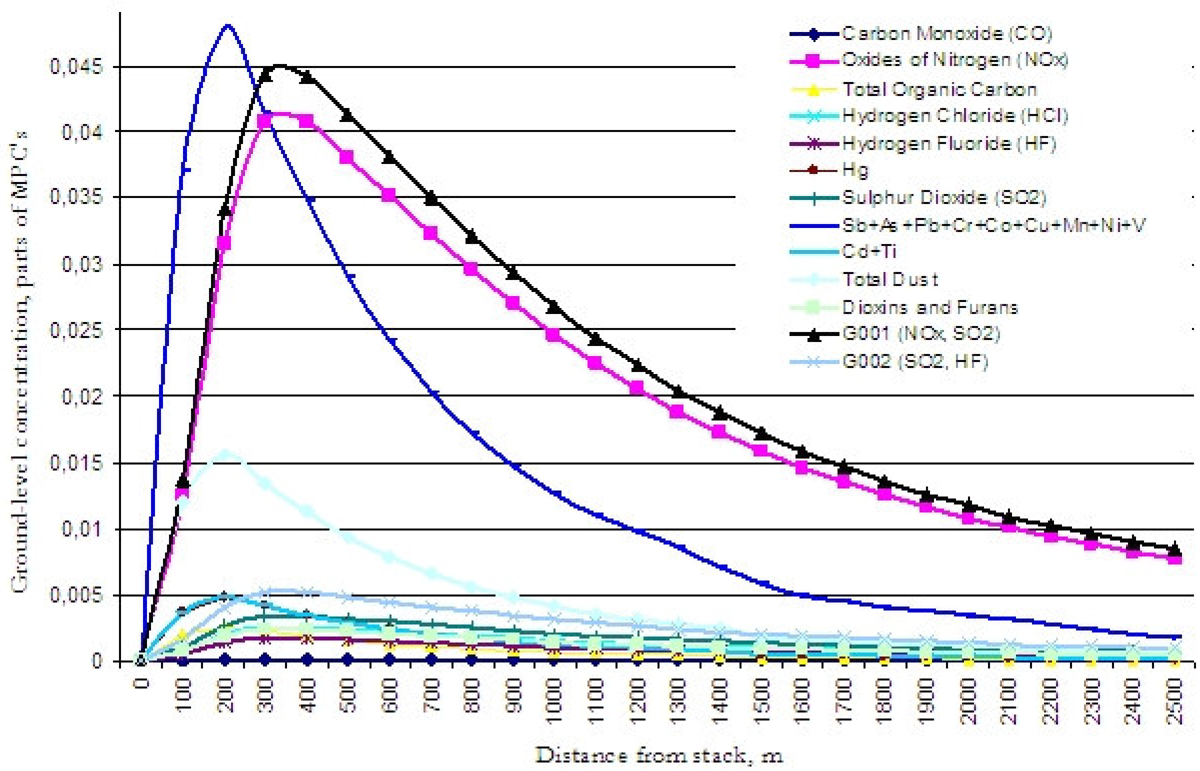


Figure 4.2 Calculated ground-level concentrations of pollutants, when concentrations in exhaust gases are at emission limit values

VARSA
CONTOUR PLOT OF CONCENTRATIONS
Incineration Facility
POLLUTANT: 250 Oxides of Nitrogen (A)
CONCENTRATION: Max: 0.04159, Min: 0.00000 No Background
Symbols: * - stack

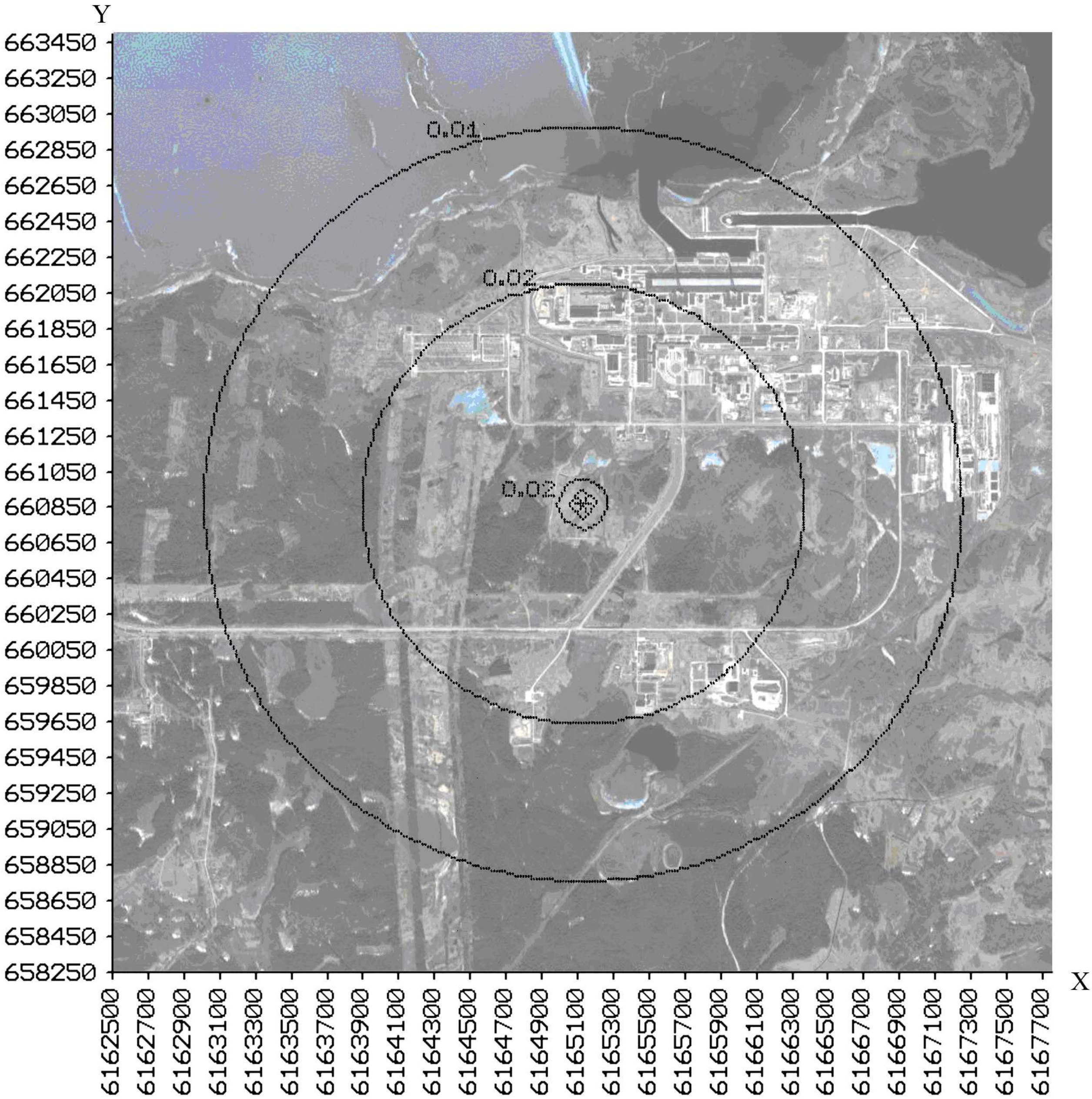


Figure 4.3 Contour plot of concentrations for pollutant code 250

VARSA
CONTOUR PLOT OF CONCENTRATIONS
Incineration Facility
POLLUTANT: 2094 Sb + As + PB + Cr + Co + Cu + Mn + Ni + V
CONCENTRATION: Max: 0.04792, Min: 0.00000 No Background
Symbols: * - stack

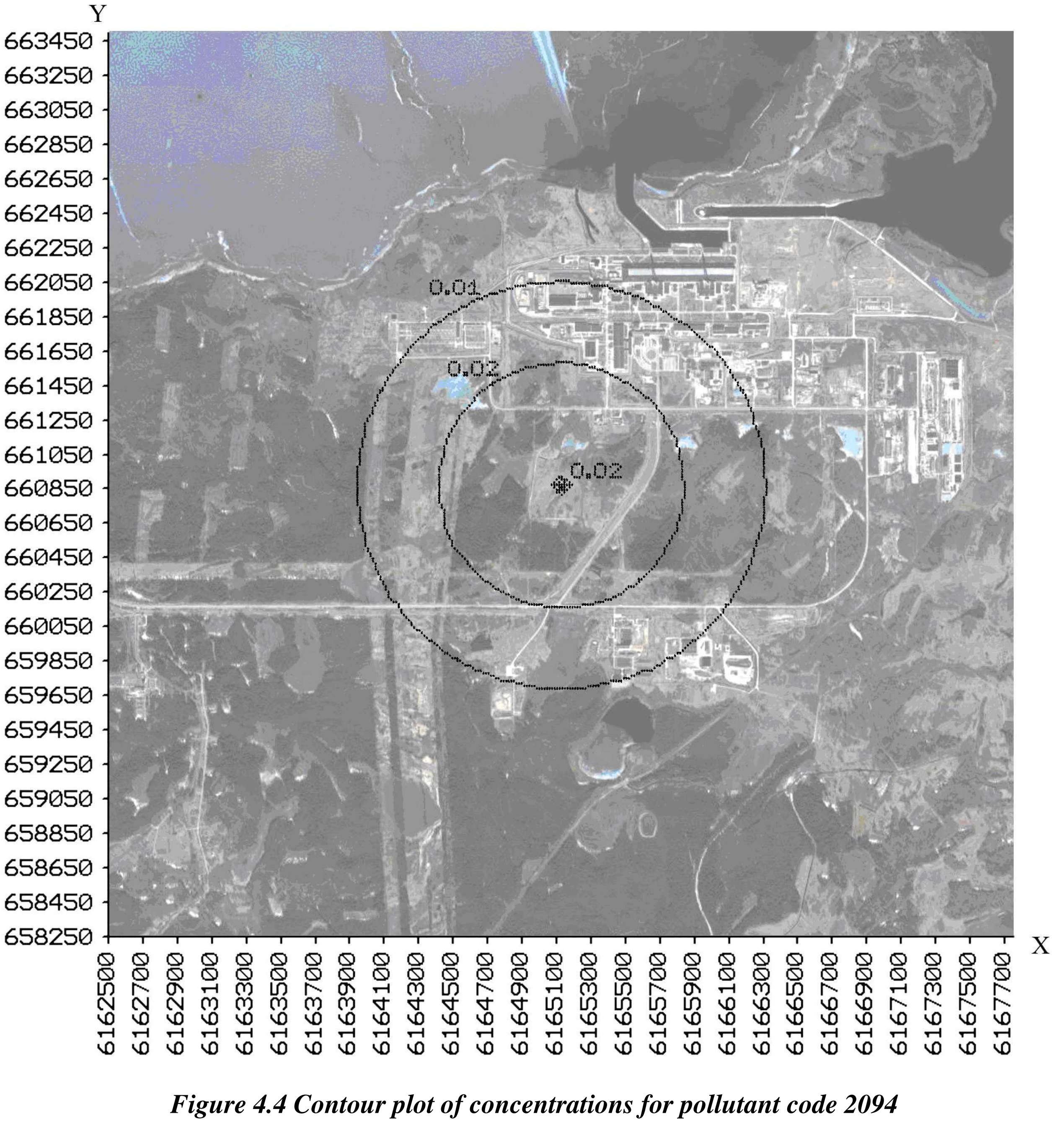


Figure 4.4 Contour plot of concentrations for pollutant code 2094

VARSA

CONTOUR PLOT OF CONCENTRATIONS

Incineration Facility

POLLUTANT: 6493 Total Dust (A)

CONCENTRATION: Max: 0.01560, Min: 0.00000 No Background

Symbols: * - stack

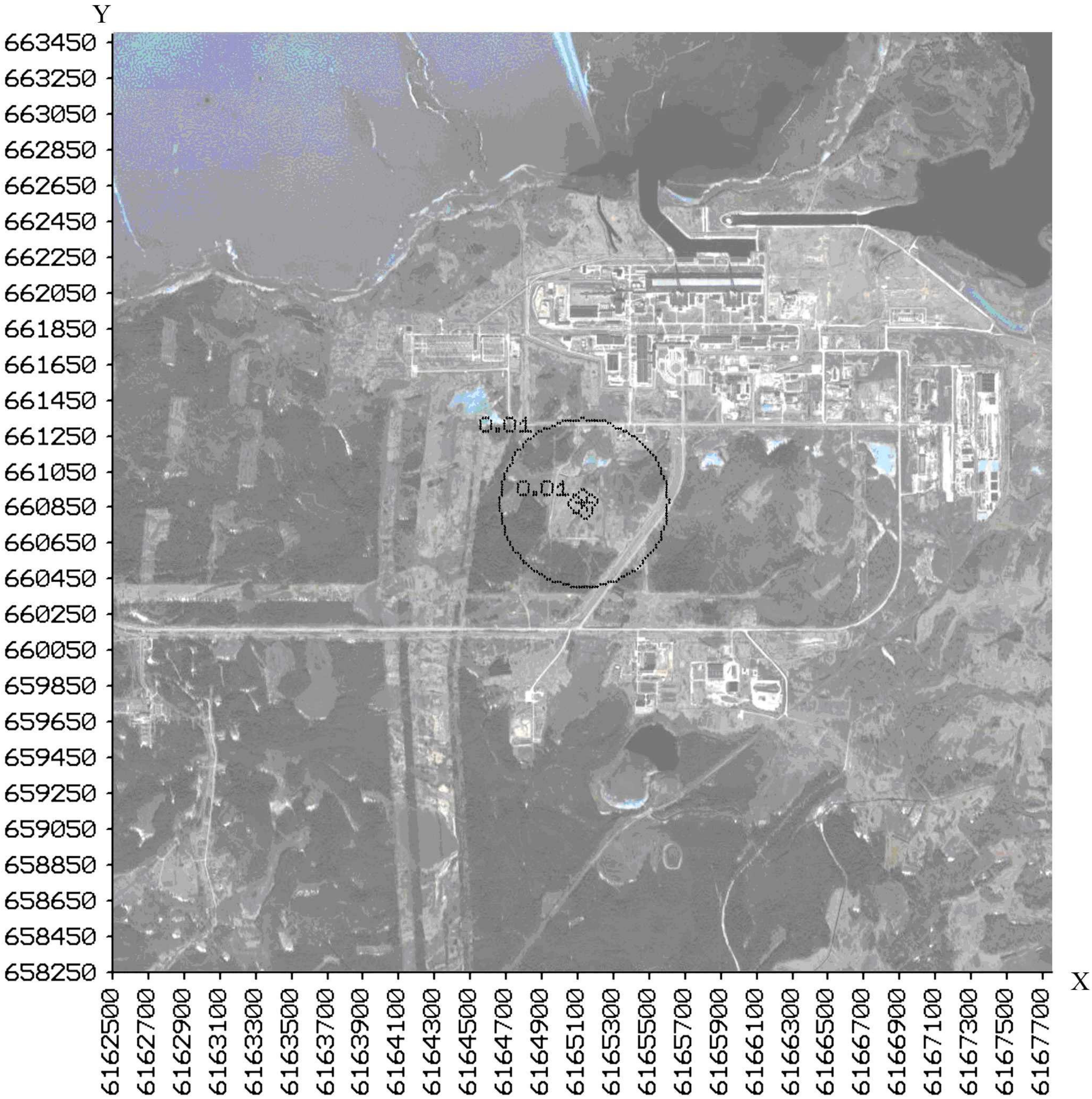


Figure 4.5 Contour plot of concentrations for pollutant code 6493

VARSA
CONTOUR PLOT OF CONCENTRATIONS
Incineration Facility
POLLUTANT: G001 Integrated Index
250 Oxides of Nitrogen (A)
1753 Sulphur Dioxide (A)
CONCENTRATION: Max: 0.04513, Min: 0.00000 No Background
Symbols: * - stack

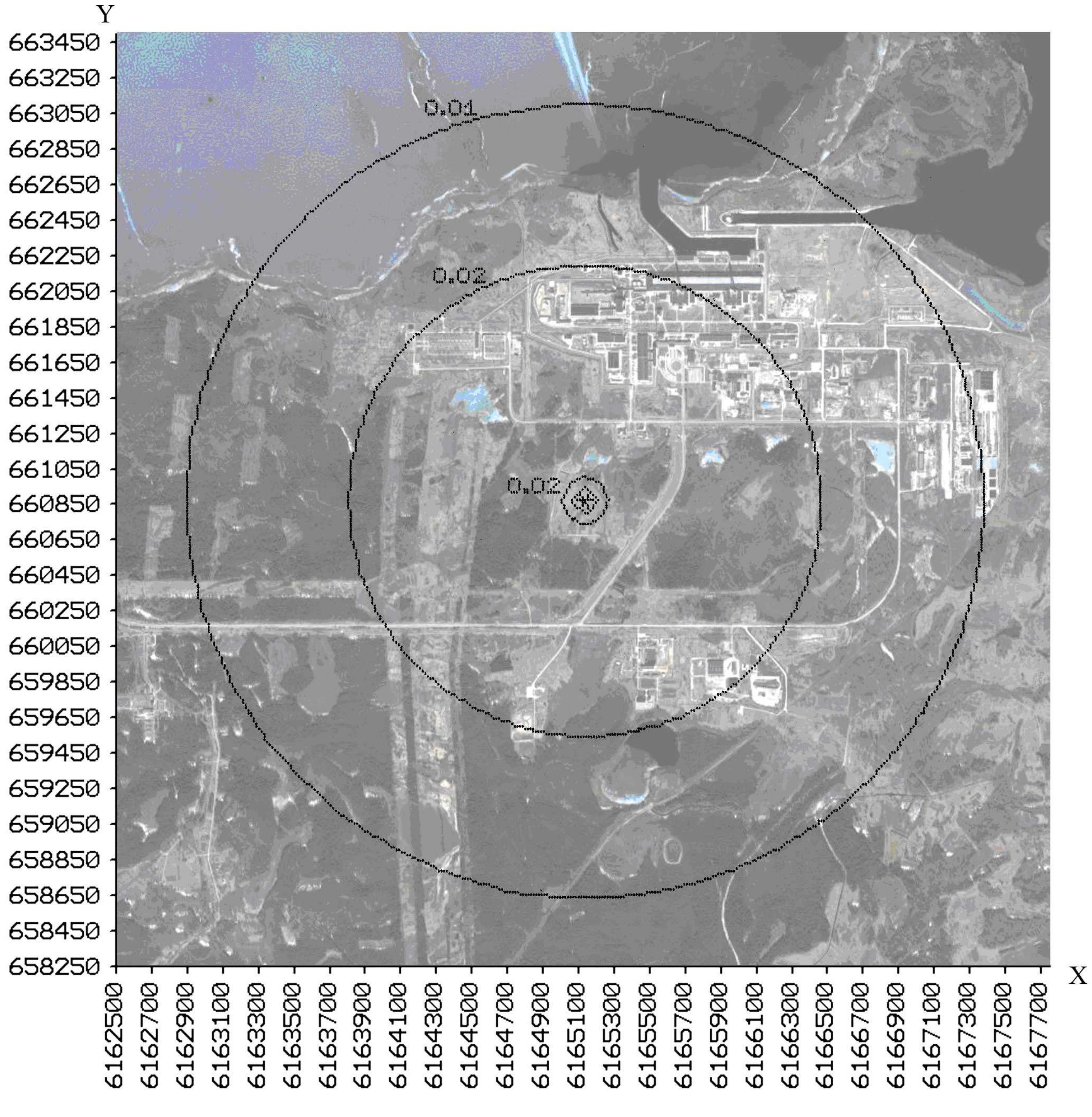


Figure 4.6 Contour plot of concentrations for pollutant code G001

VARSA
CONTOUR PLOT OF CONCENTRATIONS
Incineration Facility
POLLUTANT: 6493 Total Dust (A)
CONCENTRATION: Max: 0.05560, Min: 0.00000 With background (0.04 MPC)
Symbols: * - stack

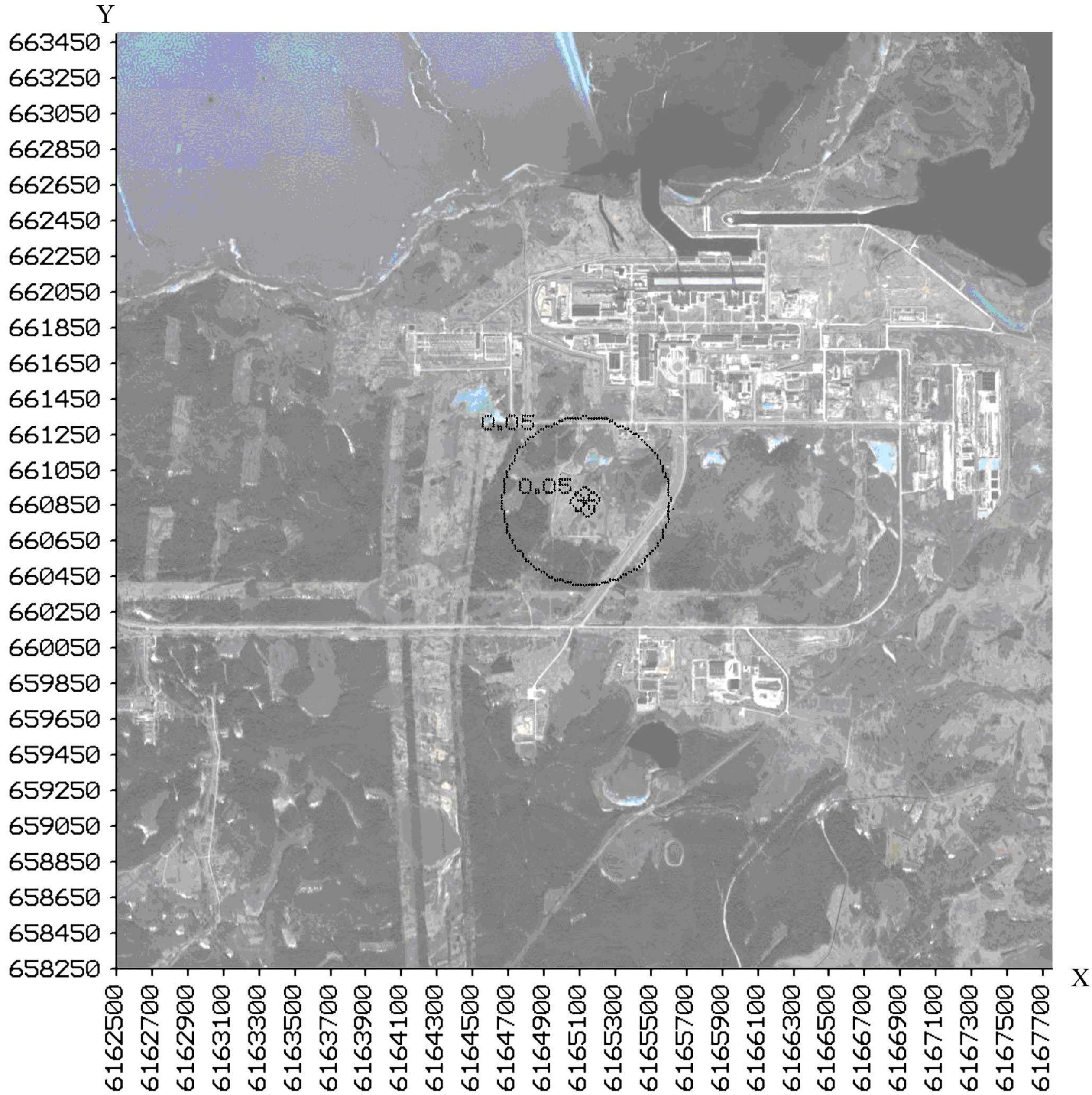


Figure 4.7 Contour plot of concentrations for pollutant code 6493 with background

VARSA
CONTOUR PLOT OF CONCENTRATIONS
Incineration Facility
POLLUTANT: G001 Integrated Index
250 Oxides of Nitrogen (A)
1753 Sulphur Dioxide (A)
CONCENTRATION: Max: 0.07723, Min: 0.03210 With background
Symbols: * - stack

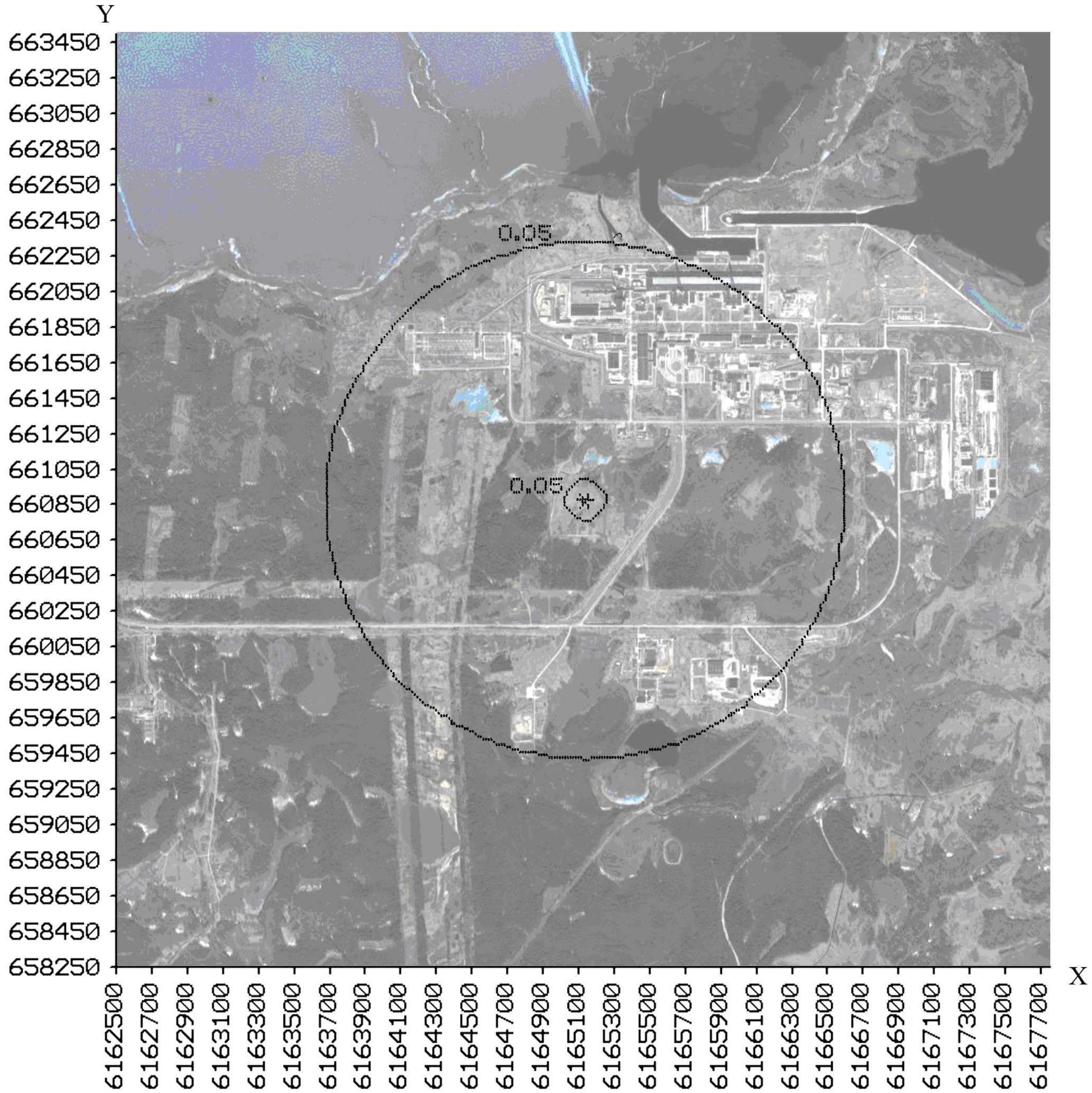


Figure 4.8 Contour plot of concentrations for pollutant code G001 with background

VARSA
CONTOUR PLOT OF CONCENTRATIONS
Incineration Facility
POLLUTANT: G002 Integrated Index
1753 Sulphur Dioxide (A)
862 Hydrogen Fluoride (HF)
CONCENTRATION: Max: 0.02467, Min: 0.01936 With background
Symbols: * - stack

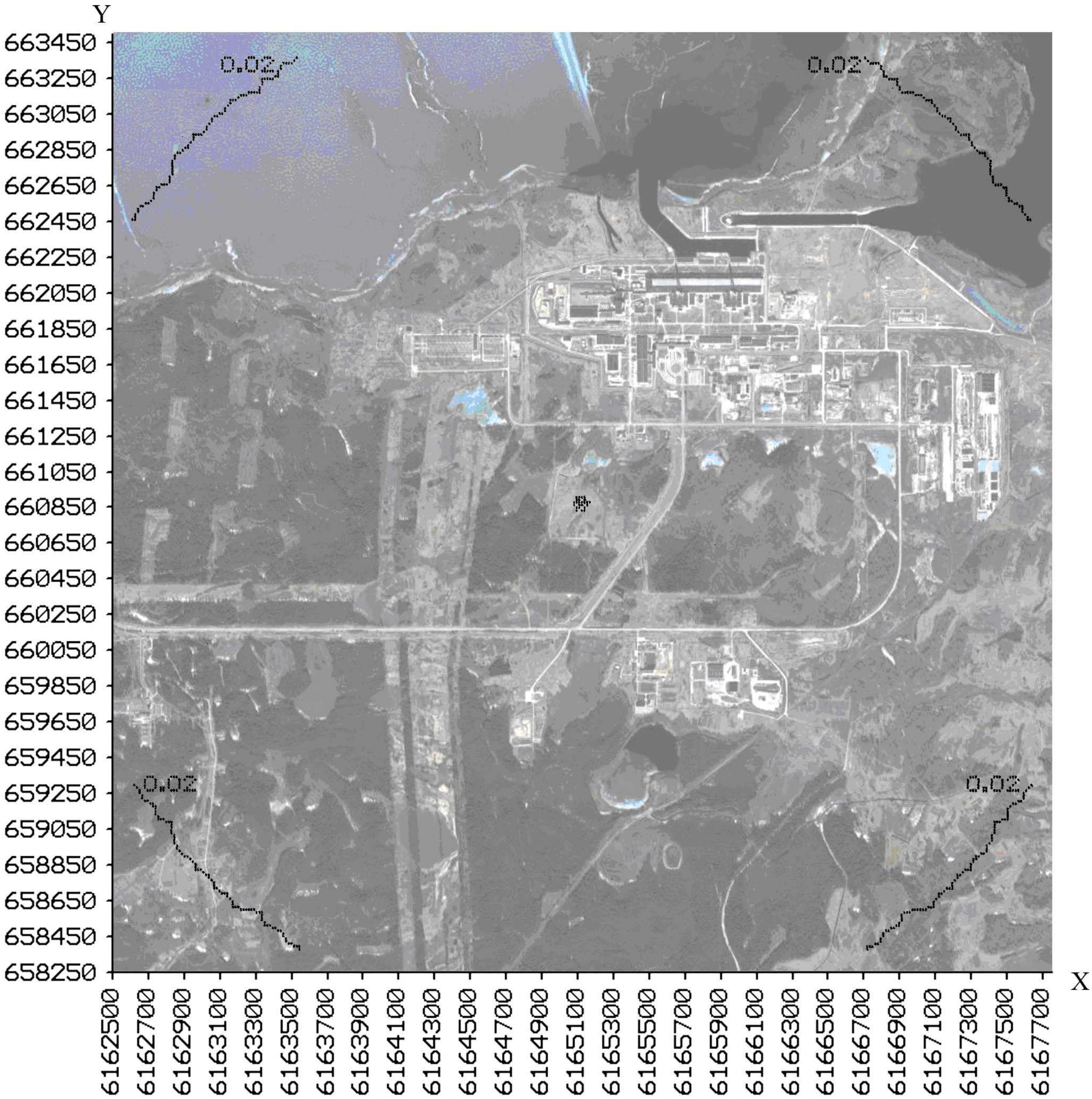


Figure 4.9 Contour plot of concentrations for pollutant code G002 with background

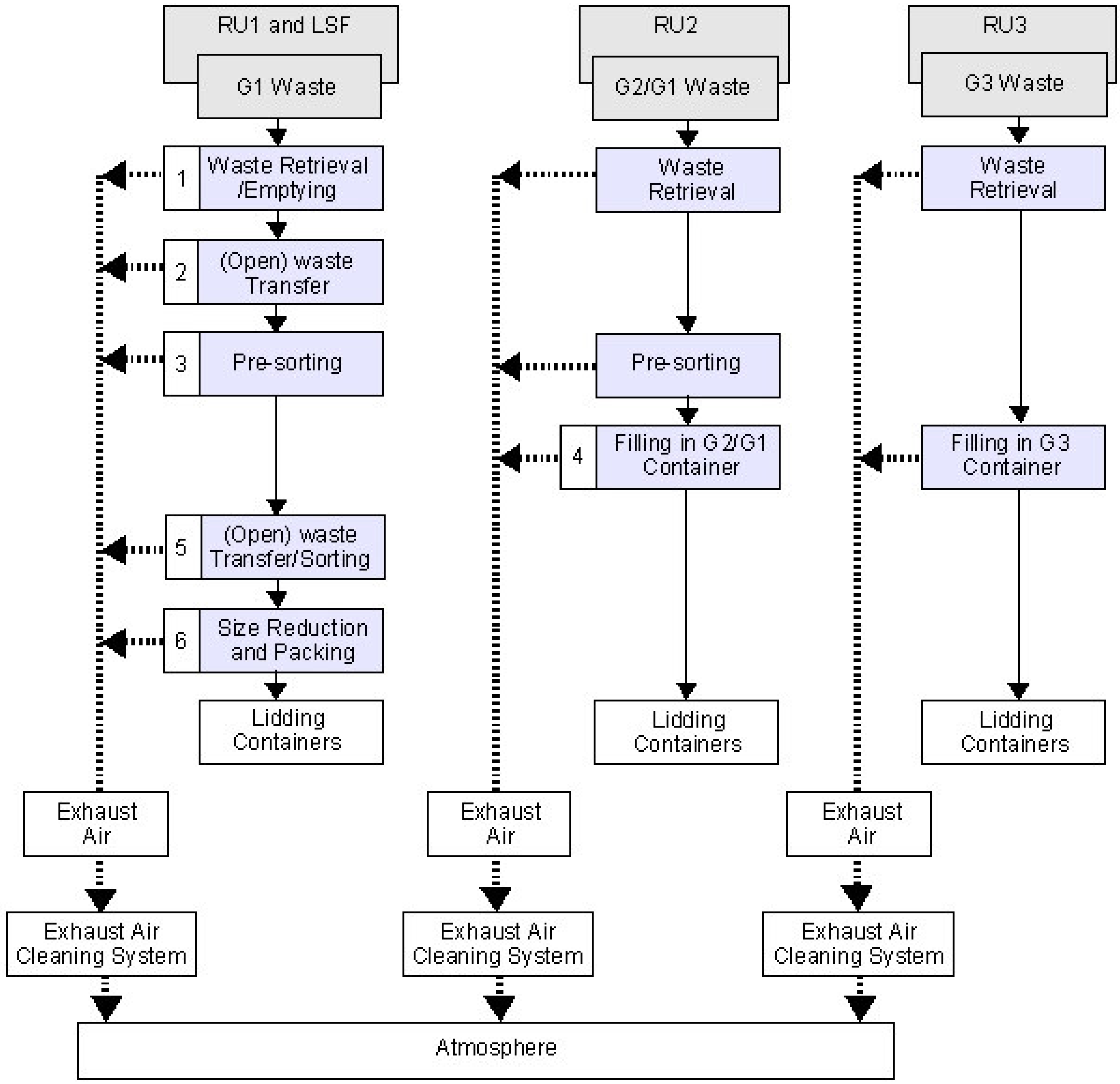


Figure 4.10 Potential sources of generation of airborne activity and airborne activity release pathways during normal operation of SWRF

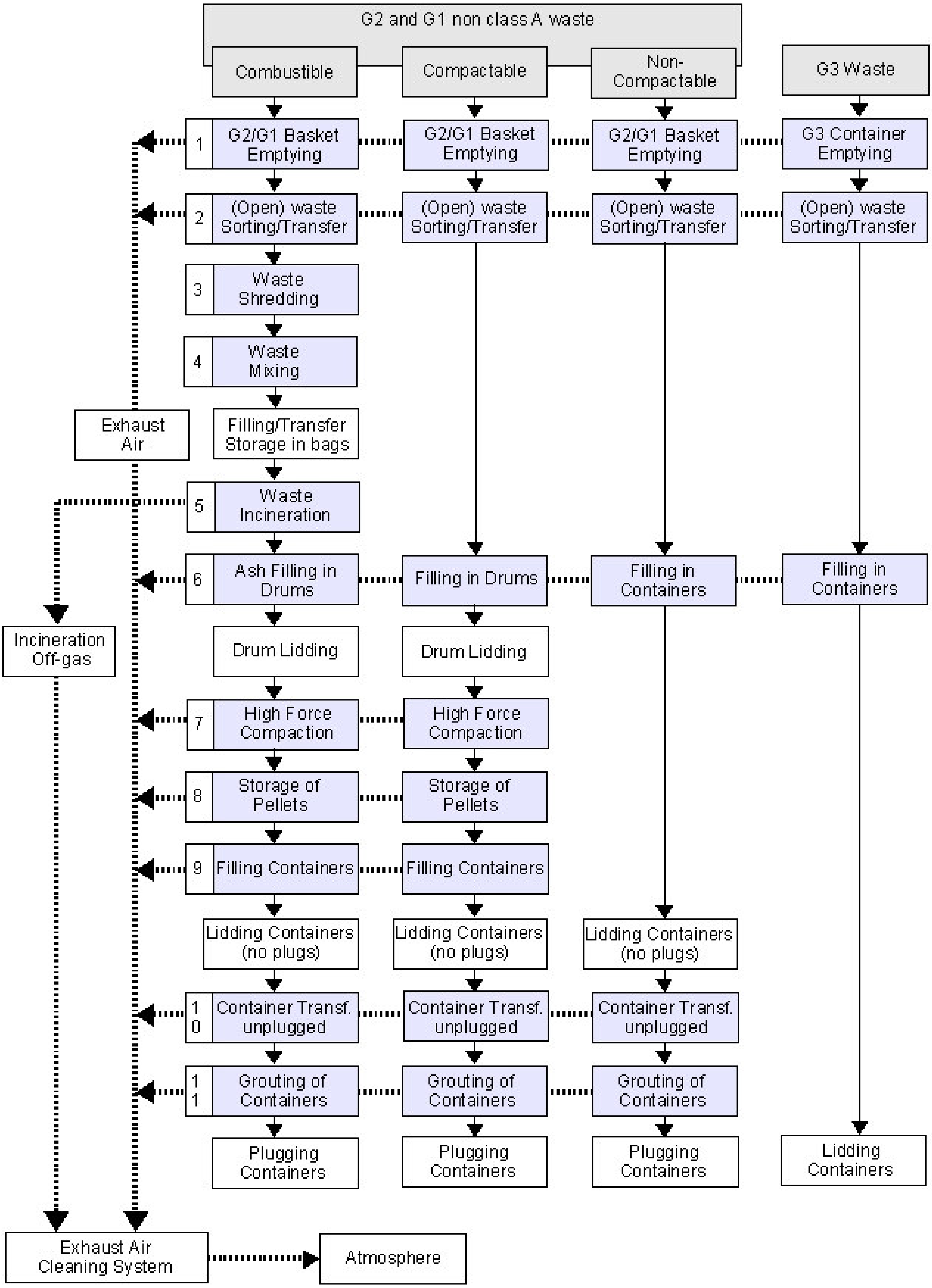


Figure 4.11 Potential sources of generation of airborne activity and airborne activity release pathways during normal operation of SWTF

4.3 Soil

The SWRF will be constructed at the INPP industrial site, within the controlled area of the existing radioactive waste storage facility. The area is smooth and contains artificially changed ground. Sandy formations, of various consistencies, prevail [39].

The surface of the SWTSF site has been artificially changed in the past (during the construction of INPP) and later re-cultivated. Construction site is thoroughly covered by mound soil: dusty sand, clay deposits of the low plasticity with organic admixture and locally encountered construction scrap. The thickness of mound is 0.3–3.2 m. Swamp sedimentation – well decomposed peat, clay deposits of the low plasticity with organic admixture, organogenic dust – are stratified on the shore-line of the swamp. The thickness of the layer is 0.8–5.9 m [41], [42].

The surface altitude varies from 151 to 160 m with general pitch to south – west direction, cf. Figure 4.12. Slopes of the hills are low-pitched, inter-hill is marshy, in some places there are trees, cf. panoramic photo of the proposed SWTSF and ISFSF sites presented in chapter "Graphic Materials". The trees have been planted about four years ago. There are trenches up to the depth of 3 m beside the western and southern side of the site.

During the site preparation activity the site surface will be smoothed. The waste arising is addressed in chapter 3 "Waste".

A fertile soil layer is found on the periphery of the site. The thickness of the layer is up to 0.3 m. During the site preparation activity a fertile layer of the soil (in average of about 0.15 m thickness) will be removed and stored separately in the special storage area nearby SE "Visagino transporto centras". To avoid erosion this layer will be sowed with lawn grass. Later this layer is intended to be used for SWTSF landscaping purposes.

Construction techniques minimizing soil erosion and the quantities of sediment in storm water runoff from the construction area will be implemented. Site grading and materials stockpiling will be performed using techniques designed to minimize the potential erosion of the topsoil. If necessary, and where appropriate, a temporary storm water sedimentation basin will be constructed that will control the peak flows of storm water runoff and allow for the settling of suspended sediment.

No soil pollution is foreseen under normal operation conditions of the proposed economic activities. The site area will be permanently monitored, cf. chapter 7 "MONITORING". In case of local soil contamination by conventional pollutants (i.e. accidental spillage of deliverables like cement etc.) or radioactive material (i.e. in case of a waste transfer accident) appropriate procedures will be implemented to eliminate the hazard and consequences of this impact.

The current radiological situation with respect to an environment soil component is described in chapter 7.3.

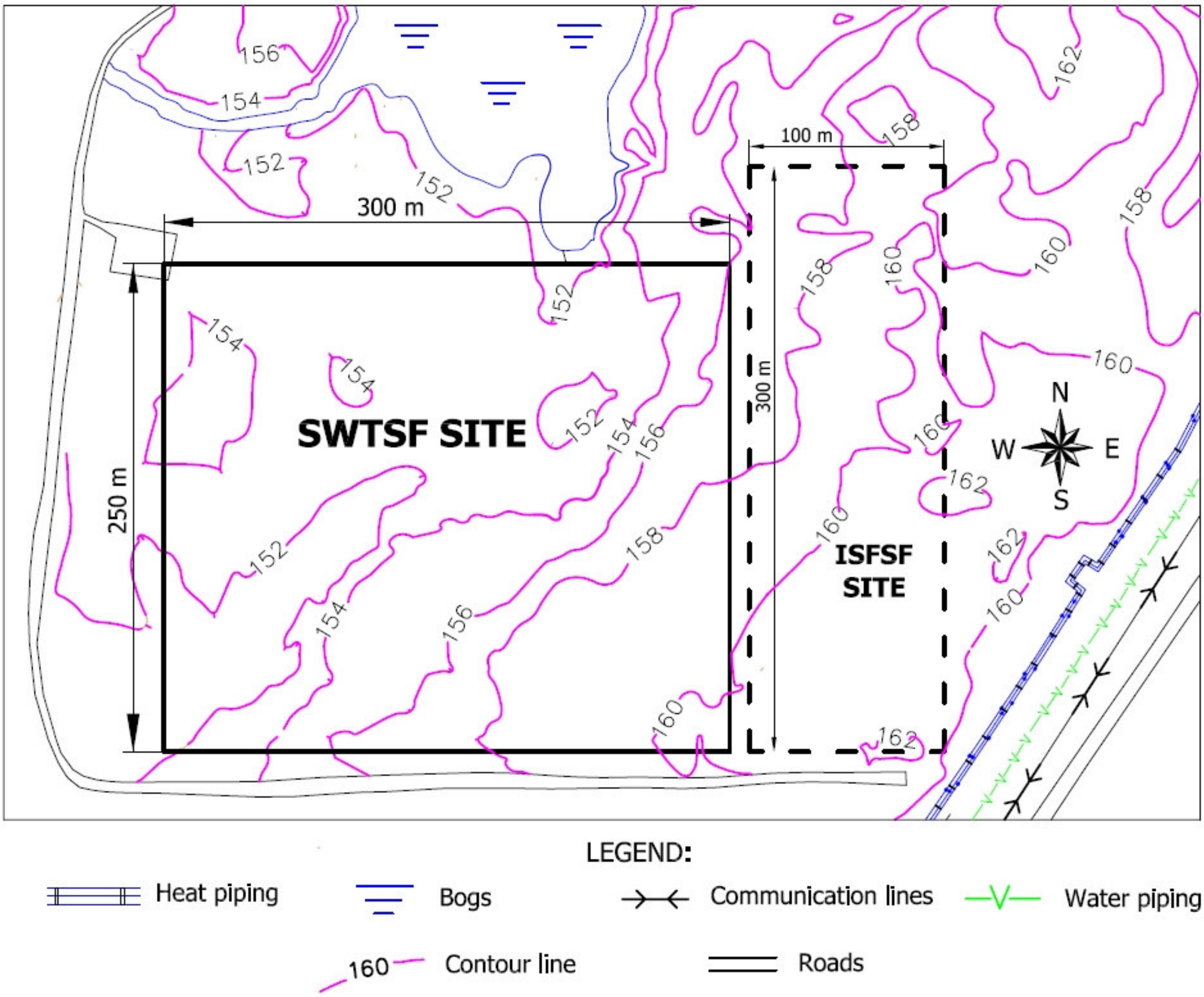


Figure 4.12 Relief of SWTSF and ISFSF sites

4.4 Underground (Geology)

4.4.1 Precambrian Crystalline Basement of the Region

The SWMSF sites are located in the western margin of the East European Platform. They are 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 [35].

The crystalline basement is buried to depth at about 720 m from the Earth's surface. 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 SWMSF varies in a 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 4.13 and Figure 4.14).

The Lower Cambrian is represented by quartz sandstone with inconsiderable admixture of glauconite, siltstone and shale. The sandstone is of different grain size with fine-grained and especially fine-grained sandstone predominating. The Middle Cambrian comprises the fine-grained and especially 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 – of 28–75 m and the total thickness of the Devonian sediments reaches 250 m [35].

4.4.2 Quaternary Cover of the Region

The Sub-Quaternary relief of the area is highly dissected by paleoincisions (Figure 4.15). 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). 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 4.16). The interstadial deposits are composed of very fine-grained and fine-grained sand, silt and peat. 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 [35].

4.4.3 Geologic Structure of the SWTSF Site

For the most part, the surface of the SWTSF site consists of the following mound (tplIV) soils: dusty sand [OH] and clay deposit of small plasticity [OT] with organic admixture. The thickness of the mound is 0.3–3.2 m [42].

The outside moraine (gtIII bl_o) of the Baltic stage lies underneath the mound soil and, in some cases, underneath a vegetative layer. It consists of clay deposit of small plasticity (TL) and, in some cases, of dusty clay (TU) mixed with gravel, pebble, and sporadically spread pebbles of dusty sand (SU_o; SU). The thickness of these sediments is 0.3–6.5 m. The outside moraine is locally covered by outside glaciofluvial formations of the Baltic stage: (ftIII bl), which consist of dusty sand (SU_o; SU). The thickness of the layer is 0.9–1.1 m. The zone of the bog bank is covered with the following wetland sediments (bIV): well decomposed peat (HZ), clay deposit of the low plasticity with organic admixture (OT), and organogenic dust (OU). The thickness of the layer is 0.8–5.9 m [42].

Within the SWTSF site limits, underneath the outside moraine, in the depth of 3.2–7.3 (145.5–154.1 m altitude) lie glaciofluvial sediments of Baltic–Gruda (fIII bl-gr) stages, which consist of dusty sand (SU_o; SU), in rare cases, of sand of bad underlying (SE) mixed with gravel and pebble, and also of dusty gravel (GU) mixed with pebble. Thixotropical pebbles of small plasticity dust (UL), which are up to 2 m thick, are found. The gIII gr relicts of Gruda stage's main moraine sediments (clay deposits of small plasticity (TL)) are also found [42].

The fluvioglacial sediments lying in the depth of 10.4–23.6 m (133.8–144.3 m altitude) are conditionally assigned to Medininkai stage, which is a stage of Gruda fIII-II gr-md. These mounds mostly consist of dusty sand (SU_o; SU) with an abundance of dusty (UL) thixotropine deposits of small plasticity and interlayers of clay deposits dusted (TU) with thixotropical pebbles. The total thickness of the sediments is 12.3–21.6 m [42].

The main bores reached main moraine sediments of glacial Medininkai stage (gII md), which are found in the depth of 30.8–36.1 m (altitude 118.5–126.3). They consist of clay deposits of small plasticity (TL) that are mixed with gravel and pebble [42].

So, geologic / lithologic structure of the SWTSF site is complicated because of the large amounts of lithologic layers, changeable shift of layer thickness and complicated stratification. The upper part (up to altitude 142.3–157.5) of the site surface has been identified as “weak” ground (poured ground, peat, sapropel, sand mellow). Only deeper located sandy and clayey sediments may be accepted as foundation base for construction works.

4.4.4 Tectonic Faults in the Region

Two types of faults were distinguished in the SWMSF area, i.e. the oldest pre-platform and younger platform features. The faults detected in the sedimentary cover are oriented N-S, W-E, NW-SE and NE-SW. The faults of the Druksiai Depression (Graben) and Anisimoviciu Graben are the most distinct tectonic features recognized in the study area. The Druksiai Depression (Graben) is as wide as 3–5 km; it consists of 0.5–1.5 km wide structural domains. The middle part of the graben is uplifted, representing the horst. The bounding faults exceed 20 km in length. The amplitude of the faults separating the horst is in the range of 25–55 m, the amplitude of the faults bounding the depression in the south and the north is about 10–20 m. The Anisimoviciu Graben is dissected by arcuate-shaped (in plan view) faults spaced at 0.5–0.7 km; the blocks stepping down to the northeast [35].

The length of the faults is about 10 km; the amplitude reaches 15–60 m. Total amplitude of the faulting with respect to the top of the Silurian is about 180 m. The faults striking N-S are common in the North Zarasai Structural terrace and eastern part of the South Druksiai Uplift. The eastern part of the North Zarasai Structural terrace is fragmented by faults bounding the narrow (0.5–1.5 km) horsts and grabens of sub-longitudinal orientation. The faults are as long as 5–9 km, the amplitude is in the range of 10–20 m. The Apvardai–Prutas and Macionys Grabens, bounded by 3–15 km long and 10–25 m amplitude faults, are mapped in the South Druksiai Depression.

The faults striking northeast and northwest are recorded in all tectonic structures (blocks) of the SWMSF area. Their length varies from 3–5 km to 15–18 km; the offset is of 15–20 m [35].

4.4.5 Neotectonics

It can be shown using morphometric, morphostructural and the interpretation of Satellite image data that most of the faults, penetrating the crystalline basement and sedimentary cover, are active neotectonically. As a rule, neotectonically active zones coincide with fault lines or are displaced near it. The faults system of the Druksiai trough, Anisimoviciu graben, and Skirnas fault are the most active. The paleoincisions are connected with neotectonically active zones. Their depth sometimes reaches 200 m (from the pre-Quaternary surface) [35], [43].

Tectonic scheme of the Ignalina NPP area is shown in the Figure 4.18.

4.4.6 Seismic Activity

Lithuanian territory is traditionally considered as non-seismic or low seismic zone. It depends on the geological structure of the territory and the long distance from tectonically active regions. Historical and recent instrumental data testify that seismic events of low or medium intensity have happened in territories of Baltic States (Figure 4.19) [44].

The most recent seismic events with magnitude of 4.4 and 5.0 after the Richter scale took place in Kaliningrad region of Russia in September 21, 2004. They were registered by seismological networks worldwide as well as by the seismological station of INPP.

Nineteen historical earthquakes took place within the radius of 250 km around the INPP since 1616 [45]. In the INPP region 4 seismological observation stations were installed in 1999. From then the Geological Survey of Lithuania according to an agreement with INPP processes and analyses the data gathered in these stations.

It is indicated [60] that earthquakes could reach an intensity of 6–7 grades on the MSK-64 scale in the seismically weak soil in the significant territory of the Baltic States and Belarus. As pointed out in [61], the same statement was formulated in 1988 by the commission investigating the possibility of constructing a third power plant unit at INPP.

Two types of earthquake conditions will be considered by design of the SWMSF – the design basis earthquake (DBE) and ultimate design basis earthquake (UDBE).

The DBE is defined as earthquake of maximal expected intensity with recurrence once in 100 years. The UDBE is defined as earthquake of maximal expected intensity with recurrence once in 10 000 years. The UDBE is more severe than DBE.

The terms DBE and UDBE originate from nuclear safety standards of former Soviet Union [48] and were used for designing of Ignalina NPP seismic-resistant structures, systems and components (SSC). The concept of DBE and UDBE is used in the updated nuclear safety standards of Russian Federation.

The parameters of DBE and UDBE for the INPP area are established on basis of extensive geological, geophysical, seismological and geotechnical investigations performed in the region for more than several decades. The INPP region local specific, regional aspects as well as historical context are also taken into account. The parameters for DBE and UDBE were revised by the Lithuanian Geological Survey [46] and are included into Technical Specification [8] which defines the design requirements for the SWMSF. The DBE for Ignalina NPP area is defined as grade 6 (according MSK-64 scale) level earthquake with maximal ground acceleration of 0.05 g. The UDBE for Ignalina NPP area is defined as grade 7 (according MSK-64 scale) level earthquake with maximal ground acceleration of 0.1 g.

The soil category of the site is of class III [48]. Weak liquefied soils (dusty sand – SU_o), thixotropical soils (dust deposit of small plasticity – UL), and dusty clay (TU) of the third seismic category, which are sensitive to dynamic impact, are commonly found in the SWTSF site [42]. Therefore the design will consider necessity to improve foundation base for the building structures of the SWTSF.

Recently, a new regulation [47] on design of seismic-resistant NPP has been introduced in the Lithuania. The new regulation is based on IAEA recommendations and defines two design levels for potential earthquakes – the seismic level 1 (SL-1) and seismic level 2 (SL-2). In the new regulation the DBE corresponds to the SL-1 and UDBA corresponds to SL-2.

4.4.7 Geomorphology and Topography of the SWTSF Site

From a geomorphological point of view the SWTSF site is dislocated in the Gaide glaciodepression of the Baltija Highland to the south of the lake Druksiai. The site is surrounded by hummocky moraine landscape of the marginal zone of the last (Nemunas) glaciation. The hummocky landscape of this depression is interspersed with numerous individual glacial forms such as kames, eskers, glaciofluvial hills and other ice-crevice forms [35].

The SWTSF site is located on a swathe of fringe formations and on the limits of two flat fluviolkamic hills with an interfoot. The slopes of hills are low-pitched. The interfoot is waterlogged. The surface altitude varies from 151 to 160 m with general pitch to south–west direction [42] (see Figure 4.12).

4.4.8 Possible Impact on Underground

The proposed economic activity will not affect the underground component of the environment. The buildings and infrastructure will decrease the area of the permeable surface; therefore it may reduce rain water infiltration. According to the land use in the area and the relatively small surface used by the project, this effect is not significant.

No valuable natural resources have been found or are expected to be found at the INPP and SWTSF sites. The planned economic activity under normal operation conditions will have no effect on possible off-site activities in the vicinity.

The SWTSF site was selected to be aside the identified tectonic faults zones.

The site seismic characteristics will be considered during preparation of Technical design and Safety Analysis Report (SAR).

4.4.9 Drawings of the Chapter "Underground (Geology)"

The following Figures are attached to the chapter "Underground (Geology)":

Figure 4.13 Pre-Quaternary geological map of the SWMSF region;

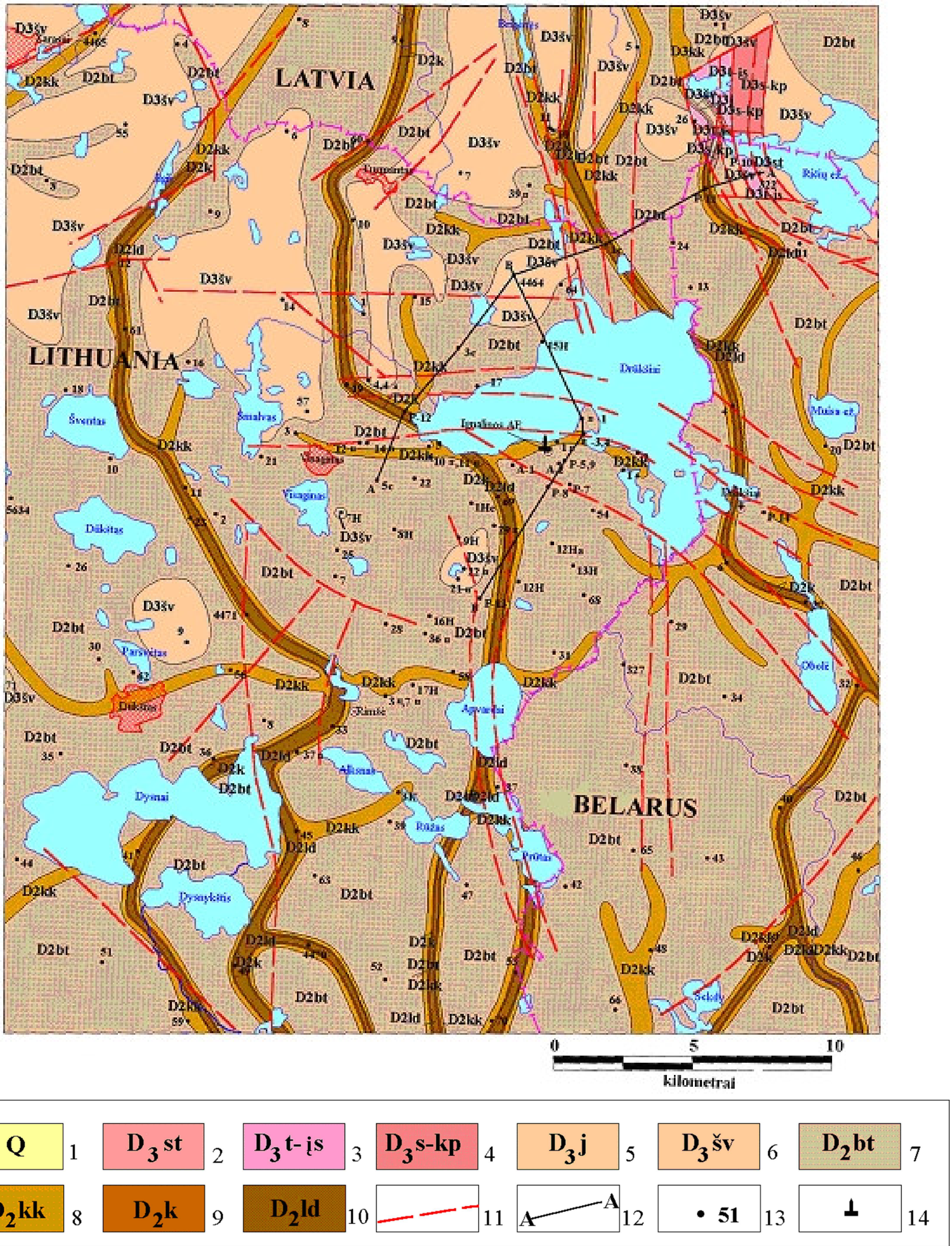


Figure 4.13 Pre-Quaternary geological map of the SWMSF region [35]

In the Figure: 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 – Ignalina NPP and SWMSF

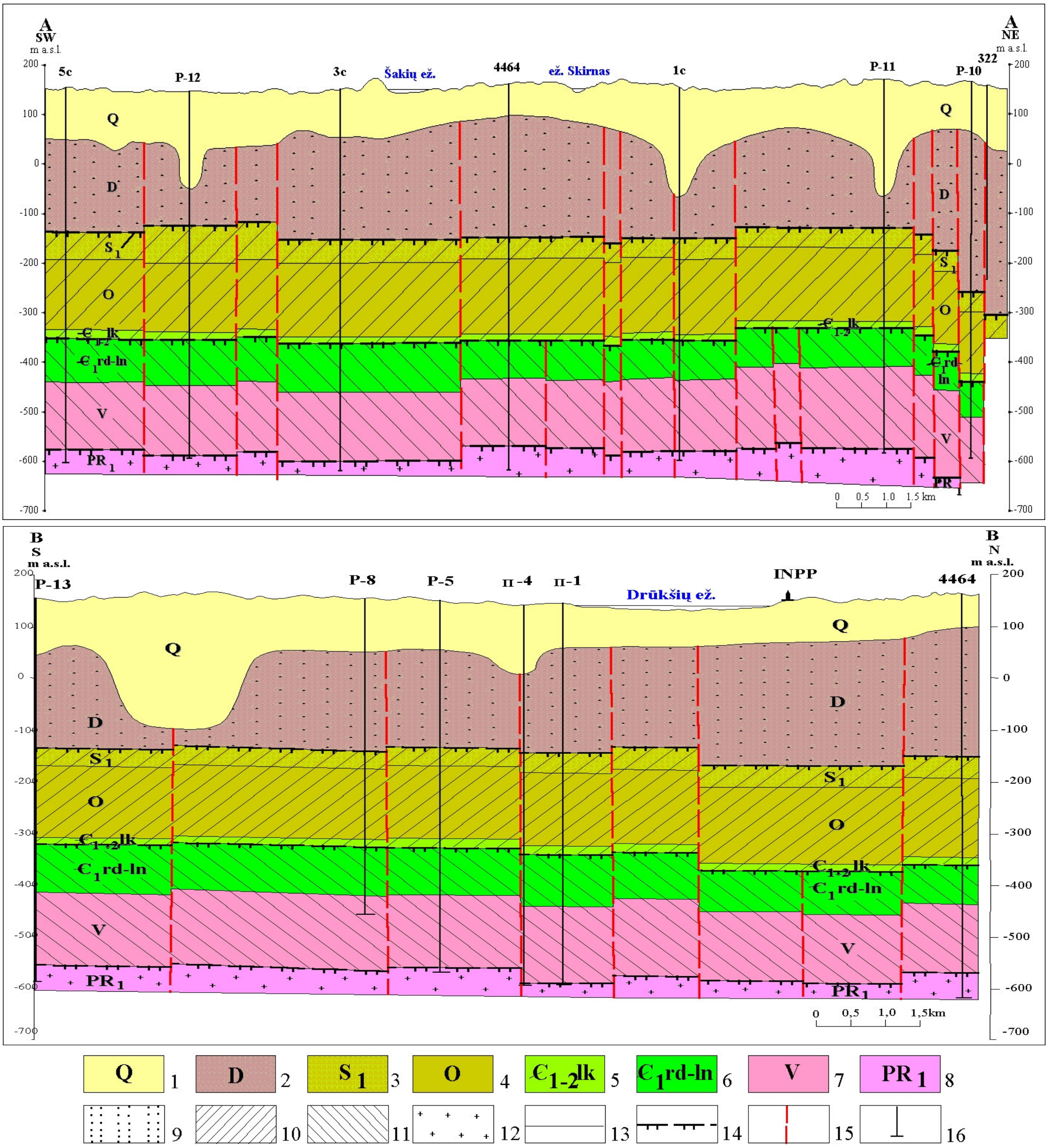


Figure 4.14 Geological-tectonic cross-sections of the SWMSF region [35]

In the Figure: 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

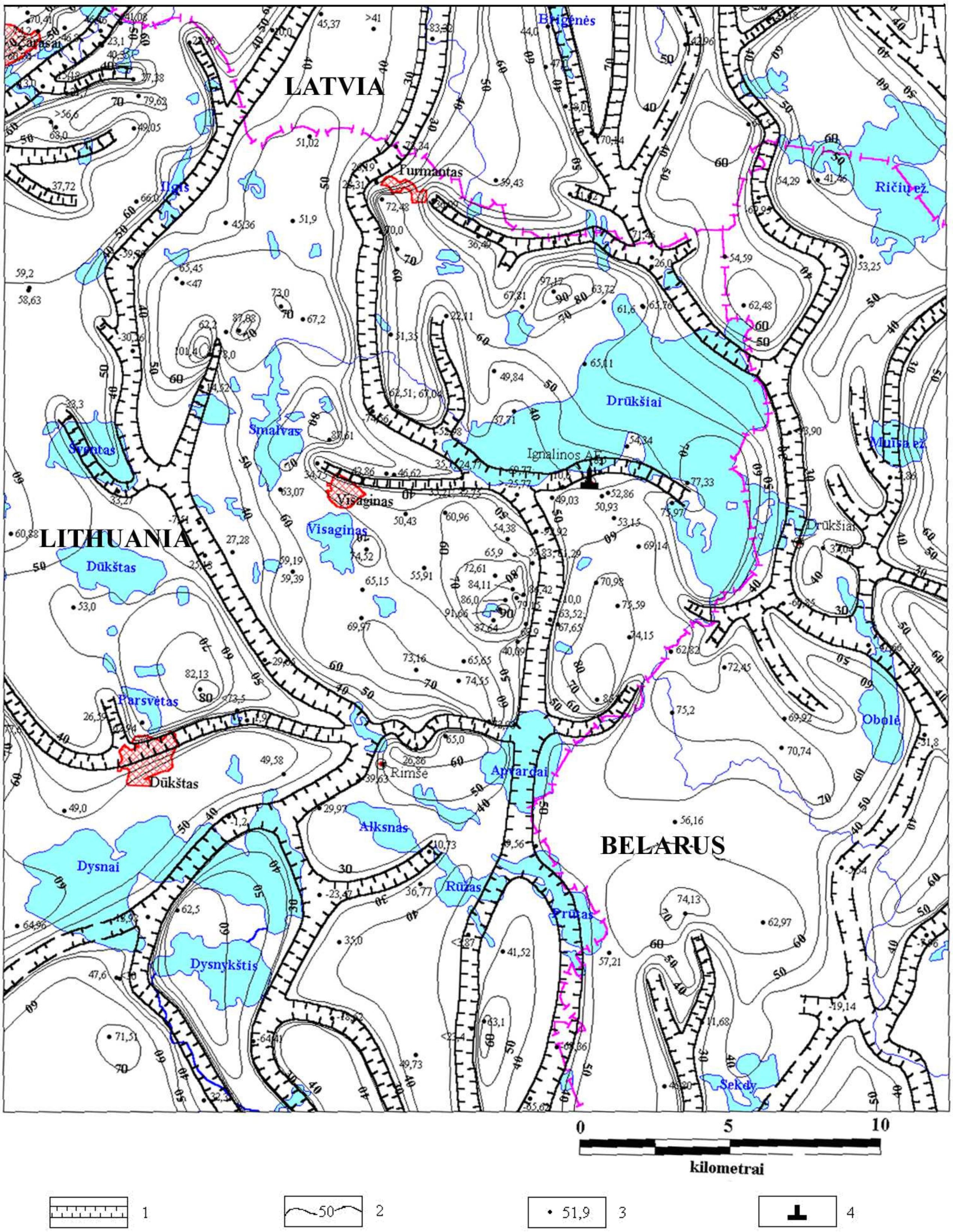


Figure 4.15 Scheme of sub-Quaternary surface of the SWMSF area [35]

In the Figure: 1 – Paleoincision; 2 – Isohypse of pre-Quaternary surface, m; 3 – Boreholes and the absolute depth of the pre-Quaternary surface: 4 – INPP and SWMSF

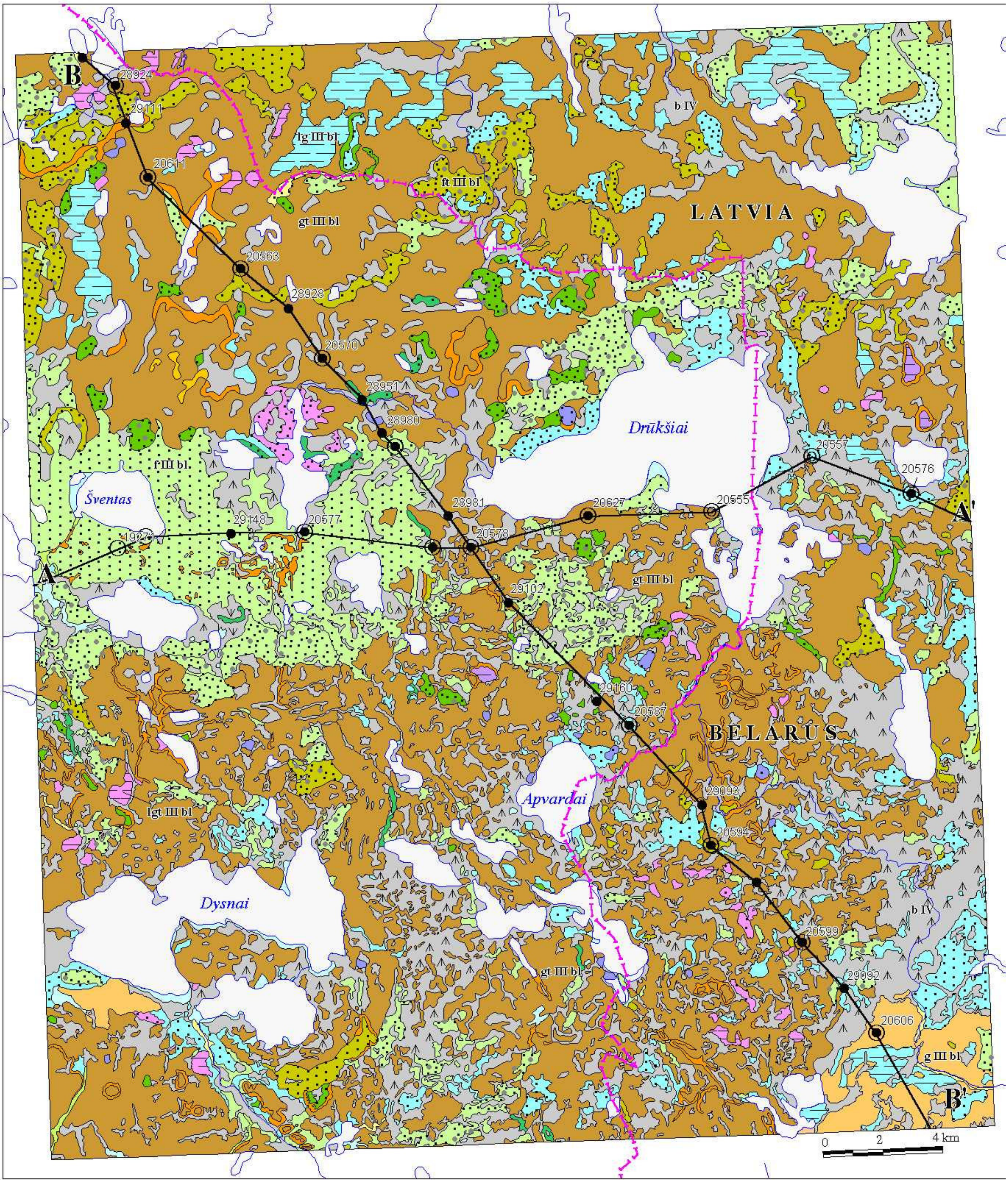


Figure 4.16 Quaternary geological map of Ignalina NPP area

Original scale 1:50 000, author: R. Guobyte [35]. Legend is provided in the Figure 4.17, below. Quaternary geological cross-sections A-A' and B-B' are provided in chapter "Graphic Material".

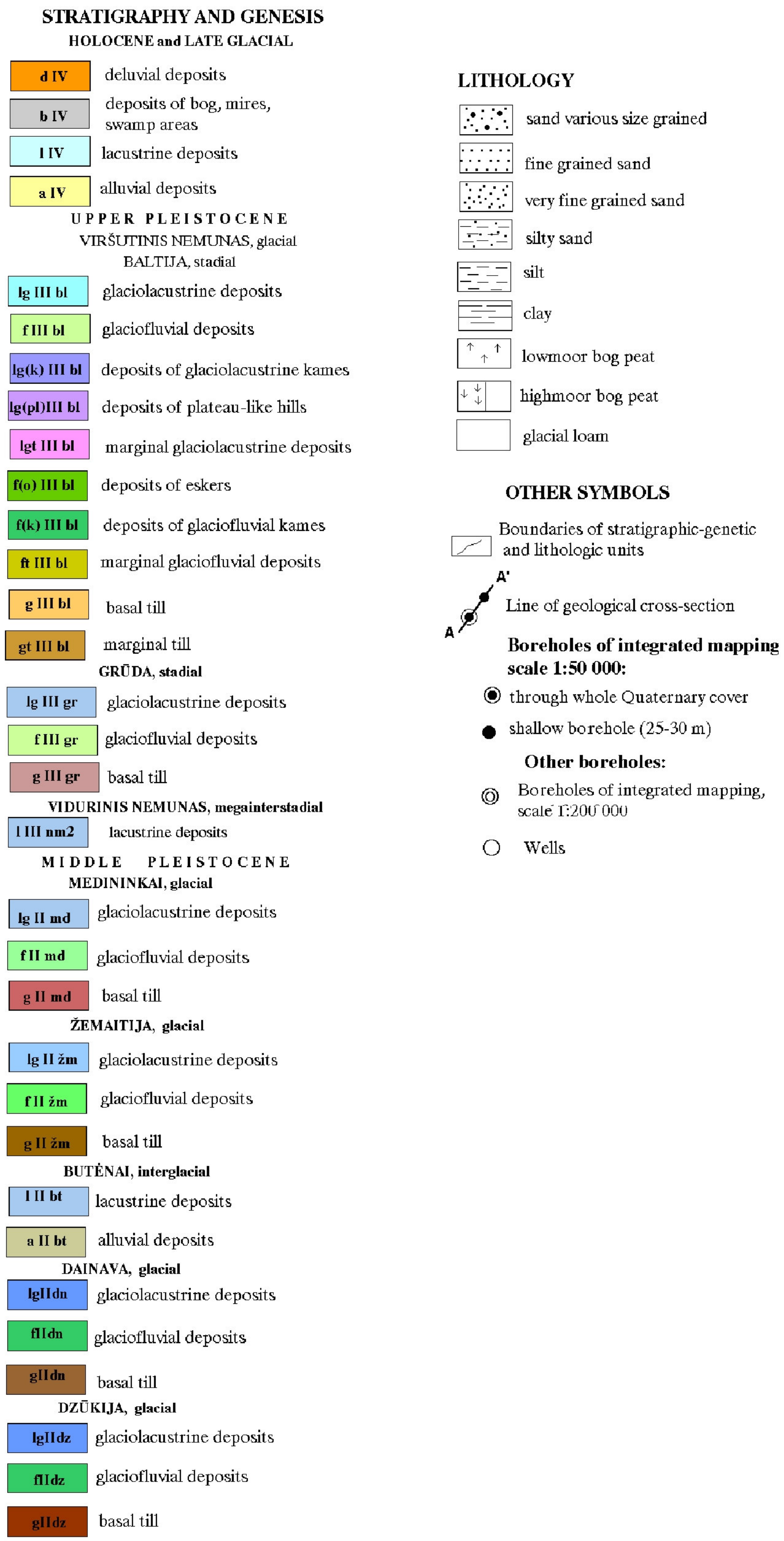


Figure 4.17 Legend for Quaternary geological map and geological cross-sections of the region

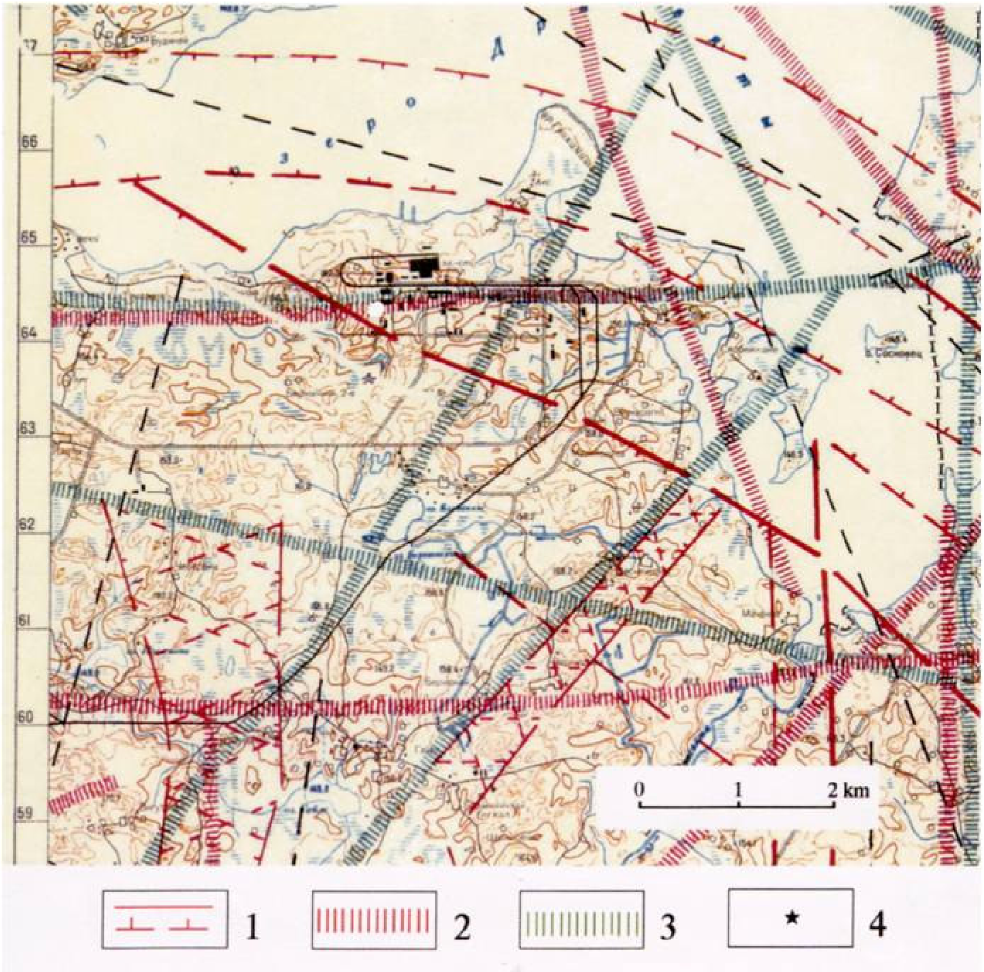


Figure 4.18 Tectonic scheme of the Ignalina NPP area

1– Tectonic faults; 2– Neotectonic zones by morphometric analysis; 3– Neotectonic zones by morphostructural analysis [35]

Figure 4.19 Seismicity of Baltic States

In the Figure: circles – historical events from 1616 to 1965; hexagons – instrumental data from 1965 to 2004; triangles – operative seismic stations

4.5 Biodiversity

The SWRF will be constructed and operated within the existing INPP industrial site. No biodiversity, which has to be protected at INPP industrial site, is identified. The activity will have no relevant interaction with biodiversity outside the INPP industrial site.

The SWTSF will be constructed and operated in the close vicinity to the INPP site and within limits of the INPP allocated land of industrial purpose, cf. chapter 1.7. The SWTSF area is relatively small. The surface of the SWTSF site has been artificially changed in the past (during the construction of INPP) and later re-cultivated [41]. No biodiversity, which has to be specially protected at the SWTSF site or in the close vicinity, is identified.

The LR government proposed NATURA 2000 network areas around the INPP and SWTSF sites are indicated in Figure 4.20 [62], [63]. Details on protected species and species related forbidden activities are summarized in Table 4.17. The potential NATURA 2000 network objects are distant from the SWMSF sites and will not be affected by the proposed economic activity. Except for the construction activity (which will be short in time, and special mitigation measures can be applied, if necessary) the proposed economic activity will have no relevant interaction with the biodiversity outside the boundaries of the SWMSF sites. No protected habitat or species are observed on the SWMSF sites.

An impact during the construction phase is the nuisance on breeding birds by the construction machines due to exhaust fumes, noise and visual irritations. It is anticipated that due to the disturbance the area around the SWTSF may be slightly devaluated as bird habitat. The main impact mitigation measure is that noisy activities will be carried out during daytime only.

The intensive presence of workers in else relatively quiet areas is a major disturbance factor which is more severe than vehicles or machinery. Therefore the construction area of the SWTSF will be fenced off.

To avoid unnecessary deterioration of vegetation communities and habitat functions the construction site will be limited to the minimum area needed for the SWTSF works, and materials will be handled within the construction site. The removed vegetation at the construction site and local borrow areas will be replanted after finalization of the SWTSF works. Vegetation replanted will be a mix of the local observed species.

Table 4.17 Protected species and species related forbidden activities in potential NATURA 2000 areas

Potential NATURA 2000 object	Protected species	Species related forbidden activity [64]
Lake Druksiai and parts of its protected area	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.
	Otter (Lutra lutra)	Canalizing of rivers and brooks, drying of habitations; Hunting with use of traps; Boating with motorboats from May to July; Fishing using nets and hoop-nets, which are not specially designed to protect otters.
Lakes Dysnai and Dysnykstis and of parts of their protected areas	Corn Crake (Crex crex)	Change the land usage main purpose excepting cases of changing to more conservative purpose; Convert meadows and pastures into ploughland. Change the hydrological regime if it leads to decrease of habitability area or quality; Plant forest.
Smalva hydrographical reserve	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.
	Otter (Lutra lutra)	Canalizing of rivers and brooks, drying of habitations; Hunting with use of traps; Boating with motorboats from May to July; Fishing using nets and hoop-nets, which are not specially designed to protect otters.
Parts of Grazutes regional park	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, expand infrastructure (in certain areas).

Potential NATURA 2000 object	Protected species	Species related forbidden activity [64]
	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 4.20 Proposed NATURA 2000 areas around the INPP and SWTSF sites

1 – Lake Druksiai, 2 – Smalva hydrographical reserve, 3 – Smalva landscape reserve, 4 – Grazute regional park, 5 – Lakes Dysnai and Dysnyksciai, 6 – Pusnis telmological reserve.

A – site of the Ignalina NPP, B – proposed sites for the SWTSF and ISFSF.

4.6 Landscape

The SWRF will be constructed and operated within the INPP industrial area. No impact on the existing landscape can be expected.

The SWTSF will be constructed and operated in the close vicinity to the INPP industrial area. From the architectural point of view the SWTSF building will have a clean functional design. Architectural design control can assure building visibility. The ISFSF building will be located aside.

The valuable landscape areas (like Grazute Regional Park and Smalva hydrographic reserve) are distant from the locations of the proposed economical activity, cf. Figure 4.20, above. The proposed economical activity will have no relevant impact on the landscape component of the environment. The present landscape of the proposed SWTSF and ISFSF sites is given in the panoramic photo presented in chapter “Graphic Materials”.

4.7 Social and Economic Environment

The proposed economic activity will be held within and in the close vicinity to the INPP industrial site and within the existing 3 km radius sanitary protected zone of INPP. The minimal distance from the SWMSF site to the boundary of the existing sanitary protected zone is about 2 km. There is no permanently living population within the existing sanitary protection zone, and the economic activity is limited as well.

The SWMSF as a nuclear object will have established its own sanitary protection zone. It is planned that the SWMSF sanitary protection zone will remain within the boundaries of the existing INPP sanitary protection zone.

Benefits associated with the proposed SWTSF site include:

- Already existing INPP infrastructure suitable for the SWTSF operation;
- A short distance to the SWRF site reducing the need for the transportation of radioactive waste over long distances;
- Nearby sources of hot and potable water, electricity, telecommunications, alarms, fire protection etc.;
- A local work force with a high skill level associated with work in the nuclear industry;
- A site in the industrial area that would not require the disturbance of any ecologically sensitive land with less work being required with regards to site preparation prior to construction.

No impacts or evident changes of social and economical environment are foreseen. The facilities will be constructed and erected contracting local civil engineering companies. The project will employ up to 70 people during the 1.5–2 year construction period. Necessary labor resources to operate facilities are available at INPP. Moreover, this project will decrease the social and economic effects of decommissioning the INPP by using the human resources currently available at the INPP. During the operation, the new SWMSF will provide direct employment for about 85 employees (about 60 employees will be necessary to operate the SWTSF and about 25 employees will be necessary to operate the SWRF) as well as indirect employment for the service workers. The training of the operating personnel will be organized within the scope of supply.

The new SWMSF will be constructed in accordance with the modern environmental requirements using state-of-the-art technologies. The new SWMSF will provide a modern solid radioactive waste management and storage system for existing, future operational and decommissioning waste. The new practice shall bring the management of the radioactive waste in Lithuania in compliance with the radioactive waste management principles of the IAEA and in compliance with good practices in other European Union Member States.

The calculations and assessments performed in this EIA Report have clearly shown, that the proposed economic activity will not produce significant impacts, neither of radiological nature nor of non-radiological nature, which could physically affect public health.

The proposed economic activity represents the large EU direct investment for the INPP decommissioning. This large infusion of new capital into the region will improve the investor's confidence in the domestic and international markets.

However, population discontent and distrust is possible. Such a psychological impact is stipulated by the changes in the existing nuclear practice (shut down and decommissioning of INPP), which result in the construction of new nuclear objects such as SWMSF and others. The psychological impact can be mitigated explaining the necessity for, goals of and benefits from the proposed economic activity. The proposed economic activity which intends to introduce advanced and proven waste management technologies for converting of existing radioactive waste into a long term stable and storage safe form will increase nuclear safety and reduce the risk of possible accidents as compared with the existing waste management and storage practice.

4.8 Ethnic and Cultural Conditions, Cultural Heritage

The majority of the residents of the town of Visaginas are Russian or Russian speakers. Insufficient knowledge of the state language makes the integration of the employees dismissed from INPP into other districts of Lithuania rather complicated. The construction and operation of the new SWMSF will provide long-term employment for up to hundred people and help them to integrate into the local community.

Cultural heritage objects identified in the vicinity of the INPP and SWTSF sites are shown in Figure 4.21.

The SWRF will be constructed and operated within the INPP industrial area. The activity will have no relevant interaction with the ethnic and cultural conditions, cultural heritage outside the INPP industrial area.

The SWTSF will be constructed at the site, which has been artificially changed in the past (during the construction of INPP) and later re-cultivated. There are no detected objects of cultural heritage or ethnic or cultural conditions that could be impacted by the proposed economic activity. The proposed economic activity will have no relevant interaction with the ethnic and cultural conditions, cultural heritage outside the boundary of SWTSF site.

The geologic / lithologic structure of the SWTSF site has been investigated by drilling a lot of bores. The main bores reached the depth of 40 m (see chapter 4.4). No traces of archaeological objects have been found.

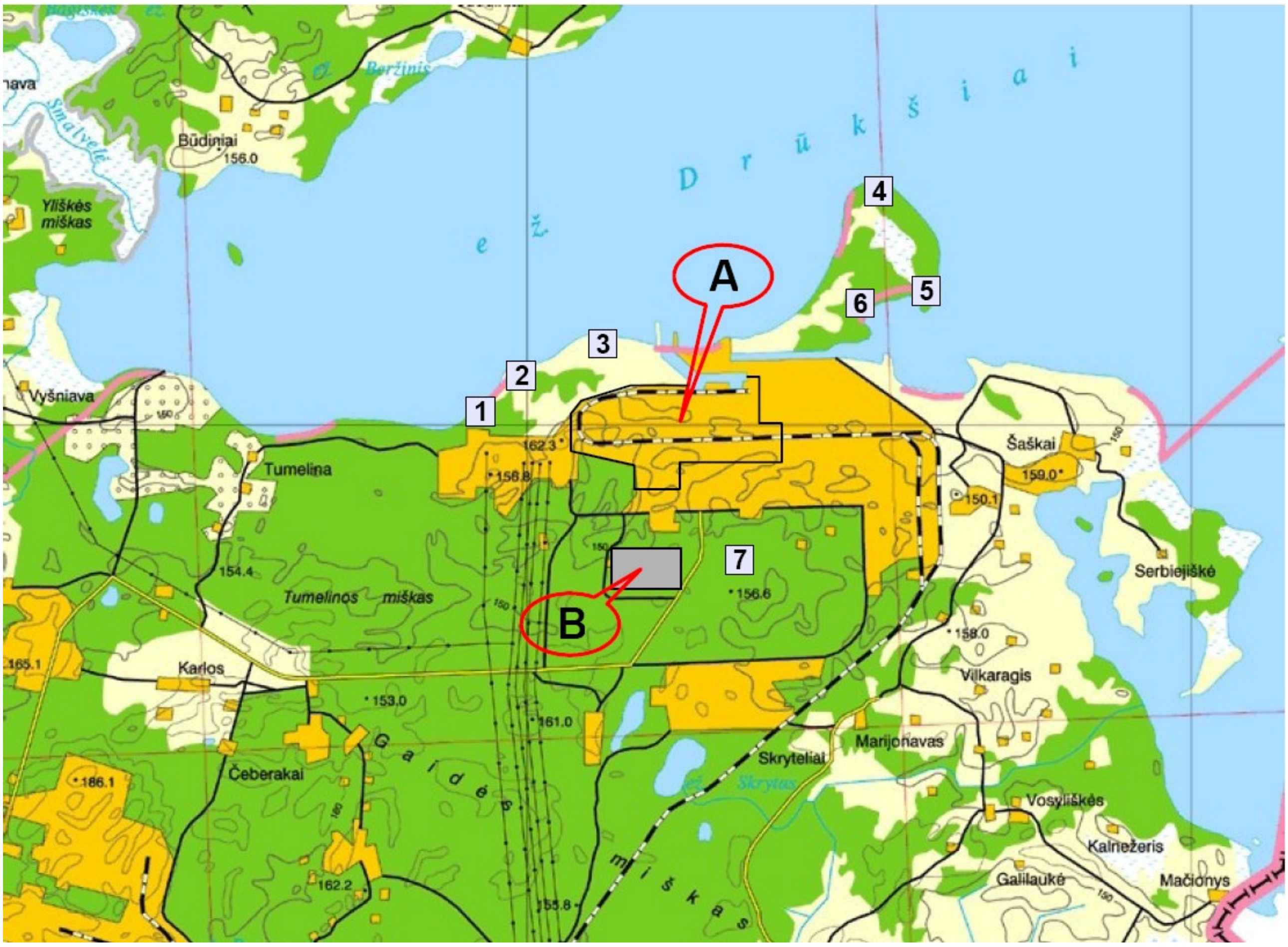


Figure 4.21 Cultural heritage objects in the vicinity of the INPP and SWTSF sites

1 – Petriskes settlement antiquities I; 2- Petriskes mound; 3 – Petriskes settlement antiquities II; 4 – Grinkiskes settlement antiquities III; 5 – Grinkiskes settlement antiquities II; 6 – Grinkiskes settlement antiquities I; 7 – Stabatiskes manor place.

A – site of the Ignalina NPP, B – proposed sites for the SWTSF and ISFSF.

4.9 Public Health

4.9.1 General Information

The proposed economic activity will be held within and in the close vicinity to the INPP industrial site and within the existing 3 km radius sanitary protected zone of INPP. The minimal distance from the SWMSF site to the boundary of the existing sanitary protected zone is about 2 km. There is no permanently living population within the existing sanitary protection zone and the economic activity is limited as well. The proposed economical activity will be distant (at least during most active phases as waste retrieval, transfer and treatment) from permanently living population.

The potential public health impact sources of conventional (i.e. non radiological) nature could be noise and airborne pollutants. Local noise increase might be expected during the SWMSF construction works. Other local noise increase sources might be radioactive waste transfer from the SWRF and INPP to the SWTSF. Once operational, the incineration facility will result in emission of certain amount of airborne pollutants. The proposed economic activity will not produce any other significant impacts of conventional nature, which could physically affect public health.

The potential public health impact source, which also has to be considered, is the ionizing radiation. Potential impact (dose to member of public) may result due to the release of airborne activity, cf. chapter 4.2.3.2, or due to the direct irradiation from structures containing radioactive materials. No release of activity into a water component of the environment from the proposed economical activity under normal operation conditions is planned.

Occupational exposure is not addressed in this EIA report. Practically proven and widely used radioactive waste management technologies will be implemented by the proposed economic activity. Operations, which present direct hazard (like waste retrieval, sorting etc.) will be operated remotely. The personnel will stay in premises where radiological-safe working conditions [77] are assured and therefore the limits for occupational exposure are not exceeded. Only exceptional cases (equipment failure, emergencies, maintenance etc.) will require human intervention. Such occupational exposure will depend on a variety of factors, which have to be adjusted during the Technical design (like equipment design and working place arrangements, organization of working activity, application of ALARA and implementation of mitigation measures, if necessary). In most of the cases applicable to this proposed economical activity the occupational exposure will depend on appropriate shielding design, exposure prevention and control measures. The existing INPP radioactive waste management practice (the same waste will be managed by the proposed economic activity) shows that the occupational exposure can be successfully handled within safe limits.

The occupational exposure will be evaluated in the preliminary SAR, which is based on the Technical design. In accordance with the best international practice and IAEA recommendations, the safety assessment will be undertaken in conjunction with the planning and design of the proposed activity rather than being a separate activity. The results of the safety assessment will be used to determine any necessary changes in the design so that compliance with the safety requirements is assured. As practically proven radioactive waste management technologies are planned, no problems from the technological point of view can be foreseen. Therefore the proposed economic activity can be implemented assuring occupational exposure to be within the limits as prescribed by the radiological safety standards in force and in line with the ALARA principle.

4.9.2 Potential Impact

4.9.2.1 Non Radiological

4.9.2.1.1 Airborne Pollutants from Incineration Facility

The near surface concentrations of airborne emissions are calculated in chapter 4.2.3.1.2. The calculations are based on the emission limit values set out in the Lithuanian regulations in force [20] and the European Parliament and the Council Directive 2000/76/EC [19] which are the design requirement for an incineration facility. The calculation results demonstrate that near surface concentrations of airborne pollutants do not exceed concentration limits as defined in Lithuanian Hygiene Standard HN 35:2002 [56].

4.9.2.1.2 Noise

The construction of the SWMSF will take approximately 2 years. Local noise increase might be expected during SWMSF construction works. Such impact, conventional for any construction activity, could be relevant only in close vicinity of SWTSF and SWRF sites where is no permanently living population. Since construction machines operate intermittently and the types of machines in use at the construction site change with the phase of the project, the noise emitted during the construction will be variable. However, since the nearest residential properties are located at least 2 km away from the SWTSF and SWRF sites, it is expected that construction noise will rarely exceed the existing levels.

Account will be taken of the possibility of multiple noise sources emitting simultaneously. If necessary, the noise level in the open air will be measured at locations in which such noise is perceived most clearly.

Account will be taken of the possibility of multiple noise sources emitting simultaneously. The noise level will be measured if such noise is perceived most clearly. If necessary, the works will be stopped and means for noise reduction will be implemented. Consequently, the construction activities will have minimal and temporary impacts on the noise environment at the locations of the nearest residential receptors.

With termination of construction works the amount of potential noise impact sources will reduce. The construction machines will be removed from the sites, the transport of construction materials will be terminated. The radioactive waste management equipment will be installed in separate compartments (due to radiation protection reasons) and will be operated remotely. Premises of operators can be adequately isolated if necessary. Operational practice of similar radioactive waste treatment equipment shows that these installations are not exceptionally noisy. In addition, the equipment inside the SWMSF will be shielded by the building structure. Once operational the SWTSF will produce no noise that will be perceptible at the nearest residential receptors.

4.9.2.2 Radiological

4.9.2.2.1 Radiological Impact due to Release of Airborne Activity

4.9.2.2.1.1 Method to Assess Radiological Impact

The radiation exposure of the critical group members of the population in the environment of INPP resulting from the determined release of radioactive material with air is calculated using appropriate models as recommended by the IAEA publication Safety Report Series No. 19 [66].

This Safety Report is intended to be a complete and self-contained manual describing a simple but robust assessment methodology that may be implemented without the need for special computing facilities. The report also describes a procedure for the application of the methodology to the assessment of impact from radioactive discharges into the environment. The report is primarily addressed to the national regulatory bodies and the technical and administrative personnel responsible for performing environmental impact analyses.

The application of the IAEA recommendations is in line with the requirements of the Technical Specification [8] – "All work carried out for or in connection with the SWMSF shall comply with and follow the recommendations of IAEA as defined in the relevant IAEA guides". The application of the methodology [66] is in line with the requirements of the Lithuanian normative document LAND 42-2007 [65] where the use of this methodology is recommended also.

The models selected [66] for this impact assessment include and consider all main airborne activity migration pathways as relevant for the environment of the SWMSF sites:

- The calculation of atmospheric dispersion and the resulting near-ground concentration of the released airborne activity at the sites specific exposure locations;
- The calculation of the external exposure annual effective dose to the human due to the submersion into a radioactive cloud and the internal exposure dose due to the inhalation of the air containing radioactive material;
- The calculation of the deposition of radioactivity on the ground and the calculation of the external exposure annual effective dose to the human from the soil contaminated by the deposited activity;
- The calculation of the deposition of radioactivity on the pasture field. The calculation of the activity accumulation in the pasture grass, transfer of activity into animal feed and calculation of the internal annual effective dose to the human due to consumption of the main animal products - milk and meat;
- The calculation of the deposition of radioactivity on the pasture field. The calculation of the activity accumulation in the crop field, transfer of activity into crop products and calculation of the internal annual effective dose to the human due to the consumption of crop products;
- The calculation of the deposition of radioactivity on the water body - Lake Druksiai including an account for activity transferred into the water body from the Lake catchment area. The calculation of the radioactivity concentration in the water and the accumulation of activity in the fish. The calculation of the annual effective dose to the human due to the consumption of the fish products;
- Effective doses are calculated for two age groups of critical group members – adults (age > 17 years) and infants (1-2 year).

The total annual effective dose E resulting from external and internal exposure pathways is calculated according to the following formula:

$$E = \sum_j H_j + \sum_j e(g)_{j,ing} I_{j,ing} + \sum_j e(g)_{j,inh} I_{j,inh}$$

Where:

H_j is a critical group member annual dose equivalent due to the external exposure from radionuclide j;

$e(g)_{j,ing}$ and $e(g)_{j,inh}$ are the committed effective doses per unit intake by ingestion and inhalation for radionuclide j by the age group g [114];

$I_{j,ing}$ and $I_{j,inh}$ are the annual intakes via ingestion or inhalation of radionuclide j.

The Gaussian plume model is applied to assess the dispersion of long-term atmospheric releases. This model is widely accepted for use in radiological assessment activities [67]. The model is considered appropriate for representing the dispersion of either continuous or long-term intermittent releases within a distance of a few kilometers of the source.

These new SWRF and SWTSF will be constructed in the INPP existing sanitary protection zone where is no permanently living population. Therefore the impact to population is assessed considering hypothetical critical group (c.f. recommendations of the article 7 of LAND 42:2007 [65]) for which the impact in the surroundings of SWRF and SWTSF sites would potentially be highest. The exposure doses are calculated for the locations of the highest impact (i.e. where maximal near ground concentrations or maximal dose rates are expected) assuming maximal annual exposure duration (2000 h within the SPZ and 8760 outside the SAZ). The EIA approach in selection of critical group and estimation of potential impact shall be considered as conservative because exposure of members of any realistic critical group will be lower.

The main parameters used for airborne dispersion, activity migration and human exposure calculation are summarized and discussed in Table 4.18. The proposed economic activity will be held at separate sites, i.e. the SWRF and the SWTSF. Therefore the locations of the maximal exposure are different, and the radiological impact for each specific site is addressed separately. Details on the mathematical models can be found in [66].

4.9.2.2.1.2 Radiological Impact due to Release of Airborne Activity at the SWRF Site

The annual average doses to a member of the critical group are calculated assuming an effective emission height of 15 m for atmospheric discharges from the RU1 stack and an effective emission height of 27 m for atmospheric discharges from the RU2 and RU3 stacks. In terms of atmospheric dispersion, the activity release takes place outside the airflow zone which can be influenced by the building structure (the effective release height is 2.5 times greater than the building height). Under these conditions the maximum airborne near-ground activity concentration for the releases from the RU1 is expected at a distance of about 200 m from the stack, c.f. Figure 4.22. The maximum airborne near-ground activity concentration for the releases from the RU2 and the RU3 is expected at a distance of about 400 m from the stack, cf. Figure 4.22.

The approximate distances from the SWRF site to the INPP site security fence are as follows: to the north – 100 m, to the east – 1500 m, to the south – 300 m and to the west – 150 m. Lake Druksiai is in more than 500 m to the north. Depending on the prevailing wind direction, the location of the maximal near ground concentration can be expected to be outside the boundaries of the INPP site security fence. The radiological conditions at the location of the maximal near ground concentration are used to characterize the maximal expected impact to the population from the external and inhalation exposure pathways within the existing SPZ of the INPP assuming an exposure duration of 2000 h per year.

The maximum one-year SWRF activity release data cf. Table 4.12 are used for the calculation of maximal expected exposure. The annual average doses to a member of a critical group due to ingestion pathways are calculated assuming a continuous discharge / activity deposition over a 10-year period (time of the operation of the SWRF).

The location of production of terrestrial foods is assumed to be close to the INPP site's permanent security fence (i.e. at the distance of 500 m from the stacks). The assumed distance for the activity deposition on to the water body Lake Druksiai is 500 m.

The dose assessment results are presented in Table 4.19. The annual effective doses are about 0.005 mSv for infant and 0.002 mSv for adult members of the critical group of the population.

The Table 4.20, Table 4.21, Table 4.22, Table 4.23, Table 4.24 and Table 4.25 provide additional information on the radionuclides and exposure pathways specific contribution to the exposure of critical group members of the population. Radionuclides with insignificant contribution to the total dose (less than 0.05%) are not included into the tables.

4.9.2.2.1.3 Radiological Impact due to Release of Airborne Activity at the SWTSF Site

The annual average doses to a member of the critical group are calculated assuming an effective emission height of 50 m for atmospheric discharges from the SWTF stack. In terms of atmospheric dispersion, the activity release takes place outside the airflow zone which can be influenced by the building structure (the release effective height is 2.5 times greater than the building height). Under these conditions the maximum airborne near-ground activity concentration is expected at a distance of about 300 m from the stack, cf. Figure 4.23.

The distance from the stack to the permanent security fence of the SWTSF/ISFSF site varies approximately from 100 (northern direction) to 200 m (corners of the site). The radiological conditions at the location of maximal near ground concentration is used to characterize the maximal expected impact to the population from the external and inhalation exposure pathways within the expected SPZ of the SWTSF/ISFSF site assuming exposure duration of 2000 h per year.

It is foreseen that at least 500 m distant a SPZ (around the site permanent security fence) will be arranged around the SWTSF/ISFSF site. The distance from the stack to the border of the SPZ of the SWTSF/ISFSF site varies approximately from 600 to 700 m. The radiological conditions at the distance of 600 m from the stack are used to characterize the maximal expected impact from the external and inhalation exposure pathways outside the expected SPZ of the SWTSF/ISFSF site. The unlimited annual exposure time of 8760 h is assumed to provide a conservative dose assessment (the reduction of doses due to the time people are staying in-house are not considered).

The maximum one-year SWTF activity release data, cf. Table 4.14 are used for the calculation of the maximal expected exposure.

The annual average doses to a member of the critical group due to ingestion pathways are calculated assuming a continuous discharge / activity deposition over a 30-year period (time of the operation of the SWTF). The approach is conservative as the treatment of all INPP G3 waste will be performed within 5 years (expected airborne releases due to the treatment of G3 waste are higher by an order as compared to the treatment of other waste streams, cf. chapter 4.2.3.2).

The location of production of terrestrial foods is assumed to be outside the expected SPZ of the SWTSF/ISFSF site (i.e. at the distance of 600 m from the stack). The selected location is within the boundaries of the existing SPZ of INPP. The assumed distance for the activity deposition on to the water body Lake Druksiai is 1500 m.

The dose assessment results are presented in Table 4.26. The annual effective doses at the location of the highest predicted exposure (inside the SPZ of INPP) are about 0.003 mSv for infant and 0.001 mSv for adult members of the critical group of the population. The annual effective doses on the border of the expected SPZ of the SWTSF/ISFSF site (without consideration of the SPZ of INPP) are about 0.004 mSv for infant and 0.002 mSv for adult members of the critical group of the population.

The Table 4.27, Table 4.28, Table 4.29, Table 4.30, Table 4.31, Table 4.32, Table 4.33 and Table 4.34 provide additional information on the radionuclides and exposure pathways specific contribution to the exposure of critical group members of the population. Radionuclides with insignificant contribution to the total dose (less than 0.05%) are not included into the tables.

4.9.2.2.1.4 Summary of Radiological Impact due to Airborne Releases from Proposed Economic Activity

Two scenarios have been considered to provide integral impact due to radioactive releases.

The first scenario considers the SWMSF state when both waste retrieval and treatment activities take place. This case is relevant to the first decade of operation of the SWMSF, cf. chapter 1.4. The scenario presumes:

- Both existing INPP and a newly established SPZ of the SWTSF exist. The SPZ of INPP envelopes the SPZ of the SWTSF, therefore precondition on the unlimited exposure duration outside the expected border of SPZ of the SWTSF is not credible;
- The prevailing wind blow direction from the INPP (i.e. SWRF) site is toward the SWTSF site and the prevailing wind blow direction from the SWTSF site is toward the INPP site. Such weather conditions, considering close location of the sites and existing meteorological observations cannot be normally expected. However such approach leads to conservative assumption that airborne contamination sets down onto the same field where terrestrial products are produced. Therefore the ingestion doses resulting from separate SWRF and SWTSF sites are summed;
- The external exposure and inhalation dose resulting from the release from the SWRF site is selected at the related highest expected exposure location. Also the external exposure and inhalation dose resulting from the release from the SWTSF site is selected at the related highest expected exposure location. The doses are added up. While these locations are close to the airborne activity release points relevant for each site, such approach leads to a conservative estimation of the integral impact.

The second scenario considers the SWMSF state after finishing of the existing waste retrieval activity. The scenario presumes:

- The waste retrieval activity is finished and no airborne activity is released from the SWRF site. However, the site for the production of terrestrial products is still contaminated by the previously settled down airborne radioactivity. No activity decay is assumed. The ingestion dose resulting from the SWRF is considered as relevant;
- The existing SPZ of INPP is reduced or removed. Only the SPZ of the SWTSF exists and the terrestrial products are produced in a no limited activity field. The ingestion dose resulting from the SWTSF is relevant;
- The external exposure and inhalation dose resulting from the airborne release from the SWTSF site is selected for the location outside the SPZ as due to the unlimited exposure duration these doses are higher than inside the SPZ.

The summary of the radiological impact due to the airborne releases from proposed economic activity for both considered scenarios are presented in Table 4.35 and Table 4.36. According to both scenarios the annual effective doses are about 0.008 mSv for infant and 0.003 mSv for adult members of the critical group of the population. The doses are insignificant and of the same order as the dose criterion applicable for exempted practice (of order of 0.010 mSv and lower).

4.9.2.2.2 Radiological Impact due to Direct Irradiation Resulting from Radioactive Waste Transfer in-between INPP and SWTSF Sites

The annual effective dose to a member of the population due to external exposure from the waste containers (packages) transferred in-between the SWRF (or INPP) and the SWTF is calculated by the equation:

$$D = \sum_j \left(N_j \times \int_0^t E_j(r)dt \right);$$

Where:

N_j is the number of waste packages of the specific waste stream transferred annually in-between the SWRF/INPP and SWTSF sites;

$E_j(r)$ is the external exposure effective dose rate at a distance r from the waste container surface of a specific waste stream, Sv/h;

t is the exposure duration due to the transfer of one waste container, h. Assuming there are no stops during waste transfer, the transfer duration is:

$$t = \frac{L}{v};$$

Where:

L = 1 km, the road connection length;

v = 5 km/h, the assumed average waste transfer (i.e. truck) speed. The truck speed is limited to 10 km/h.

The dose rate values from the waste containers of the specific waste streams are presented in Table 4.37. Considering impact due to the transfer of group G1 and G2 waste streams it is conservatively assumed that only G2 waste is transferred during the year from the SWRF to the SWTF. G1 waste is less active therefore dose rates from a G1 container are lower (even if a G1 container is designed with a lower shielding capacity). The transfer of neutralized scrubber solution from the flue gas treatment of the incineration facility is selected as representative liquid waste activity stream for the consideration of the liquid waste transfer impact. This is the most active waste stream and activities of other types of liquid wastes are conservatively enveloped. For comparison purpose, the activity of the concrete ILW-SL waste container, filled with compacted waste (i.e. compacted activity) is provided in Table 4.37 also. During the INPP decommissioning activity a certain amount of waste will be delivered to the SWTF already characterized and packed in the ILW-SL waste container. The dose rates from the G2 waste transfer container are higher. G2 waste containers are of a lower waste load capacity, and more transfers will be necessary for the same SWTF waste throughput. The impact due to the transfer of decommissioning waste is enveloped by the impact from the transfer of G2 waste containers and therefore is not considered separately.

The amount of annual waste transfers for each specific waste stream is evaluated basing on the SWTF throughput, cf. chapter 1.5, and considering the container's effective filling volume. The considered amount of annual liquid waste transfers includes the transfer of other liquid waste streams, cf. Table 3.2 (with exception for the personnel decontamination shower and area cleaning water, which due to the expected lower activity and shielding properties of a waste tank were not considered). The evaluation of the annual amount (used for impact assessment) of the waste containers transferred in-between the SWRF/INPP and the SWTSF sites is presented in Table 4.38.

The summary of the radiological impact due to the direct irradiation resulting from the radioactive waste transfer in-between INPP and SWTSF sites is provided in Table 4.39, Table 4.40 and Table 4.41. In the Northern direction the exposure position of a member of the population is in 30 m distance from the waste transfer road connection fence. Eastern, southern and western positions are coincident with the locations of the maximal exposure resulting from the building structures located at the site, cf. 4.9.2.2.3.2.

The maximal exposure results from the G3 waste transfer. The G3 waste retrieval and treatment phase will last approximately 5 years. In the close vicinity to the planned waste transfer connection fence (assuming that the same member of the population will accompany all the waste transfers coming aside) the annual exposure of this member of the population may exceed the dose constraint. While it cannot be reasonable to expect that such situation might be relevant, the presence of the population in the close vicinity to the connection fence during the G3 waste transfer shall be limited. Other technical solutions can be foreseen by the design.

No additional constraints to the existing SPZ requirements are imposed starting from the distance of 30 m from the connection fence.

4.9.2.2.3 Radiological Impact due to Direct Irradiation from Structures Containing Radioactive Material

4.9.2.2.3.1 Radiological Impact due to Direct Irradiation from Structures at SWRF Site

The new installation and operation of the SWRF facilities at INPP site will not lead to any additional negative effects on the existing radiological situation outside the INPP site, i.e. will not lead to an increase of the direct irradiation fields outside the border of the INPP site in comparison with the present situation and - as a result – will not lead to an increase of the population exposure as compared with the present situation. It will even provide better conditions, especially by providing additional barriers (housing and active ventilation). Finally it leads to the reduction of the radiation level due to the continuous reduction of the waste volume and the activity stored in the existing waste storage facilities. A more detailed comparison of the existing and expected (with introducing of the SWRF) radiological situation is presented in Table 4.42.

It can be expected that radiation fields locally (e.g. in the close vicinity to the walls of the existing waste storage buildings or close to the waste loading apertures on the roof of the existing waste storage buildings) will be reformed due to the introduction of new structures and more intensive activities. However the radiological influence will be limited within the border of the existing waste storage buildings site. The design of the RU and the LSF will assure radiological fields to be within the prescribed dose rate limits for the INPP site. This statement will be justified in SAR basing on detailed shielding calculations.

4.9.2.2.3.2 Radiological Impact due to Direct Irradiation from Structures at SWTSF and ISFSF Sites

During the construction phase the radioactive clean equipment installation works within the premises of the SWTSF will be performed and therefore the planned economic activity will not create any radiological impact to the population.

The external irradiation dose rate values from the SWSF building structures under normal operation conditions are evaluated in [72]. The external irradiation dose rate values from the ISFSF building structure (located on the same site close to the SWTSF buildings) under normal operation conditions are evaluated in [73].

All reports are based on the same modeling approach. The dose rates due to direct gamma radiation and due to skyshine outside the buildings are computed with the Monte Carlo code MCNP [76]. MCNP is a general-purpose Monte Carlo N-Particle code that can be used for neutron, photon and electron or coupled neutron/photon/electron transport, including the capability to calculate for critical systems.

The computer model for the ISFSF is created on the basis of the drawings of the ISFSF building with additional structures for a Hot Cell, the social area and the Cask Service Station area. The main features of the model are listed below. More details can be found in [73].

- The ISFSF is modeled in detail as a concrete structure. The wall thickness is considered with 0.6 m (0.7 m southern wall). The roof is modeled as a 0.2 m thick concrete plate with 0.12 m insulating material on the top;
- The air inlets in the side walls of the ISFSF as well as the air outlets in the roof are modeled according to their real dimensions as labyrinths. The concrete supports and roof trusses placed every 6 m along the axis are considered in the model. For the concrete supports a width of 0.6 m and an average height of 2.35 m are assumed;

- No shielding of the gates and emergency doors is assumed, but the model includes the additional shielding walls in front of the emergency exits;
- The ground of the ISFSF itself is described as a concrete plate of a thickness of 0.2 m, and the ground of the surrounding area and below the concrete plate is assumed as soil.
- Inside the ISFSF and around the ISFSF up to a radius of 1800 m air is modeled to take the scattering, especially of the neutrons on air (sky-shine), into account;
- The buildings for the SWTSF are modeled as concrete hulls at their positions on the site with 0.3 m wall thickness;
- The casks in the Storage Hall are arranged in rows of 2 × 3. The modeled array of the 202 casks follows the loading pattern with 2 rows of only 3 casks facing the Reception Hall and a row of 4 casks at the opposite end of the Storage Hall;
- A surface source will be applied on the 202 casks, which are modeled simplified as massive CONSTORIT cylinders with a steel liner and a 0.25 m concrete plate on the top. The source is normalized to the maximum dose rate values of about 730 µSv/h at the cask side wall (190 µSv/h from neutrons) and about 12 µSv/h at the top of the cask with a concrete plate (8 µSv/h from neutrons).

The computer model for the SWSF is created on the basis of the drawings of the SWSF buildings. The main features of the model are listed below. More details can be found in [72].

- In the SLW concrete container the radioactive waste is homogeneously distributed in a concrete matrix with a density of 2.25 g/cm^3. In the LLW steel container the waste is homogeneously distributed in a matrix which consists of a mixture of zirconium and steel with a density of 0.9 g/cm^3. The nuclide inventory is given in Table 4.43;
- The buildings rest on 60 cm deep concrete foundations. The SWSF building walls and roofs are made up of concrete with a density of 2.2 g/cm^3. The ground outside the buildings is made up of soil;
- For the dose rate computations the SWSF buildings (SLW and LLW) are filled to their maximum capacity with their appropriate containers; each SLW with 6 × 48 × 4 concrete containers and LLW with 8 × 44 × 5 steel containers. The potential future extension of the SWSF is also taken into consideration;
- For the final dose rate computations the individual containers are not modeled in their details. Instead, the container piles in the SLW are modeled as a solid concrete block. In the LLW the piles are made of solid steel.
- The buildings of the SWTF and the ISFSF are modeled as solid concrete blocks;
- The dose rates are computed by applying so-called "mesh-tallies": the entire SWTSF site (and 250 meters beyond) is divided into 116 × 104 × 4 volume tallies. The horizontal grid resolution out-side the perimeter fence and east of the ISFSF building is 10 meters. Inside the fence (and west of the ISFSF) it is 5 meters, close to the SWSF building outside walls the mesh size is decreased to 0.5 meters. In vertical direction the grid size of the mesh is 1 meter (up to 4 meters). The mesh grid is set in such a way that the mesh grid boundary coincides with the fence. At a radius of 500 m, 1 km, 1.5 km and 2 km from the mesh origin are placed so-called "ring detectors" at a man's height of 1.5 m;
- In order to account for gamma-ray scattering effects on air molecules (skyshine) in the MCNP model, the SWTSF site is enveloped by a spherical air shell with a radius of 3 km.

The total effect of the external irradiation for the entire SWTSF and ISFSF site is assessed and summarized in [74], using calculation results from the reports [72] and [73].

This report also includes the consideration of the impact from the SWTF. The source of radiation of the SWTF building is coming from the containers filled with radioactive waste occupying a relatively small volume on the upper level of the building. This radiation exits the building solely through the roof over an area of no more than 144 m^2. The mean dose rate above this roof area amounts to 2.6 μSv/h. In comparison, the mean dose rate above the roof of the SWSF short lived waste storage is 3.7 μSv/h however over an area of 9607 m^2. Because of this much larger roof area and larger dose rate, the dose rates on the site from the SWTF building is about 1 % of the contribution from the roof of SWSF short lived waste storage facility. Compared to the much larger dose rate values on the site coming from the ISFSF and SWSF buildings, the contribution from the SWTF building was neglected in the summarization report [74].

The positioning of the SWTSF and the ISFSF on the site and against the MCNP model calculation mesh origin point is shown in Figure 4.24. The calculation results – the dose rate values along the perimeter of the permanent security fence of the SWTSF and ISFSF site are shown in Figure 4.25 (north side), Figure 4.26 (east side), Figure 4.27 (south side) and Figure 4.28 (west side). The calculated dose rate values beyond the permanent security fence are presented in Table 4.44.

The calculated annual effective dose to a member of the population from the SWTSF and ISFSF site are presented in Table 4.45. The annual exposure time is set to 2000 h within the planned sanitary protection zone and 8760 h outside the border of the sanitary protection zone.

The maximal exposure of the member of population could be expected in the vicinity of the permanent security fence of the SWTSF/ISFSF protective zone. The maximal annual effective dose is expected in the eastern direction and on the permanent security fence of the SWTSF/ISFSF protective zone and is 0.166 mSv. The annual effective dose at the permanent security fence of the SWTSF/ISFSF protective zone in the southern direction is 0.148 mSv.

The potential exposure of a member of the population sharply decreases with the increase of the distance from the permanent security fence. At the boundary of SWTSF/ISFSF site, which is distant in approximately 50 m apart from the permanent security fence of the SWTSF/ISFSF protection zone, exposure from the SWTSF/ISFSF site decreases (depending on the exposure direction) approximately by a factor of 1.5. The highest annual effective dose is expected in the eastern direction and is 0.100 mSv. The annual effective dose in the southern direction decreases to 0.080 mSv.

At the distance of 500 m from the site security fence exposure of a member of the population could be considered as insignificant - annual effective dose in all directions is below 0.001 mSv.

4.9.2.2.4 Summary of Radiological Impact and Compliance with Radiation Protection Requirements

This chapter summarizes all assessed radiological impacts, considers their total effect and demonstrates the compliance of the radiological impact with the radiation protection requirements.

4.9.2.2.4.1 Radiation Protection Requirements

The Republic of Lithuania normative document [114] defines dose limits for members of the public:

- The limit of the effective dose – 1 mSv in a year;
- In special circumstances the limit for the effective dose – 5 mSv in a year, provided that the average over five consecutive years does not exceed 1 mSv in a year;
- The limit of the equivalent dose for the lens of the eye – 15 mSv in a year;
- The limit of the equivalent dose for the skin – 50 mSv in a year. This limit has to be averaged over 1 cm^2 area of the 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 [114]. The dose constraint for the members of the public due to operation and decommissioning of nuclear facilities is 0.2 mSv per year [77].

If radionuclides are dispersed into environment by several pathways (e.g. by atmospheric and water paths) and the 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 [65].

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 [65].

The Republic of Lithuania normative document [65] defines principle of radiation protection for other environment components:

- Assessment of the impact to the environment should be based on the principle, according which protection measures ensuring an adequate safety for human are sufficient to protect both the environment and natural resources.

4.9.2.2.4.2 Radiological Impact from other Existing and Planned Nuclear Facilities

The new SWMSF will be constructed inside the INPP existing sanitary protection zone. For the purposes of dose assessment with regard to the dose constraint, the contribution of doses from the other existing and planned nuclear facilities located in the INPP sanitary protection zone must also be considered.

The construction of SWMSF is one of separate Ignalina NPP decommissioning projects. According to the INPP Final Decommissioning Plan [78] the 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 [79] 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.

4.9.2.2.4.2.1 Existing and Planned Nuclear Facilities in the SPZ of INPP

In addition to the SWMSF the INPP decommissioning project foresees to construct a new Interim Spent Nuclear Fuel Storage Facility (ISFSF), very low-level radioactive waste disposal facility (Landfill repository), low and intermediate level radioactive waste near-surface disposal facility. 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 (Perlite) deposits) was started to operate in year 2006. Solidified waste will be temporary stored in a 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.

Existing and planned nuclear facilities, located in the Ignalina NPP sanitary protection zone of 3 km radius are shown in Figure 4.29. Activity phases (operation, decommissioning, institutional surveillance, etc.) of the nuclear facilities are summarized in Figure 4.30.

4.9.2.2.4.2.2 Impact due to Radioactive Releases

Impact due to Radioactive Releases from the Existing Facilities in the SPZ of INPP

Doses due to the actual waterborne release and airborne emission from the INPP site are presented in Figure 4.31. The data are taken from [80]. It can be concluded that the doses due to the actual releases from the INPP site are far below the dose constraint (0.2 mSv per year). Starting from 1995 the dose due to waterborne releases gradually decreases. The dose due to airborne releases in general is considerably lower. The dose increase in 2004 is due to the increase of the release of I-131 from the INPP liquid radioactive waste treatment facility (building 150).

The transfer of SNF from the INPP Reactor Units into the existing dry type SNF storage facility is performed since 1999. 20 CASTOR RBMK-1500 and 60 CONSTOR RBMK-1500 casks with spent nuclear fuel were exported until the end of 2006.

It is planned that INPP will be in operation till the end of 2009. To forecast future doses the last seven years (1999 – 2006, when the spent nuclear transfer is performed) observed dose maximum is selected as a conservative estimation of the impact due to the operation of INPP till the year 2010. The assumed annual effective dose to a member of the population due to airborne emission is 1.9×10^{-6} Sv (year 2004 dose), and due to waterborne releases is 4.1×10^{-6} Sv (year 2002 dose).

A forecast of the impact from the existing nuclear facilities in the SPZ of INPP also includes the dose forecast due to the emissions and discharges from the following planned activities:

- INPP Reactor Unit 1 reactor final shutdown, de-fuelling and in-line decontamination phase of the INPP Decommissioning Project (i.e. U1DP0 activities) [81]. The U1DP0 activities are planned to be implemented in years from 2005 to 2012;
- The start-up of the operation of the new Cement Solidification Facility for liquid radioactive waste solidification and of the Interim Storage Building for the storage of solidified waste in the year 2006 [82]. The Cement Solidification Facility will operate for about 14 years. The Interim Storage Building is designed for operation of approximately 60 years.

The forecast for the dose to the population due to airborne emissions and liquid discharges from the existing nuclear facilities in the SPZ of INPP is summarized in Figure 4.32. It can be seen that the doses due to airborne emissions and liquid discharges from the existing nuclear facilities in the SPZ of INPP are low. The observed dose maximum (9.6×10^{-6} Sv) in year 2009 is mainly due to the planned start up of the in-line decontamination activities at the Reactor Unit 1 (3.6×10^{-6} Sv) and the assumption that the doses resulting from the operation of INPP (6.0×10^{-6} Sv) are still relevant.

The dose forecast as presented in Figure 4.32 does not include similar in-line decontamination activities at the Reactor Unit 2. A separate project (U2DP0) will be prepared for these activities. The estimation of the doses due to activity releases is not available at the moment. Therefore only approximate assessment is possible. Considering availability of ISFSF it is planned to finish the de-fueling of the Reactor Unit 2 in several years after the final reactor shutdown. In comparison to activities at the Reactor Unit 1, the equipment in-line decontamination at the Reactor Unit 2 could start in shorter time after the final reactor shutdown. Therefore the activity of radioactive releases (short-lived Mn-54, Fe-55, Co-58, Co-60, Cs-134, etc.) will be higher and could result in higher doses as compare to the doses from the similar U1DP0 activities. It is anticipated that equipment in-line decontamination at the Reactor Unit 2 can stipulate approximately two times higher annual dose to the critical group member of population (i.e. up to 8.0×10^{-6} Sv instead of 3.6×10^{-6} Sv in a single year). Therefore it is forecasted that during years 2005–2018 the annual effective dose due to airborne emissions and liquid discharges from the existing nuclear facilities in the SPZ of INPP will be below 1×10^{-5} Sv.

No dose estimations due to activity releases during further decommissioning projects for existing INPP facilities are available at the moment. EIA Program of INPP decommissioning [79] provides that every subsequent environmental impact assessment shall take into account the results of previous reports.

Impact due to Radioactive Releases from the Newly Planned Facilities in the SPZ of INPP

With respect to the newly planned nuclear facilities in the SPZ of INPP the radioactive releases can be stipulated by this proposed economic activity (SWMSF), the new Interim Spent Nuclear Fuel Storage Facility (ISFSF) and the newly planned nuclear power plant.

The estimation of doses resulting from airborne emissions from the SWTSF is presented in chapter 4.9.2.2.1.4. The conservatively estimated annual effective dose to the critical group member of population due to radioactive airborne emissions during the waste retrieval and treatment phase (i.e. in the period 2010-2020) is equal to 7.29×10^{-6} Sv. With finishing of waste retrieval the radioactive airborne emissions and subsequently the exposure of the population will decrease.

The impact from ISFSF is assessed in the EIA Report for ISFSF [59]. The conservatively estimated annual effective dose to the critical group member of population due to radioactive airborne emissions stipulated by the SNF handling at the Reactor Units and ISFSF will not exceed 4.15×10^{-7} Sv. It is planned that by the year 2016 the all spent nuclear fuel from INPP will be loaded into the leak-tight storage casks and will be isolated from the environment. Later on the radioactive airborne emissions due to the SNF handling activity could be possible only in the case of fuel reloading in the Fuel Inspection Hot Cell (FIHC) of ISFSF.

In case of SNF reloading in the FIHC of ISFSF additional exposure of up to 1.67×10^{-7} Sv is possible. However, it is not anticipated that a cask will fail during its storage life. The necessity for occurrence of a fuel repacking operation is low probable. The cask will be designed as double-barrier welded system for the safe operation time of at least 50 years. Therefore the operation of the FIHC should not be considered as a part of normally expected ISFSF operations.

Lietuvos Energija AB in year 2007 has initiated an environmental impact assessment procedure aiming to assess the environmental impact of the proposed economic activity “New nuclear power plant (new NPP) in Lithuania”. As the INPP will be shut down by the year 2010 and the current Lithuanian electricity generating capacities, including small capacity combined heat and power plants that are planned to be constructed, will be sufficient to meet the national demand until 2013, the concept of the proposed economic activity foresees construction of a new nuclear power plant in the INPP existing SPZ.

The total electricity production of new nuclear power plant would be at most 3400 MW. Possible technological alternatives for the new nuclear power plant are as follows: boiling water reactors, pressurized water reactors or pressurized heavy water reactors. It is planned that at least the first unit of the new nuclear power plant is in operation not later than 2015. The operation of the new reactors would last about 60 or more years.

Environmental impact assessment for the new nuclear power plant has not been performed yet and the results of environmental impact assessment are not available at present. Therefore the potential impact of the new nuclear power plant is not considered in this report. The design and environmental impact assessment of the newly planned NPP shall consider the potential environmental impacts from the INPP decommissioning activities and to adjust planned design solutions correspondingly.

There will be no radioactive releases from other newly planned nuclear facilities during operation of the SWMSF.

Only solid and solidified radioactive waste packages will be disposed of in the near-surface disposal facility for low and intermediate level waste [83]. The repository will have no radioactive waste treatment installations. The conditioned, packed and ready for disposal waste packages will be delivered to the repository. Packages shall meet the Waste Acceptance Criteria for a near-surface repository. No release of activity into the atmosphere either in aerosol or gas forms is expected under normal operation conditions. During phase of waste disposing of the vaults of the repository will be equipped with a temporary drainage system. No radioactive liquid releases into the environment will be present.

Radioactive waste will be disposed of in the repository approximately until 2030, till Ignalina NPP is dismantled and treatment of produced waste is finished. After the waste disposal of is finished the repository will be closed by constructing long-term engineering barriers. Radioactive waste will be isolated both from the environment and from the impact from environment.

After closure the active surveillance of the repository will be carried out. It is planned that active institutional surveillance period will last not shorter than 100 years. During this period the operator of repository will assure physical protection, will perform surveillance and monitoring of the repository, will kept records and, if needed, will perform corrective actions. Functionality of the engineering barriers will be ensured and no radioactive liquid releases during operation time of the SWMSF are foreseen.

The passive institutional surveillance of the repository (at least of 200 years) will start afterwards. The land use activities will be limited. The surveillance periods could be prolonged in the light of new information received. The engineering barriers could be rebuilt even after 300 years or the disposed waste could be resorted.

Environmental impact assessment for very low-level radioactive waste near-surface disposal facility (Landfill) has not been performed yet. The INPP Final Decommissioning Plan [78], the Concept of the Disposal Facility [84] and study of Derivation of Preliminary Waste Acceptance Criteria for Landfill Facility [85] defines that only solid and solidified radioactive waste packages will be disposed of in the facility. The repository will have no radioactive waste treatment installations. The conditioned, packed and ready for disposal waste packages will be delivered to the repository. An adequate isolation of radionuclides from the environment and from its impacts shall be ensured during waste transfer to the repository ant during waste disposal of. Therefore this study assumes that no radioactive releases during SWMSF operation time will occur from very low level radioactive waste disposal facility.

It is planned that by the end of the INPP decommissioning (in about 2030) the INPP existing Bituminized Waste Storage Facility will be converted into a repository. Environmental impact assessment for Bituminized Waste Disposal Facility has not been performed yet.

The radioactive residues resulting from the treatment of INPP radioactive liquids by use of evaporation technology are immobilized into the bitumen matrix. The resulting product – solidified bituminized waste is stored in the Bituminized Waste Storage Facility. The operational experience of the storage facility confirms that no radioactive gaseous or aerosol releases occur from bitumen matrix. Conversion of the storage facility into a repository includes dismantling of unnecessary technological systems and construction of long-term engineering barriers. The engineering barriers will isolate radioactive waste both from the environment and from the impacts from environment. The active institutional surveillance will be carried out to ensure functionality of engineering barriers. Therefore this study assumes that no radioactive releases during SWMSF operation time will occur from Bituminized Waste Disposal Facility.

Forecast of the maximal dose due to radioactive releases

Forecast of the maximal annual effective dose to the critical group member of population due to radioactive releases (airborne emissions and liquid discharges) from the existing and planned nuclear facilities located in the SPZ of INPP is summarized in Figure 4.33.

4.9.2.2.4.2.3 Impact due to Direct Irradiation

The monitoring of radiation fields performed in the INPP industrial site and its surroundings shows that increase in ionizing radiation dose rates is observed locally and only close to some of radioactive material handling facilities. Only in exceptional cases the increase of ionizing radiation dose rate is measured outside the border of INPP industrial site. Locally increased radiation fields are also registered around the existing SNF storage facility.

Measurements performed in the proposed SWTSF and ISFSF sites demonstrate (c.f. chapter 7.3.7) that gamma radiation background at these sites does not distinguish from gamma radiation background outside the border of the existing SPZ of INPP. The mean of local dose rates corresponds to the mean of dose rates measured the INPP region [80]. Therefore assessment of impact due to direct irradiation in the surroundings of the SWTSF / ISFSF sites assumes that INPP presently existing nuclear facilities do not create exceptional impact in the environment of SWTSF / ISFSF sites that could be considered as a digression from the natural background stipulated exposure. Potential changes in ionizing radiation fields resulting from modifications of the presently existing nuclear facilities and from construction of new nuclear facilities are discussed below.

It can be noted that during decommissioning of INPP the radioactive materials (spent nuclear fuel, radioactive waste, etc.) will be removed from the buildings and storage facilities located at the INPP site. Therefore with the reactors final shutdown and progress in decommissioning the radiation fields in the INPP industrial site should only to decrease.

Bituminized Waste Disposal Facility

The radiation fields monitoring data show that increase in ionizing radiation dose rate is observed only in some spots close to the Bituminized Waste Storage Facility building structure. No impact from ionizing radiation is present outside the INPP industrial site.

At present the storage facility is filled up to about of 60% of the design volume. Operational experience shows that filling of the storage facility with the waste results in insignificant changes of radiation fields.

Conversion of the storage facility into a repository includes dismantling of unnecessary technological systems and construction of long-term engineering barriers. A cap from clayey material, sand and soil will be formed around and over the facility. With installation of the cap radiation fields around the disposal facility will only to decrease.

New Interim Storage Facility for solidified radioactive waste

New Cement Solidification Facility for liquid radioactive waste solidification (spent ion-exchange resins and filter aid (Perlite) deposits) was started to operate in year 2006. Produced radioactive waste packages will be temporary stored in a new Interim Storage Facility, constructed at the INPP site, c.f. Figure 4.29. The facility is designed for the safe waste storage time of up to 60 years. The storage will be temporary since the solidified radioactive waste packages eventually will be disposed in a low and intermediate level radioactive waste near-surface disposal facility. Therefore the operational period of this facility may be shorter as designed and will depend on availability of the final disposal facility.

The assessment of the potential annual dose to the member of population due to direct ionizing irradiation from the SWTSF / ISFSF sites and the interim storage facility is summarized in Figure 4.34. The calculations consider maximally loaded facilities and assume annual exposure duration of 2000 hours.

It can be observed that the conservatively estimated impact from the interim storage facility is low and does not become apparent in the proposed SPZ of SWTSF / ISFSF.

New Interim Spent Nuclear Fuel Storage Facility

The new Interim Spent Nuclear Fuel Storage Facility (ISFSF) will be constructed close to the SWTSF. Both facilities will have a common physical security fence and a common SPZ. The assessment of the total impact due to direct irradiation from the facilities located in the SWTSF / ISFSF sites is presented in chapter 4.9.2.2.3.2.

Existing Spent Nuclear Fuel Storage Facility

Spent nuclear fuel has been stored in the existing SNF storage facility since 1999. According to the license conditions, appended by VATESI in 2006, 20 CASTOR RBMK-1500 and up to 78 CONSTOR RBMK-1500 casks will be stored in the storage facility. One more modification is planned, which would increase the storage capacity by additional 10 CONSTOR RBMK-1500 casks. In this case up to 88 CONSTOR RBMK-1500 casks would be stored in the storage facility. The existing SNF storage facility will be filled up until the beginning of ISFSF operation.

20 CASTOR RBMK-1500 and 61 CONSTOR RBMK-1500 casks with spent nuclear fuel have been accommodated in the storage facility by the end of 2006. Measurements of radiation fields performed during years 2000–2006 [86] show that the maximum ionizing irradiation dose rates around the fence of the storage facility site were measured when SNF was transfered and stored using CASTOR RBMK-1500 type casks. The casks of this type were utilized by INPP in the years of 1999–2001. With use of CONSTOR RBMK-1500 casks for SNF storage the radiation fields around the site have been stabilized and later on are changing marginally.

The increase of ionizing radiation dose rate is measured in the close vicinity to the existing SNF storage facility. The design of the existing SNF storage facility defines a 1 km radius SPZ around this facility. The existing SNF storage facility is at more than 1.7 km distance from SWTSF site. The designed sanitary protection zone of the existing SNF storage facility and the proposed sanitary protection zone for the SWTSF do not overlap. These nuclear facilities do not have a common SPZ, c.f. Figure 4.29.

Considering trends in changes of radiation fields monitored in the recent years and taking into account significant distance in between the SWTSF and the existing SNF storage facility, it is not foreseen that the further operation of the existing SNF storage facility according to the appended license conditions could influence the radiological situation in the proposed SPZ of SWTSF, outside borders of which the impact of direct ionizing radiation stipulated by SWTSF / ISFSF may not further be taken into consideration.

Near-surface Disposal Facility for Low and Intermediate Level Short-lived Radioactive Waste in Stabatiskes Site

One of the proposed locations for the near-surface disposal facility for low and intermediate level short-lived radioactive waste is Stabatiskes site. The site is to the east from SWTSF / ISFSF, c.f. Figure 4.29. Owing to the complicated site landscape the vaults for radioactive waste disposal might be constructed on two hills located in this site. During development of Technical design the layout, altitudes and dimensions of vaults as well as other parameters will be revised and adjusted considering features the of the engineering barriers and waste packages and updated amount of waste [83]. According to preliminary estimation the nearest vault of the disposal facility could be 600 m away from the permanent security fence of SWTSF / ISFSF sites.

A fence around the disposal site and security zones will be established in order to ensure physical protection of the disposal facility. According to preliminary estimations the permanent security fence will be installed 150 m away from the disposal vaults and it is also recommended to establish a sanitary protection zone of up to 300 m distance around the disposal facility.

The public exposure due to direct irradiation from operating disposal facility (i.e., during the disposal of radioactive waste packages) is estimated in [83]. The following exposure sources have been considered: (1) interim storage of radioactive waste packages in the buffer store, (2) internal transfer of radioactive waste packages, (3) vault filling operations, (4) vaults with disposed of radioactive waste. Calculations of radiation fields assume that during waste disposal of only one vault is open (from the top). The tops of other two already filled vaults are closed. The side walls of the remaining filled up and top closed vaults are additionally banked with clay and sand. It is presumed that the disposal facility constitutes from 50 vaults.

The assessment of the potential annual dose to the member of population due to direct ionizing irradiation from the SWTSF / ISFSF sites and the near-surface disposal facility site is summarized in Figure 4.35. The calculations assume annual exposure duration of 2000 hours.

The close of disposal facility includes construction of a multi-layer cover from clayey material and sand around and on the top of vaults. The thickness of cover would reach about 2 m (in the upper part of the cap) and more (on the flanks). After the close of facility the impact from direct ionizing irradiation in locations outside the security fence of the site is considered to become insignificant and further is not evaluated.

The near-surface disposal facility will accommodate all short-lived low and intermediate level radioactive waste produced during INPP operation and decommissioning. This also includes solidified waste from interim storage facility in the INPP site and short-lived waste from SWTSF. Therefore with transfer and disposal of short-lived waste packages into the near-surface disposal facility the radiation fields in the SWTSF and INPP sites will reduce.

Near-surface Disposal Facility for Very Low Level Radioactive Waste (Landfill) in the Southern Site

One of the proposed sites for the Landfill facility (i.e. the southern site) is located in the close vicinity to the ISFSF and SWTSF, c.f. Figure 4.29. The disposal facility site is in the proposed sanitary protection zone of SWTSF. As it was already indicated the environmental impact assessment for very low-level radioactive waste near-surface disposal facility has not been performed yet.

Maximal total impact to population from the new SWTSF / ISFSF and the disposal facility may be expected in the relatively small area in-between these two nuclear facilities. The maximal impact to population due to direct ionizing radiation from SWTSF / ISFSF is expected at the permanent security fence of these facilities. The impact rapidly decreases with increasing distance from the SWTSF / ISFSF security fence. At the southern border of the SWTSF / ISFSF sites (at the distance of 50 m from the SWTSF / ISFSF security fence) about a half of the dose constraint (0.1 mSv) is available for very low-level radioactive waste disposal facility project.

If the reserve of dose constraint left by SWTSF and ISFSF projects would be insufficient, administrative and / or engineering measures might be proposed by the Landfill repository design thus restricting the public access into the area in-between SWTSF / ISFSF and the disposal facility sites. A common security zone might be foreseen for these two nearby located sites. This zone of controlled access would ensure that the total impact of these nuclear facilities does not exceed the dose constraint.

New Nuclear Power Plant

Environmental impact assessment for the new nuclear power plant has not been performed yet and the results of environmental impact assessment are not available at present. Therefore the potential impact of the new nuclear power plant is not considered in this report. The design and environmental impact assessment of the newly planned NPP shall consider the potential environmental impacts from the INPP decommissioning activities and to adjust planned design solutions correspondingly.

4.9.2.2.4.3 Summary of Radiological Impact and Conclusions

The summarized radiological impact considers maximal total effect of impacts potentially arising from different impact sources of this proposed economical activity under normal operation conditions:

- Release of airborne activity from the SWRF and SWTSF sites;
- Direct irradiation resulting from the radioactive waste transfer operations in-between the INPP and SWTSF sites;
- Direct irradiation from structures at the SWRF and SWTSF sites.

The summarized radiological impact also considers up-till-now available evaluations of radiological impacts from other existing and planned nuclear facilities in the SPZ of INPP.

The summarized radiological impact addresses impacts at specific locations around the SWTSF / ISFSF sites where maximal or location specific radiological impacts can be expected:

- At the permanent SWTSF / ISFSF sites security fence;
- At the SWTSF / ISFSF sites border (at the distance of 50 m of from the permanent site security fence);
- At the border of the proposed SWTSF / ISFSF sites Sanitary Protected Zone (SPZ).

Details on the radiological impact assessment locations around the SWTSF / ISFSF sites are provided in Figure 4.36.

The potential radiological impact (potential annual effective dose to the critical group member of population) is summarized in Table 4.46, Table 4.47 and Table 4.48. The results and conclusions of the summarized radiological impact are discussed below.

The annual effective dose to the critical group member of population at the permanent security fence of the SWTSF / ISFSF sites is summarized in Table 4.46. The highest expected annual effective dose in the most exposed eastern direction is 0.194 mSv. The annual effective dose in all locations around the permanent security fence is below the dose constraint (0.2 mSv) and therefore the radiological protection requirements are not violated.

The annual effective dose to the critical group member of population at the border of the SWTSF / ISFSF sites (i.e. about 50 m away from the permanent security fence) is summarized in Table 4.47. At the border of the SWMSF / ISFSF sites the exposure of the critical group member is limited to the annual effective dose of 0.184 mSv in the most exposed northern direction. The impact is governed by the exposure resulting from the G3 waste transfer activity. When the G3 waste retrieval and transfer will be finished, the exposure of the critical group member will become limited to the annual effective dose of 0.128 mSv in the eastern direction. The annual effective dose in the southern direction (towards one of potential locations for Landfill repository) is 0.099 mSv.

The reserve of about 0.1 mSv from the dose constraint is available for the Landfill repository project at the SWTSF / ISFSF sites border.

The annual effective dose to the critical group member of population at the distance of 500 m from the SWTSF / ISFSF sites is summarized in Table 4.48. The annual effective dose in the northern direction is 0.173 mSv and results mostly from the G3 waste transfer activity. The annual effective dose due to the proposed economic activity including spent nuclear fuel management activities is below 0.020 mSv in the eastern, southern and western directions (and northern direction after the G3 waste transfer is finished). The dose is governed by the exposure from airborne releases (which is very low). If the near surface repository will be constructed at the Stabatiskes site, the annual effective dose in the eastern direction will increase to 0.180 mSv.

The calculated exposure of the critical group member of population in the proposed SPZ for ISFSF / SWTSF due to normal operation of the proposed economical activity including the exposure from existing and other planned activities are below the established dose constraint 0.2 mSv. Therefore it can be concluded that the radiological protection requirements will not violated and the proposed economic activity is possible. The radiological impact on environment outside the boundary of the proposed SPZ is governed by impacts from existing and future planned nuclear facilities located in the SPZ of INPP.

The Figure 4.37, Figure 4.38, Figure 4.39 and Figure 4.40 provide a more explicit overview of the expected radiological situation around the SWTSF / ISFSF site. Figures are based on data from the Table 4.46, Table 4.47 and Table 4.48.

The potential exposure to a critical group member of the population in the most critical eastern direction from the SWTSF / ISFSF site resulting from the proposed economical activity (including external exposure from spent nuclear fuel stored in the ISFSF) is presented in Figure 4.37. A similar exposure distribution is also relevant for southern and western directions however the annual doses are lower.

It can be observed, that exposure due to the release of airborne activity and due to radioactive waste transfer is low. The calculated annual effective dose is about 0.010 mSv.

The highest annual dose to the population may be expected only in the close vicinity of the SWTSF / ISFSF permanent security fence. The dose to the member of the population is governed by external exposure from the radioactive waste and spent nuclear fuel stored within the SWSF and ISFSF buildings, and is directly proportional to the exposure time. Calculations conservatively assume that the exposure duration of the member of population close to the security fence is not specially limited (annual exposure time – 2000 h), and therefore the calculated annual effective dose due to the proposed economic activity equals to 0.180 mSv.

It should be indicated, that permanent activity of the population in the vicinity of the SWTSF / ISFSF permanent security fence is normally not expected. According to the requirements for physical protection of nuclear facilities [87], presence of the population in the vicinity of the SWTSF / ISFSF sites must be controlled (and limited). Moreover, the calculations of the SWTSF and ISFSF radiation fields are based on conservative source terms and assume completely filled SWSF and ISFSF. Therefore, the actually expected population exposure will be lower than it is evaluated in this EIA Report.

With increasing distance from the SWTSF / ISFSF sites, the potential exposure of the population rapidly decreases. At the distance of 500 m from the ISFSF / SWTSF permanent security fence the radiological impact to the member of population due to the proposed economic activity can be considered as insignificant. The calculated annual effective dose due to the proposed economic activity is below 0.010 mSv.

In the northern direction the potential exposure is also lower than in the critical eastern direction. However the distribution of exposure constituents is different, c.f. Figure 4.38. The impact is governed by the dose resulting from the G3 waste transfer activity. The existing G3 waste retrieval and the treatment phase will last approximately 5 years. When the G3 waste retrieval and transfer will be finished, the potential exposure to the member of the population will significantly decrease. It shall also be pointed out, that the exposure is calculated conservatively, assuming that the same member of the population accompanies all waste transfers coming aside. Such a situation normally cannot be expected.

Total exposure from the proposed economical activity including the exposure from existing and planned activities at the SPZ of INPP for the same critical eastern and northern directions is presented in Figure 4.39 and Figure 4.40. The highest exposure could be expected in the close vicinity to the SWTSF / ISFSF sites. At the distance of 500 m from the permanent security fence the radiological impact on the environment from the existing and future planned activities at the SPZ of INPP becomes prevailing.

Basing on the radiation exposure assessment results at least a 500 m wide sanitary protected zone (around the site security fence) could be recommended for the SWTSF / ISFSF sites. Outside this zone the exposure of population resulting from the proposed economical activity could be considered as insignificant (annual effective dose to the critical group member of population is about or below 0.010 mSv). The actual boundaries for the sanitary protection zone of SWTSF / ISFSF site will be specified during the Technical Design.

Outside the boundary of the proposed SPZ the new SWMSF practically imposes no restrictions regarding the use of the dose constraint for other nuclear activities with the condition, that the impacts from these new activities are limited by the border of the proposed SPZ for the SWMSF / ISFSF sites (the impact due to the airborne releases from the SWTSF / ISFSF sites extends outside the border of the proposed SPZ and is of order of 0.010 mSv).

4.9.3 Impact Mitigation Measures

4.9.3.1 Non Radiological

The construction and the operation of the SWMSF will produce no noise that will be perceptible at the residential territories. Account shall be taken of the possibility of multiple noise sources emitting simultaneously.

Due to low forecasted traffic levels the impact level of the emissions of the mobile sources (vehicles and construction equipment) will be acceptable both in the construction and operation phases. Most of the works will be carried out in open air so that the natural air circulation will prevent the accumulation of significant concentrations of such substances. Electric driven trucks are planned for the transfer of the radioactive waste containers in-between the SWRF and the SWTSF.

Minor short-term lowering of the groundwater table may occur in the vicinity of the SWTSF site during dewatering of the foundation excavations. The water from the dewatering activities could contain suspended solids. Measures shall be taken to remove settleable solids prior to the discharging water from the site, including the use of sediment sumps or other sediment control structures. The limited drawdown from the dewatering activity is not expected to have a significant impact.

Accidental spills of combustive-lubricating materials, paints or other materials during the construction phase could contaminate coastal or inland waters. A written emergency response plan shall be prepared and retained on the site, and the workers shall be trained to follow specific procedures in the event of an accidental spill.

4.9.3.2 Radiological

The radiological impact mitigation measures include:

- Safety of the design:
  - Multi-barrier design;
  - Safety SSC preferred over Administrative Controls;
  - Passive SSC preferred over active SSC;
  - Preventive controls preferred over mitigate controls. The controls that are effective for multiple hazards can be resource effective
  - Adequate facility physical design (e.g. area layout, equipment layout, shielding, confinement and ventilation etc.);
  - Air flow from lower to higher activity / contamination zones (a cascaded pressure concept in the design of the ventilation system);
  - Minimize possibilities for spread out of confined radioactive contamination (e.g. the use of double lid lock systems);
- Safety of operation:
  - Supervision of work by the radiation protection staff;
  - A preventive maintenance and repair concept;
  - A preventive cleaning / decontamination concept;
  - Checking of the dose rates and contamination of waste packages before the transportation in open environment takes place;
  - Online monitoring of the airborne releases from the stacks;
  - Effluent monitoring and control;
- The application of the ALARA principle;
- The monitoring of the environment components on radioactive contamination.

4.9.4 Summary of Public Health Assessment

Considering requirements of the Recommendations on Assessment of Impact on the Public Health [88] this chapter summarizes information on factors and features influencing public health. The direct and indirect impacts of the proposed economic activity on factors influencing the public health are presented in Table 4.49. Possible impact of the proposed economic activity on public groups is presented in Table 4.50. Assessment of impact features is presented in Table 4.51.

4.9.5 Tables and Drawings of the Chapter “Public Health”

The following Tables are attached to the chapter “Public Health”:

Table 4.18 Main parameters used for assessment of critical group member exposure due to release of airborne radioactivity;

Table 4.19 Maximally expected annual effective dose to a critical group member of the population due to release airborne activity from the SWRF under normal operation conditions;

Table 4.20 Radionuclides and exposure pathways specific contribution to the annual effective dose for the infant member of a critical group of the population due to release of airborne activity from the RU1;

Table 4.21 Radionuclides and exposure pathways specific contribution to the annual effective dose for the adult member of a critical group of the population due to release of airborne activity from the RU1;

The following Figures are attached to the chapter “Public Health”:

Figure 4.39 Annual exposure of the critical group member of population in the eastern direction from the SWTSF / ISFSF sites due to the proposed economical activity and other existing and planned activities;

Figure 4.40 Annual exposure of the critical group member of population in the northern direction from the SWTSF/ISFSF sites due to the proposed economical activity and other existing and planned activities.

Table 4.18 Main parameters used for assessment of critical group member exposure due to release of airborne radioactivity

Parameter	Value	Remark
The fraction of the time during the year that the wind blows toward the receptor of interest in 30º sector, dimensionless	0.25	Generic value, also conservative respect to local conditions
The geometric mean of the wind speed representative of one year, m/s	4	At the height of 10 m, local conditions
Forage grass exposure period (growing season), d	30	Generic value
Food crops exposure period (growing season), d	60	Generic value
Delay (hold-up) time between harvest and consumption of forage in the pasture, d	0	Generic value
Delay (hold-up) time between harvest and consumption of forage stored in the store, d	90	Generic value
Delay (hold-up) time between harvest and consumption of food crops, d	14	Generic value
Average time between collection and human consumption of milk, d	1	Generic value
Average time between slaughter and human consumption of meat, d	20	Generic value
Amount of feed consumed by milk produced animal (large animal), kg/d	16	Generic value
Amount of feed consumed by meat produced animal (large animal), kg/d	12	Generic value
Fraction of the year that animals consume fresh vegetation, dimensionless	0.7	Generic value
Surface dry weight of the pasture soil (10 cm depth), kg/m^2	130	Generic value
Surface dry weight of the plough land (plowshare depth of 20 cm), kg/m^2	260	Generic value
Lake surface area, m^2	4.90E+07	Lake Druksiai
Lake catchment basin area, m^2	5.64E+08	Lake Druksiai
Fraction of the activity deposited on the lake catchment basin which reaches the lake, dimensionless	0.02	Generic value, also conservative respect to local sites. For SWRF site leads to limiting estimation that all released activity sets down into the lake.
Lake volume, m^3	3.69E+08	Lake Druksiai
Annual water exchange fraction from total lake volume, dimensionless	0.29	Lake Druksiai
Adult breathing rate, m^3/s	2.66E-04	Generic value
Infant (1-2 a) breathing rate, m^3/s	4.44E-05	Generic value
Annual crop (fruit, vegetables and grain, including potatoes) intake for adult, kg/a	410	Generic value
Annual crop (fruit, vegetables and grain, including potatoes) intake for infant (1-2 a), kg/a	150	Generic value
Annual milk intake for adult, L/a	250	Generic value

Parameter	Value	Remark
Annual milk intake for infant (1-2 a), L/a	300	Generic value
Annual meat intake for adult, kg/a	100	Generic value
Annual meat intake for infant (1-2 a), kg/a	40	Generic value
Annual fish intake for adult, kg/a	30	Generic value
Annual fish intake for infant (1-2 a), kg/a	15	Generic value

Table 4.19 Maximally expected annual effective dose to a critical group member of the population due to release airborne activity from the SWRF under normal operation conditions

Exposure location	Annual effective dose, Sv						
	External exposure	Inhalation		Ingestion		Total	
		Infant	Adult	Infant	Adult	Infant	Adult
RU1: G1 non combustible waste retrieval, presorting and treatment							
INPP SPZ *)	3.89E-08	6.96E-11	1.52E-10	1.37E-07	1.78E-07	1.76E-07	2.17E-07
RU2: G2 non combustible waste retrieval and presorting							
INPP SPZ *)	6.36E-09	6.44E-12	1.28E-11	3.92E-08	1.23E-08	4.56E-08	1.86E-08
RU3: G3 waste retrieval							
INPP SPZ *)	5.45E-07	5.46E-10	1.11E-09	3.72E-06	8.29E-07	4.26E-06	1.38E-06
Total SWRF							
INPP SPZ *)	5.90E-07	6.22E-10	1.27E-09	3.90E-06	1.02E-06	4.48E-06	1.62E-06

*) External exposure and inhalation doses are calculated at the location of the highest predicted exposure. As this location is within the SPZ of INPP, the annual exposure time used for the external exposure and inhalation dose calculation is 2000 h. Terrestrial foods ingestion doses are calculated at the location close to the INPP security fence.

Table 4.20 Radionuclides and exposure pathways specific contribution to the annual effective dose for the infant member of a critical group of the population due to release of airborne activity from the RU1

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Mn-54	3.40E-09	1.9%	1.3%	0.0%	0.5%	0.1%	0.0%	0.0%
Fe-55	4.77E-09	2.7%	0.0%	0.0%	1.1%	0.1%	1.4%	0.1%
Co-58	4.68E-09	2.7%	0.3%	0.0%	0.5%	1.2%	0.7%	0.0%
Co-60	5.73E-08	32.6%	9.7%	0.0%	2.9%	11.5%	8.0%	0.5%
Ni-63	3.03E-09	1.7%	0.0%	0.0%	0.0%	1.6%	0.0%	0.0%
Sr-90	8.36E-10	0.5%	0.0%	0.0%	0.1%	0.3%	0.1%	0.0%
Cs-134	5.74E-08	32.7%	6.2%	0.0%	3.4%	10.0%	4.9%	8.1%
Cs-137	4.41E-08	25.1%	4.6%	0.0%	2.0%	6.8%	3.4%	8.4%
Total for all released nuclides	**1.76E-07**	**100.0%**	**22.1%**	**0.0%**	**10.5%**	**31.6%**	**18.6%**	**17.1%**

Table 4.21 Radionuclides and exposure pathways specific contribution to the annual effective dose for the adult member of a critical group of the population due to release of airborne activity from the RU1

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Mn-54	2.90E-09	1.3%	1.0%	0.0%	0.3%	0.0%	0.0%	0.0%
Fe-55	1.66E-09	0.8%	0.0%	0.0%	0.3%	0.0%	0.4%	0.0%
Co-58	1.69E-09	0.8%	0.2%	0.0%	0.2%	0.1%	0.2%	0.0%
Co-60	2.56E-08	11.8%	7.9%	0.0%	0.8%	1.0%	2.0%	0.1%
Ni-63	4.93E-10	0.2%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%
Sr-90	5.09E-10	0.2%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%
Cs-134	1.07E-07	49.4%	5.0%	0.0%	9.0%	8.0%	11.8%	15.6%
Cs-137	7.70E-08	35.5%	3.7%	0.0%	4.7%	5.0%	7.4%	14.6%
Total for all released nuclides	**2.17E-07**	**100.0%**	**17.9%**	**0.1%**	**15.3%**	**14.3%**	**22.0%**	**30.4%**

Table 4.22 Radionuclides and exposure pathways specific contribution to the annual effective dose for the infant member of a critical group of the population due to release of airborne activity from the RU2

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Mn-54	1.55E-09	3.4%	1.5%	0.0%	1.4%	0.2%	0.0%	0.2%
Fe-55	3.40E-09	7.5%	0.0%	0.0%	2.9%	0.2%	3.8%	0.5%
Co-58	3.06E-09	6.7%	0.3%	0.0%	1.2%	3.2%	1.9%	0.1%
Co-60	3.36E-08	73.8%	11.8%	0.0%	7.8%	30.6%	21.3%	2.4%
Ni-63	2.09E-09	4.6%	0.0%	0.0%	0.1%	4.4%	0.1%	0.0%
Cs-134	9.79E-10	2.1%	0.2%	0.0%	0.2%	0.6%	0.3%	0.9%
Cs-137	8.08E-10	1.8%	0.1%	0.0%	0.1%	0.4%	0.2%	0.9%
Total for all released nuclides	**4.56E-08**	**100.0%**	**14.0%**	**0.0%**	**13.7%**	**39.6%**	**27.6%**	**5.1%**

Table 4.23 Radionuclides and exposure pathways specific contribution to the annual effective dose for the adult member of a critical group of the population due to release of airborne activity from the RU2

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Mn-54	1.18E-09	6.3%	3.8%	0.0%	2.2%	0.1%	0.1%	0.3%
Fe-55	1.17E-09	6.3%	0.0%	0.0%	2.7%	0.1%	3.2%	0.3%
Co-58	9.84E-10	5.3%	0.8%	0.0%	1.4%	1.1%	1.9%	0.0%
Co-60	1.14E-08	61.1%	28.8%	0.0%	6.6%	7.9%	16.4%	1.5%
Ni-63	3.41E-10	1.8%	0.0%	0.0%	0.1%	1.6%	0.1%	0.0%
Nb-94	1.34E-11	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Cs-134	2.01E-09	10.8%	0.4%	0.0%	1.6%	1.4%	2.1%	5.3%
Cs-137	1.55E-09	8.3%	0.3%	0.0%	0.8%	0.9%	1.3%	5.0%
Total for all released nuclides	**1.86E-08**	**100.0%**	**34.1%**	**0.1%**	**15.3%**	**13.0%**	**25.1%**	**12.4%**

Table 4.24 Radionuclides and exposure pathways specific contribution to the annual effective dose for the infant member of a critical group of the population due to release of airborne activity from the RU3

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Fe-55	4.45E-07	10.4%	0.0%	0.0%	4.1%	0.3%	5.3%	0.7%
Co-60	3.39E-06	79.5%	12.7%	0.0%	8.4%	32.9%	22.9%	2.6%
Ni-63	4.22E-07	9.9%	0.0%	0.0%	0.2%	9.4%	0.2%	0.0%
Nb-94	6.49E-09	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Total for all released nuclides	**4.26E-06**	**100.0%**	**12.8%**	**0.0%**	**12.7%**	**42.7%**	**28.5%**	**3.3%**

Table 4.25 Radionuclides and exposure pathways specific contribution to the annual effective dose for the adult member of a critical group of the population due to release of airborne activity from the RU3

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Fe-55	1.54E-07	11.2%	0.0%	0.0%	4.7%	0.1%	5.7%	0.6%
Co-60	1.15E-06	83.4%	39.3%	0.1%	8.9%	10.7%	22.4%	2.0%
Ni-63	6.88E-08	5.0%	0.0%	0.0%	0.3%	4.4%	0.3%	0.0%
Nb-94	5.71E-09	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%
Total for all released nuclides	**1.38E-06**	**100.0%**	**39.7%**	**0.1%**	**14.0%**	**15.2%**	**28.4%**	**2.7%**

Table 4.26 Maximally expected annual effective dose to a critical group member of the population due to release of airborne activity from the SWTF under normal operation conditions

Exposure location	Annual effective dose, Sv						
	External exposure	Inhalation		Ingestion		Total	
		Infant	Adult	Infant	Adult	Infant	Adult
G2 combustible waste treatment							
Inside SPZ *)	5.06E-08	3.60E-09	7.37E-09	2.94E-07	1.66E-07	3.48E-07	2.24E-07
Outside SPZ **)	1.32E-07	9.39E-09	1.92E-08	2.94E-07	1.66E-07	4.35E-07	3.17E-07
G3 waste treatment							
Inside SPZ *)	5.41E-07	4.00E-10	8.15E-10	2.05E-06	4.44E-07	2.59E-06	9.85E-07
Outside SPZ **)	1.41E-06	1.04E-09	2.13E-09	2.05E-06	4.44E-07	3.46E-06	1.86E-06
Total SWTF							
Inside SPZ *)	5.92E-07	4.00E-09	8.18E-09	2.34E-06	6.10E-07	2.94E-06	1.21E-06
Outside SPZ **)	1.54E-06	1.04E-08	2.14E-08	2.34E-06	6.10E-07	3.90E-06	2.18E-06

*) External exposure and inhalation doses are calculated at the location of the highest predicted exposure. As this location is within the SPZ of the SWTSF and INPP, the annual exposure time used for the external exposure and inhalation dose calculation is 2000 h. Terrestrial foods ingestion doses are calculated at the location close to the both INPP and SWTSF security fences.

**) The external and internal exposure is calculated at the border of the expected SPZ for the SWTSF site (e.g. 500 m from the site security fence) without consideration of the SPZ of the INPP. Annual exposure time for external exposure and inhalation dose calculation is 8760 h (unlimited exposure duration). This is also a location used for the calculation of ingestion doses. The location is close to the both INPP and SWTSF security fences.

Table 4.27 Radionuclides and exposure pathways specific contribution to the annual effective dose for the infant member of a critical group of the population due to release of airborne activity from the SWTF in the case of treatment of G2 combustible waste and for the exposure location inside SPZ

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
C-14	1.25E-07	35.9%	0.0%	1.0%	34.9%			
Mn-54	7.59E-09	2.2%	1.2%	0.0%	0.8%	0.1%	0.0%	0.1%
Fe-55	1.34E-08	3.8%	0.0%	0.0%	1.5%	0.1%	2.0%	0.1%
Co-58	1.27E-08	3.7%	0.3%	0.0%	0.6%	1.7%	1.0%	0.0%
Co-60	1.71E-07	49.2%	12.8%	0.0%	4.3%	18.6%	12.9%	0.7%
Ni-63	1.41E-08	4.1%	0.0%	0.0%	0.1%	3.9%	0.1%	0.0%
Nb-94	2.33E-10	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Cs-134	1.81E-09	0.5%	0.1%	0.0%	0.1%	0.2%	0.1%	0.1%
Cs-137	1.67E-09	0.5%	0.1%	0.0%	0.0%	0.1%	0.1%	0.1%
Total for all released nuclides	**3.48E-07**	**100.0%**	**14.6%**	**1.0%**	**84.4%**			

Table 4.28 Radionuclides and exposure pathways specific contribution to the annual effective dose for the adult member of a critical group of the population due to release of airborne activity from the SWTF in the case of treatment of G2 combustible waste and for the exposure location inside SPZ

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
C-14	1.29E-07	57.5%	0.0%	3.3%	54.2%			
Mn-54	6.19E-09	2.8%	1.9%	0.0%	0.7%	0.0%	0.0%	0.0%
Fe-55	4.64E-09	2.1%	0.0%	0.0%	0.9%	0.0%	1.1%	0.1%
Co-58	4.30E-09	1.9%	0.4%	0.0%	0.5%	0.4%	0.7%	0.0%
Co-60	7.11E-08	31.8%	19.9%	0.0%	2.3%	3.0%	6.3%	0.3%
Ni-63	2.31E-09	1.0%	0.0%	0.0%	0.1%	0.9%	0.1%	0.0%
Nb-94	2.27E-10	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Cs-134	3.47E-09	1.5%	0.1%	0.0%	0.3%	0.3%	0.4%	0.5%
Cs-137	2.86E-09	1.3%	0.1%	0.0%	0.2%	0.2%	0.3%	0.5%
Total for all released nuclides	**2.24E-07**	**100.0%**	**22.6%**	**3.3%**	**74.1%**			

Table 4.29 Radionuclides and exposure pathways specific contribution to the annual effective dose for the infant member of a critical group of the population due to release of airborne activity from the SWTF in the case of treatment of G2 combustible waste and for the exposure location outside SPZ

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
C-14	1.31E-07	30.1%	0.0%	2.1%	27.9%			
Mn-54	1.46E-08	3.3%	2.6%	0.0%	0.6%	0.1%	0.0%	0.1%
Fe-55	1.34E-08	3.1%	0.0%	0.0%	1.2%	0.1%	1.6%	0.1%
Co-58	1.42E-08	3.3%	0.6%	0.0%	0.5%	1.4%	0.8%	0.0%
Co-60	2.42E-07	55.8%	26.7%	0.0%	3.4%	14.8%	10.3%	0.5%
Ni-63	1.41E-08	3.2%	0.0%	0.0%	0.1%	3.1%	0.1%	0.0%
Nb-94	5.90E-10	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Cs-134	2.23E-09	0.5%	0.2%	0.0%	0.0%	0.1%	0.1%	0.1%
Cs-137	2.19E-09	0.5%	0.2%	0.0%	0.0%	0.1%	0.1%	0.1%
Total for all released nuclides	**4.35E-07**	**100.0%**	**30.4%**	**2.1%**	**67.5%**			

Table 4.30 Radionuclides and exposure pathways specific contribution to the annual effective dose for the adult member of a critical group of the population due to release of airborne activity from the SWTF in the case of treatment of G2 combustible waste and for the exposure location outside SPZ

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
C-14	1.40E-07	44.3%	0.0%	6.0%	38.3%			
Mn-54	1.32E-08	4.1%	3.6%	0.0%	0.5%	0.0%	0.0%	0.0%
Fe-55	4.65E-09	1.5%	0.0%	0.0%	0.6%	0.0%	0.8%	0.0%
Co-58	5.83E-09	1.8%	0.8%	0.0%	0.3%	0.3%	0.5%	0.0%
Co-60	1.43E-07	45.1%	36.6%	0.0%	1.6%	2.1%	4.5%	0.2%
Ni-63	2.31E-09	0.7%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%
Nb-94	5.84E-10	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%
Cs-134	3.89E-09	1.2%	0.2%	0.0%	0.2%	0.2%	0.3%	0.4%
Cs-137	3.38E-09	1.1%	0.3%	0.0%	0.1%	0.1%	0.2%	0.3%
Total for all released nuclides	**3.17E-07**	**100.0%**	**41.6%**	**6.1%**	**52.3%**			

Table 4.31 Radionuclides and exposure pathways specific contribution to the annual effective dose for the infant member of a critical group of the population due to release of airborne activity from the SWTF in the case of treatment of G3 waste and for the exposure location inside SPZ

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Fe-55	2.07E-07	8.0%	0.0%	0.0%	3.2%	0.3%	4.2%	0.3%
Co-60	2.03E-06	78.5%	20.4%	0.0%	6.8%	29.6%	20.6%	1.0%
Ni-59	1.27E-09	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ni-63	3.36E-07	13.0%	0.0%	0.0%	0.3%	12.4%	0.3%	0.0%
Nb-94	1.17E-08	0.5%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%
Total for all released nuclides	**2.59E-06**	**100.0%**	**20.9%**	**0.0%**	**10.4%**	**42.3%**	**25.1%**	**1.3%**

Table 4.32 Radionuclides and exposure pathways specific contribution to the annual effective dose for the adult member of a critical group of the population due to release of airborne activity from the SWTF in the case of treatment of G3 waste and for the exposure location inside SPZ

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Fe-55	7.20E-08	7.3%	0.0%	0.0%	3.2%	0.1%	3.8%	0.2%
Co-60	8.46E-07	85.9%	53.8%	0.1%	6.2%	8.2%	17.0%	0.7%
Ni-63	5.48E-08	5.6%	0.0%	0.0%	0.3%	4.8%	0.4%	0.0%
Nb-94	1.14E-08	1.2%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Total for all released nuclides	**9.85E-07**	**100.0%**	**54.9%**	**0.1%**	**9.8%**	**13.1%**	**21.2%**	**0.9%**

Table 4.33 Radionuclides and exposure pathways specific contribution to the annual effective dose for the infant member of a critical group of the population due to release of airborne activity from the SWTF in the case of treatment of G3 waste and for the exposure location outside SPZ

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Fe-55	2.07E-07	6.0%	0.0%	0.0%	2.4%	0.2%	3.2%	0.2%
Co-60	2.89E-06	83.4%	39.9%	0.0%	5.1%	22.2%	15.4%	0.8%
Ni-63	3.36E-07	9.7%	0.0%	0.0%	0.2%	9.3%	0.2%	0.0%
Nb-94	2.96E-08	0.9%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%
Total for all released nuclides	**3.46E-06**	**100.0%**	**40.8%**	**0.0%**	**7.8%**	**31.7%**	**18.8%**	**1.0%**

Table 4.34 Radionuclides and exposure pathways specific contribution to the annual effective dose for the adult member of a critical group of the population due to release of airborne activity from the SWTF in the case of treatment of G3 waste and for the exposure location outside SPZ

Radio-nuclide	Total dose		Exposure pathway contribution to the total dose					
	Sv/a	Contri-bution	External exposure	Inhalation	Ingestion of food products			
					Crops	Milk	Meat	Fish
Fe-55	7.21E-08	3.9%	0.0%	0.0%	1.7%	0.0%	2.0%	0.1%
Co-60	1.70E-06	91.6%	74.4%	0.1%	3.3%	4.3%	9.0%	0.4%
Ni-63	5.48E-08	3.0%	0.0%	0.0%	0.2%	2.6%	0.2%	0.0%
Nb-94	2.93E-08	1.6%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Total for all released nuclides	**1.86E-06**	**100.0%**	**76.0%**	**0.1%**	**5.2%**	**7.0%**	**11.3%**	**0.5%**

Table 4.35 Annual exposure of critical group members due to airborne radioactive releases during the first stage of operation of SWMSF (waste retrieval and treatment)

Exposure source	**Annual effective dose for critical group member, Sv**						
	External exposure	**Inhalation**		**Ingestion**		**Total**	
		Infant	**Adult**	**Infant**	**Adult**	**Infant**	**Adult**
SWRF	5.90E-07	6.22E-10	1.27E-09	3.90E-06	1.02E-06	4.48E-06	1.62E-06
SWTF	5.92E-07	4.00E-09	8.18E-09	2.34E-06	6.10E-07	2.94E-06	1.21E-06
Total	**1.18E-06**	**4.62E-09**	**9.46E-09**	**6.24E-06**	**1.63E-06**	**7.42E-06**	**2.82E-06**

Table 4.36 Annual exposure of critical group members due to airborne radioactive releases during the second stage of operation of SWMSF (waste treatment only)

Exposure source	**Annual effective dose for critical group member, Sv**						
	External exposure	**Inhalation**		**Ingestion**		**Total**	
		Infant	**Adult**	**Infant**	**Adult**	**Infant**	**Adult**
SWRF	-	-	-	3.90E-06	1.02E-06	3.90E-06	1.02E-06
SWTF	1.54E-06	1.04E-08	2.14E-08	2.34E-06	6.10E-07	3.90E-06	2.18E-06
Total	**1.54E-06**	**1.04E-08**	**2.14E-08**	**6.24E-06**	**1.63E-06**	**7.79E-06**	**3.20E-06**

Table 4.37 Effective dose rates at defined distances from the external surfaces waste transfer and storage containers

Distance from container surface, m	Effective dose rate from the surface of waste containers of specific type, µSv/h			
	G2 *)	G3 **)	Liquid waste tank ***)	ILL-SL waste container ****)
1.0	3.70E+02	4.71E+02	2.85E+01	1.88E+02
2.0	1.28E+02	1.83E+02	1.29E+01	7.94E+01
5.0	2.59E+01	4.58E+01	3.02E+00	1.67E+01
10	7.41E+00	2.13E+01	8.43E-01	4.42E+00
30	8.57E-01	3.25E+00	9.50E-02	4.66E-01
100	6.13E-02	2.69E-01	6.80E-03	3.00E-02
300	2.46E-03	1.34E-02	3.00E-04	1.20E-03
600	1.14E-04	6.97E-04	1.60E-05	5.50E-05
1000	3.45E-06	2.26E-05	6.50E-07	1.90E-06
1800	6.14E-09	4.45E-08	8.00E-09	4.30E-09

*) Loaded with G2 waste, effective filling volume 2.2 m^3. Data taken from [68];

**) Loaded with G3 waste, effective filling volume 0.15 m^3. Data taken from [69];

***) Loaded with neutralized scrubber solution, effective filling volume 2 m^3. Data taken from [70];

****) Loaded with G2 compacted and G2 combustible (ash) waste pellets, effective filling volume about 3-3.5 m^3. Data are taken from [71].

Table 4.38 Annual amount (used for impact assessment) of waste containers transferred in-between SWRF/INPP and SWTSF sites

Waste stream	Throughput, m^3/d	Annual operation time, days	Annual throughput, m^3/a	Effective volume of container, m^3	Number of annually transferred containers
G2	2.8	245	686.0	2.2	312
G3	0.9	245	220.5	0.15	1470
Liquid waste			90 *)	2.0	45

*) Cf. Table 3.2

Table 4.39 Annual effective dose to the member of population on the permanent security fence of SWTSF / ISFSF site due to radioactive waste transfer. Solid radioactive waste retrieval and treatment phase

Waste stream	Annual effective dose for direction, Sv			
	North *)	East	South	West
G2	3.54E-06	2.80E-07	4.02E-08	3.61E-08
G3	6.51E-05	5.99E-06	9.89E-07	9.37E-07
Liquid waste	5.67E-08	4.55E-09	6.98E-10	6.44E-10
Total waste transfer dose	**6.87E-05**	**6.28E-06**	**1.03E-06**	**9.74E-07**

*) And at the distance of 30 m from waste transfer road fence, c.f. Figure 4.36.

Table 4.40 Annual effective dose to the member of population on the SWTSF/ISFSF site border (i.e. about 50 m away from the permanent security fence) due to radioactive waste transfer. Solid radioactive waste retrieval and treatment phase

Waste stream	Annual effective dose for direction, Sv			
	North *)	East	South	West
G2	5.55E-06	2.30E-07	2.28E-08	2.91E-08
G3	1.01E-04	4.98E-06	5.95E-07	7.58E-07
Liquid waste	8.88E-08	3.76E-09	4.09E-10	5.21E-10
Total waste transfer dose	**1.07E-04**	**5.21E-06**	**6.18E-07**	**7.87E-07**

*) And at the distance of 30 m from waste transfer road fence, c.f. Figure 4.36.

Table 4.41 Annual effective dose to the member of population on border of proposed SPZ for SWTSF/ISFSF site (i.e. about 500 m away from the permanent security fence) due to radioactive waste transfer. Solid radioactive waste retrieval and treatment phase

Waste stream	Annual effective dose for direction, Sv			
	North *)	East	South	West
G2	6.59E-06	4.09E-09	5.98E-10	1.21E-09
G3	1.21E-04	1.15E-07	1.75E-08	3.51E-08
Liquid waste	1.05E-07	8.10E-11	1.30E-11	2.55E-11
Total waste transfer dose	**1.28E-04**	**1.19E-07**	**1.81E-08**	**3.63E-08**

*) And at the distance of 30 m from waste transfer road fence, c.f. Figure 4.36.

Table 4.42 Overview over the radiological situation at the INPP site according to the solid waste storages: (1) current situation, (2) new situation with installation and operation of new SWRF for existing waste retrieval and (3) comparison of these two situations

(1) Current situation	(2) New situation	(3) Comparison
Storage buildings 155 and 155/1		
The buildings are closed and contain a certain amount of very low-level waste classified as G1. No active ventilation is installed.	RU1-LSF facility is installed along the long side of the 2 buildings. Existing storage buildings will be connected to this new building by 4 tunnels (one tunnel between RU1 and each compartment). The entrances to the waste compartments will not be opened before installation of appropriate shielding. The tunnels will have doors to close the connection between storage compartments and RU1. Only one tunnel will be opened at a time. Active ventilation with filtering will be provided. A limited amount of waste will be retrieved, sorted, treated, and packed at a time. Packed waste will be send to its final destination (Landfill repository or the SWTF) immediately. Waste volume and the total activity are reduced continuously.	Only very low-level waste will be processed. Only a small, limited amount of waste will be handled at a time. Design and operation of the new facility assure that the current radiation exposure outside the facility to other facilities will be in accordance with the INPP radiation protection requirements and will not affect radiation exposure to other facilities in a negative way. The stored waste volume and activities are reduced continuously, thus improving the overall radiation situation at the site.
Storage building 157/1		
The building consists of 3 separate building sections with a number of compartments where G1 and G2 waste is stored. The waste is dumped into the compartments via the open air filling hatches. Up to 4 filling units are operated (=up to 4 open compartments). The shielding thickness of these hatches is approximately 1cm. No active ventilation is available.	RU2 is installed on the top of the building and covers an opening to a compartment. RU2 provides an airtight barrier including active ventilation with filtering. Spread of contamination and airborne release is prevented (minimized). A sliding hatch (approx. shielding thickness 4 cm) covers the opening. It will be open only during retrieval process. In this case it is only open half of the initial opening and it will be closed when no retrieval takes place. The installation procedure of the	The new situation will improve the current situation because the number of open compartments is reduced and the thicker sliding hatch provides a better shielding. The active ventilation and airtight structure of RU2 provides an additional activity release barrier to the environment. The stored waste volume and activities are reduced continuously, thus improving the overall radiation situation at the site.

(1) Current situation	(2) New situation	(3) Comparison
	sliding hatch is similar to the existing INPP procedure for the removal of the filling hatch (after compartment is filled up with waste) and closing of the compartment with concrete slabs. Retrieved waste is put into shielded containers and is immediately transferred for further treatment to the respective facilities (SWTF, RU1-LSF). Waste volume and the total activity are reduced continuously.	
Storage building 157		
This building contains G1, G2 and G3 waste. The G1 and G2 compartments are closed. The compartments for G3 waste are still in operation. The shielded sliding hatch for emptying of the G3 containers shields and covers the opening of the compartment in operation. Active ventilation during emptying is provided.	The old shielded emptying device is replaced by a new better or equivalent shielded hatch. RU3 is installed above the compartment and will provide an additional barrier (including separate ventilation). Spread of contamination and airborne release is prevented (minimized). Installation of the emptying device and waste retrieval equipment will follow the existing INPP procedures for changing of the existing sliding hatch. All retrieval operations and container filling operations will take place inside of the shielded compartment. Retrieved waste is put into shielded containers and immediately transferred for further treatment. Waste volume and the total activity are reduced continuously. After the 2 G3 compartments are emptied with RU3 (estimated operation time 5 years) RU3 will be de-installed and RU2 will be moved from 157/1 to 157 to retrieve G1 and G2 waste from the compartments.	The new situation concerning G3 waste will add an additional barrier (air tight barrier including active ventilation with filtering). The waste shielding level will be the same or even better. The stored waste volume and activities are reduced continuously, thus improving the overall radiation situation at the site. The new situation concerning G1 and G2 waste will also add an additional barrier (air tight barrier including active ventilation with filtering). For further details see above Building 157/1.

Table 4.43 Activity inventory in SLW and LLW storage containers used in the MCNP model

SLW container activity inventory	
Total activity	8.32E+10 Bq/container
Activity Co-60	48% from total activity
Activity Cs-137	2% from total activity
Activity Ni-63	No gamma activity
Material	Concrete
Density	2.2 g/cm^3

LLW container activity inventory	
Total activity	3.6E+13 Bq/container
Activity Co-60	36% from total activity
Activity Fe-55	No gamma activity
Activity Ni-63	No gamma activity
Material	Zirconium/steel
Material ratio	70/600 (by weight)
Density	0.9 g/cm^3

Table 4.44 Total dose rate beyond the perimeter of permanent security fence

Northern direction	
Distance beyond fence, m	**Total dose rate, μSv/h**
0	2.5E-02
50 *)	2.0E-02
200	2.3E-03
400	2.3E-04
650	2.6E-05

Eastern direction	
Distance beyond fence, m	**Total dose rate, μSv/h**
0	8.3E-02
50 *)	5.0E-02
300	9.2E-04
600	4.2E-05
950	3.1E-06

Southern direction	
Distance beyond fence, m	**Total dose rate, μSv/h**
0	7.4E-02
50 *)	4.0E-02
300	1.0E-03
600	4.9E-05
970	2.6E-06

Western direction	
Distance beyond fence, m	**Total dose rate, μSv/h**
0	4.4E-02
50 *)	3.2E-02
250	9.4E-04
500	5.2E-05
740	5.6E-06

*) Location on the SWTSF and ISFSF site border

Table 4.45 Annual effective dose to a member of population due to direct irradiation from structures at SWTSF and ISFSF sites

Distance from security fence, m	Annual exposure duration, h	Annual effective dose for exposure direction, Sv				Remark
		North	East	South	West	
0	2000	5.00E-05	1.66E-04	1.48E-04	8.80E-05	On the security fence of the site
50	2000	4.00E-05	1.00E-04	8.00E-05	6.40E-05	On the boundary of the site
500	2000	1.80E-07	2.00E-07	2.20E-07	1.04E-07	On the border of proposed SPZ
	8760	7.88E-07	8.76E-07	9.64E-07	4.56E-07	
950	2000	-	6.20E-09	6.00E-09	2.00E-09	
	8760	-	2.72E-08	2.63E-08	8.76E-09	

Table 4.46 Annual effective dose to the critical group member of population at the permanent security fence of SWTSF/ISFSF site during solid radioactive waste retrieval and treatment phase (SNF handling at the reactor units and transfer to the ISFSF is performed at the same time)

Impacts and activities	**Annual effective dose for direction, Sv**			
	North	**East**	**South**	**West**
External and internal irradiation due to release of airborne activity from SWRF and SWTSF sites, 1)	7.42E-06	7.42E-06	7.42E-06	7.42E-06
External irradiation due to waste transfer from INPP to SWTSF site, 2)	6.87E-05	6.28E-06	1.03E-06	9.74E-07
External irradiation from SWTSF and ISFSF structures, 3)	5.00E-05	1.66E-04	1.48E-04	8.80E-05
Total dose from proposed economic activity (SWMSF)	**1.26E-04**	**1.80E-04**	**1.56E-04**	**9.64E-05**
External and internal irradiation due release of airborne activity from SNF handling at INPP (related to operation of ISFSF), 4)	4.15E-07	4.15E-07	4.15E-07	4.15E-07
External irradiation due to SNF transfer from INPP to ISFSF site, 5)	1.53E-05	8.87E-08	3.01E-08	2.02E-08
External and internal irradiation due to release of airborne activity from SNF reloading at ISFSF 6)	1.46E-07	1.46E-07	1.46E-07	1.46E-07
External and internal irradiation due to radioactive releases from existing nuclear facilities of INPP 7)	1.00E-05	1.00E-05	1.00E-05	1.00E-05
External irradiation from interim storage facility of solidified radioactive waste in INPP site 8)	1.80E-08			
External irradiation from near-surface repository of low and intermediate level short-lived radioactive waste in Stabatiskes site 8)		3.80E-06		
Total dose from proposed economic activity together with other existing and planned activities	**1.52E-04**	**1.94E-04**	**1.67E-04**	**1.07E-04**

1) Maximal dose for the most critical member (i.e. infant) of the critical group of population. Assessment is presented in chapter 4.9.2.2.1 and summarized in chapter 4.9.2.2.1.4;

2) Assessment is presented in chapter 4.9.2.2.2;

3) Assessment is presented in chapter 4.9.2.2.3.2;

4) Data taken from [59], chapter 5.1.5.2 and represents maximal exposure values for the most conservative scenario – "One year maximal effective dose due to handling of all leaking fuel".

5) Data taken from [59], chapter 5.2.2.2.

6) Data taken from [59], chapter 5.1.5.3.

7) Assessment is presented in chapter 4.9.2.2.4.2.2. Includes operation of INPP, operation of new CSF, shutdown, de-fueling and on-line decontamination of RU1 and RU2.

8) Assessment is presented in chapter 4.9.2.2.4.2.3.

Table 4.47 Annual effective dose to the critical group member of population at the border of SWTSF/ISFSF site (i.e. about 50 m away from the permanent security fence) during solid radioactive waste retrieval and treatment phase (SNF handling at the reactor units and transfer to the ISFSF is performed at the same time)

Impacts and activities	**Annual effective dose for direction, Sv**			
	North	**East**	**South**	**West**
External and internal irradiation due to release of airborne activity from SWRF and SWTSF sites, 1)	7.42E-06	7.42E-06	7.42E-06	7.42E-06
External irradiation due to waste transfer from INPP to SWTSF site, 2)	1.07E-04	5.21E-06	6.18E-07	7.87E-07
External irradiation from SWTSF and ISFSF structures, 3)	4.00E-05	1.00E-04	8.00E-05	6.40E-05
Total dose from proposed economic activity (SWMSF)	**1.54E-04**	**1.13E-04**	**8.80E-05**	**7.22E-05**
External and internal irradiation due release of airborne activity from SNF handling at INPP (related to operation of ISFSF), 4)	4.15E-07	4.15E-07	4.15E-07	4.15E-07
External irradiation due to SNF transfer from INPP to ISFSF site, 5)	1.96E-05	7.22E-08	1.81E-08	1.75E-08
External and internal irradiation due to release of airborne activity from SNF reloading at ISFSF, 6)	1.46E-07	1.46E-07	1.46E-07	1.46E-07
External and internal irradiation due to radioactive releases from existing nuclear facilities of INPP 7)	1.00E-05	1.00E-05	1.00E-05	1.00E-05
External irradiation from interim storage facility of solidified radioactive waste in INPP site 8)	3.00E-08			
External irradiation from near-surface repository of low and intermediate level short-lived radioactive waste in Stabatiskes site 8)		5.00E-06		
Total dose from proposed economic activity together with other existing and planned activities	**1.84E-04**	**1.28E-04**	**9.86E-05**	**8.28E-05**

Notes 1), 2), 3), 4), 5), 6), 7), 8) are explained below the Table 4.46.

Table 4.48 Annual effective dose to the critical group member of population at the border of proposed SPZ for SWTSF/ISFSF site (i.e. about 500 m away from the permanent security fence) during solid radioactive waste retrieval and treatment phase (SNF handling at the reactor units and transfer to the ISFSF is performed at the same time)

Impacts and activities	**Annual effective dose for direction, Sv**			
	North	**East**	**South**	**West**
External and internal irradiation due to release of airborne activity from SWRF and SWTSF sites, 1)	7.42E-06	7.42E-06	7.42E-06	7.42E-06
External irradiation due to waste transfer from INPP to SWTSF site, 2)	1.28E-04	1.19E-07	1.81E-08	3.63E-08
External irradiation from SWTSF and ISFSF structures, 3)	1.80E-07	2.00E-07	2.20E-07	1.04E-07
Total dose from proposed economic activity (SWMSF)	**1.36E-04**	**7.74E-06**	**7.66E-06**	**7.56E-06**
External and internal irradiation due release of airborne activity from SNF handling at INPP (related to operation of ISFSF), 4)	4.15E-07	4.15E-07	4.15E-07	4.15E-07
External irradiation due to SNF transfer from INPP to ISFSF site, 5)	2.03E-05	7.96E-09	4.20E-09	5.36E-09
External and internal irradiation due to release of airborne activity from SNF reloading at ISFSF 6)	2.25E-08	2.25E-08	2.25E-08	2.25E-08
External and internal irradiation due to radioactive releases from existing nuclear facilities of INPP 7)	1.00E-05	1.00E-05	1.00E-05	1.00E-05
External irradiation from interim storage facility of solidified radioactive waste in INPP site 8)	6.30E-06			
External irradiation from near-surface repository of low and intermediate level short-lived radioactive waste in Stabatiskes site 8), 9)		1.62E-04		
Total dose from proposed economic activity together with other existing and planned activities	**1.73E-04**	**1.80E-04**	**1.81E-05**	**1.80E-05**

Notes 1), 2), 3), 4), 5), 6), 7), 8) are explained below the Table 4.46.

9) At the security fence of the near-surface disposal facility site, about 450 m away from the permanent security fence of the ISFSF / SWTSF site.

Table 4.49 Direct and indirect impacts of the proposed economic activity on factors influencing the health (positive (+), negative (-))

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health	Forecasted changes of the analyzed indicators	Possibilities to mitigate (eliminate) the negative impact	Comments and remarks
1. Factors of behavior and lifestyle (nutrition habits, alcohol consumption, smoking, consumption of narcotic and psychotropic drugs, safe sex and other)	SWMSF construction and operation	Not foreseen				The proposed economic activity will be implemented within existing INPP sanitary protection zone, where is no permanently living population. Potential impact of physical nature can be expected in the vicinity of SWTSF only. The INPP personnel will be used to the largest extent in the operation of SWMSF. The working conditions will be assured in accordance with requirements of regulations in force.
2. Factors of physical environment						
2.1. Air quality	Traffic of heavy vehicles during construction of SWMSF. Operation of road construction equipment. Waste transfer activities in between INPP and SWTF. Operation of the Incineration facility. Ventilation systems of the SWMSF.	Air pollution due to dust generation, emission of exhaust products from engines, emission of combustion products from Incinerator facility.	(-)	The affected area is limited by the construction route and nearby environment in a range of about 100 m. The results of dispersion calculations of releases from Incineration facility show compliance with the established limiting concentrations what will	Electric driven trucks are planned for the transfer of radioactive waste containers in-between the SWRF and the SWTSF. Emissions from the SWTSF will be filtrated and monitored.	Details are provided in chapter 4.2.3.1. The possible maximal annual rates for the harm to the environment are presented in chapter 4.10.

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health	Forecasted changes of the analyzed indicators	Possibilities to mitigate (eliminate) the negative impact	Comments and remarks
				enable to operate the incineration facility at the projected load with negligible impact on the environment. All impacts will be reversible.		
2.2. Water quality	SWTSF domestic sewerage system and surface drain water system	Possible limited and controlled pollution due to utilities type sewage release.	(-)	Sewage water will be routed to the existing waste water treatment plant. Planned annual discharges are low. No significant impacts or changes in the existing environment are forecasted.	The SWTSF sewage water system and site surface drain water collection systems will be designed in accordance with the requirements of appropriate normative documents. Sewage water discharges will be monitored and controlled. Survey boreholes (wells) for monitoring groundwater will be established around the SWMSF as part of required environmental monitoring.	Planned amounts of sewage and drain water discharges are presented in chapter 3.2.1. Details on potential impact are provided in chapters 4.1.4, 4.1.5 and 4.1.6.
2.3. Food quality	SWMSF construction and operation	Not foreseen				The proposed economic activity will be implemented within the existing INPP sanitary protection zone, where no permanently living population exists and economic activity is limited.

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health	Forecasted changes of the analyzed indicators	Possibilities to mitigate (eliminate) the negative impact	Comments and remarks
						The SWTSF site will have its own sanitary protection zone. Possible impact and changes in the environment will be monitored.
2.4. Soil	SWMSF construction and operation	Not foreseen				No soil pollution is foreseen under normal operation conditions. The site area will be permanently monitored. In case of local soil contamination by conventional pollutants (i.e. accidental spillage of deliverables like cement etc.) or radioactive material (i.e. in case of a waste transfer accident) appropriate procedures will be implemented to eliminate the hazards and consequences of this impact.
2.5. Non-ionizing radiation	SWMSF construction and operation	Not foreseen				
2.6. Ionizing radiation	1. Solid radioactive waste retrieval and packaging in the SWRF at the INPP site. 2. Radioactive waste transfer in-between INPP and SWTSF sites. 3. Radioactive waste treatment at the SWTF.	Exposure of population	(-)	Possible local increase of exposure near the SWTSF and the road connection in-between INPP and SWTSF sites.	Around the SWTSF site, a sanitary protection zone will be established, in which there are no permanent inhabitants and economic activities are limited. Monitoring of ionizing	Possible exposure under normal operation conditions will not exceed safety limits prescribed by radiation protection requirements (c.f. chapter 4.9.2.2). Possible exposure under emergency situations can be assured to be within the limits

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health	Forecasted changes of the analyzed indicators	Possibilities to mitigate (eliminate) the negative impact	Comments and remarks
	4. Radioactive waste storage at SWSF.				radiation impact and changes in the environment will be performed.	prescribed by radiation protection requirements (c.f. chapter 8).
2.7. Noise	SWMSF construction and operation	Noise increase	(-)	Noise increase can be expected during construction of the SWTSF which will last approximately 2 years. Since the nearest residential properties are located approximately in a distance of 2 km from the SWTSF site, it is estimated that construction noise will rarely exceed existing levels. Once operational the SWTSF will produce no noise that will be perceptible at the nearest residential receptors.	The noisy activities will be carried out during daytime only. The noise level will be measured; if the level is exceeded, the works will be stopped and means for noise reduction will be implemented.	Details are provided in chapter 4.9.2.1.2
2.8. Home conditions	SWMSF construction and operation	Not foreseen				
2.9. Safety	Radioactive waste	Increase of the nuclear and radiation safety	(+)	The proposed economic activity, which introduces an advanced radioactive waste management technology, will increase		Radioactive waste will be managed in accordance with recommendations of IAEA and in compliance with good practices in other European Union Member

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health	Forecasted changes of the analyzed indicators	Possibilities to mitigate (eliminate) the negative impact	Comments and remarks
				nuclear safety and significantly reduce risk of possible accidents as compared with the existing situation.		States.
2.10. Means of communication	SWMSF construction	Traffic increase on public roads	(-)	Possible temporary traffic increase. The SWTSF construction will last approximately 2 years.		
2.11. Territory planning	SWMSF construction	Not foreseen				SWMSF will be constructed in the existing INPP sanitary protection zone
2.12. Waste management	SWMSF construction and operation	Generation of secondary waste	(-)	Secondary waste amounts generated by the SWMSF will be small. No hazardous waste will be produced. Solid radioactive waste produced during operation of the SWMSF will be managed by the SWMSF. No significant impacts or changes in the existing environment are forecasted.	Non radioactive waste will be managed in accordance with the requirements of the waste management legislation and regulations in force. Most of the SWMSF operations will be undertaken remotely, and the generation of secondary solid radioactive waste will be limited. Waste minimization will be considered by design.	Details are provided in chapter 3
2.13. Power appliance	SWMSF construction and operation	Not foreseen				

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health	Forecasted changes of the analyzed indicators	Possibilities to mitigate (eliminate) the negative impact	Comments and remarks
2.14. Risk of accidents	SWMSF construction and operation	Not foreseen				Risk of accidents can be eliminated or reduced by appropriate technical solutions. Possible exposure under emergency situations can be assured to be within limits prescribed by radiation protection requirements (c.f. chapter 8). The working conditions will be assured in accordance with requirements of regulations in force.
2. 15. Passive smoking	SWMSF construction and operation	Not foreseen				
3. Social and economic factors						
3.1. Culture	SWMSF construction and operation	Not foreseen				
3.2. Discrimination	SWMSF construction and operation	Not foreseen				
3.3. Property	SWMSF construction and operation	Not foreseen				
3.4. Income	SWMSF construction and operation	Increase of income	(+)	The proposed economic activity represents the EU direct investment for the INPP decommissioning. Local companies, among		

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health	Forecasted changes of the analyzed indicators	Possibilities to mitigate (eliminate) the negative impact	Comments and remarks
				others, will be involved in the construction of the SWMSF.		
3.5. Education possibilities	SWMSF construction and operation	Not foreseen				
3.6. Employment, labor market, business opportunities	SWMSF construction and operation	Workplace creation	(+)	Local companies, among others, will be involved in the construction of the SWMSF. The INPP personnel will be used at the largest extent in the operation of SWMSF.		
3.7. Criminality	SWMSF construction and operation	Not foreseen				
3.8. Leisure, recreation	SWMSF construction and operation	Not foreseen				
3.9. Movement	SWMSF construction and operation	Not foreseen				
3.10. Social security (social contact and welfare)	SWMSF construction and operation	Not foreseen				
3.11. Sociality, sociability, cultural contact	SWMSF construction and operation	Not foreseen				
3.12. Migration	SWMSF construction and operation	Reduce of migration	(+)	Employment reduces migration.		No significant changes are foreseen.

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health	Forecasted changes of the analyzed indicators	Possibilities to mitigate (eliminate) the negative impact	Comments and remarks
3.13. Family constitution	SWMSF construction and operation	Not foreseen				
4. Professional risk factors (chemical, physical, biological, ergonomic, psychosocial, manual work)	SWMSF construction and operation	Not foreseen				Most of the SWMSF operations which may present direct hazards will be undertaken remotely. The working conditions will be assured in accordance with the requirements of regulations in force. Professional risk can be eliminated or reduced by appropriate technical solutions.
5. Psychological factors						
5.1. Aesthetical appearance	SWMSF construction and operation	Impact on landscape	(-)	The construction of the SWMSF near the INPP will not produce any major effect on the landscape and will not disrupt the equilibrium between the natural and anthropogenic territories. Considering its location and general layout, visual impact of the new SWMSF will be insignificant. The visibility of the buildings of the SWMSF will be mainly limited to the	Landscaping, selection of proper design, materials and construction types and planting of greenery will be used to enhance the appearance of the SWMSF.	

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health	Forecasted changes of the analyzed indicators	Possibilities to mitigate (eliminate) the negative impact	Comments and remarks
				closest roads.		
5.2. Comprehensibility	SWMSF construction and operation	Not foreseen				
5.3. Capability to hold the situation	SWMSF construction and operation	Not foreseen				
5.4. Significance	SWMSF construction and operation	Not foreseen				
5.5. Possible conflicts	SWMSF construction and operation	Possible population discontent and distrust in Latvia and Belorussia.	(-)	Such a psychological impact is stipulated by changes in existing nuclear practice (shutdown and decommissioning of INPP), which results in the construction of new nuclear objects such as SWMSF and others.	Psychological impact can be mitigated explaining necessity, goals and benefits of the proposed economic activity.	
6. Social and health services (acceptability, suitability, succession, efficiency, protection, availability, quality, self-help technique)	SWMSF construction and operation	Not foreseen				

Table 4.50 Possible impact of proposed economic activity on public groups (positive (+), negative (-))

Public groups	Kind of activity or means, contamination sources	Group size	Impact	Comments and remarks
1. Public groups (local population) in the zone of activity impact	Ionizing radiation	There is no permanently living population in the sanitary protection zone. Economical activity is limited.	(-)	Impact within the sanitary protection zone will be minimal and will not exceed the limits prescribed by radiation protection requirements (c.f. chapters 4.9 and 8). Outside the sanitary protection zone of the SWMSF impact can be considered as insignificant.
2. Personnel	Ionizing radiation	Personnel of SWMSF, about 100 employees in SWMSF and 20 employees in SWRF	(-)	Personnel exposure due to the proposed economic activity can be controlled and limited using, where appropriate, shielding, remote-controlled equipment, proper operational procedures etc. Personnel exposure will be optimized during the Technical Design and will not exceed the limits prescribed by radiation protection requirements.
3. Uses of activity products	Not relevant			
4. Persons with slender income	Not relevant			
5. The jobless	Not relevant			
6. Ethnical groups	Not relevant			
7. Persons sick with same diseases (dependence on drugs, alcohol etc.)	Not relevant			
8. Disables	Not relevant			
9. Single persons	Not relevant			
10. Refugees, emigrants and persons seeking political asylum	Not relevant			
11. The homeless	Not relevant			

Public groups	Kind of activity or means, contamination sources	Group size	Impact	Comments and remarks
12. Other population groups (arrestees, persons of special occupations, manual hard workers etc.)	Not relevant			
13. Other groups (single persons)	Not relevant			

Table 4.51 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**			
	< 500	**501–1000**	**> 1001**	**Clear**	**Probable**	**Possible**	**Short (< 1 y)**	**Medium (1–3 y)**	**Long (> 3 y)**	
1. Ionizing radiation	X			X (personnel)	X (population)				X	Possible local impact to the population near the SWMSF. The impact outside the sanitary protection zone can be considered as insignificant. Exposure (of population and personnel) will not exceed limits prescribed by radiation protection requirements.
2. Generation of dust and air pollution	X				X			X		Possible local impact near the SWMSF.
3. Controlled slight pollution due to utilities type sewage water release to environment	X				X				X	Sewage water will be routed for cleaning to enterprise “Visagino energija”
4. Soil erosion	X					X		X		
5. Noise	X			X				X		Possible local impact near the SWMSF.
6. Waste management	X			X					X	
7. Impact on landscape			X		X				X	

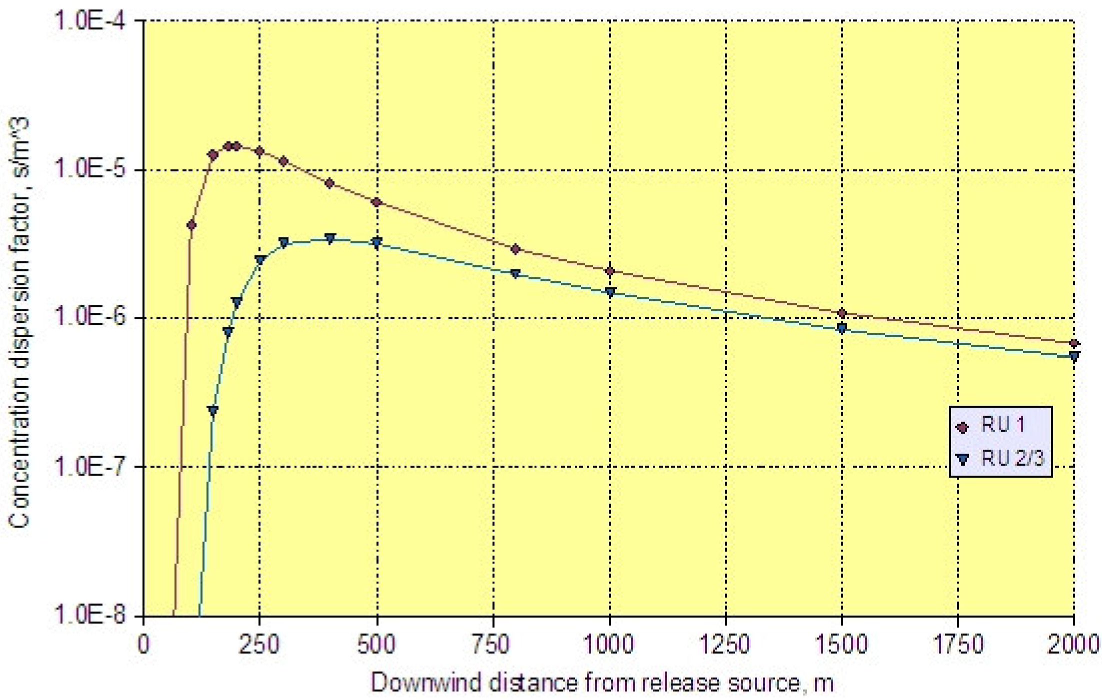


Figure 4.22 Concentration dispersion factor (on-axis ground level concentration for unit release) for releases through the ventilation stacks of RU1, RU2 and RU3 of SWRF

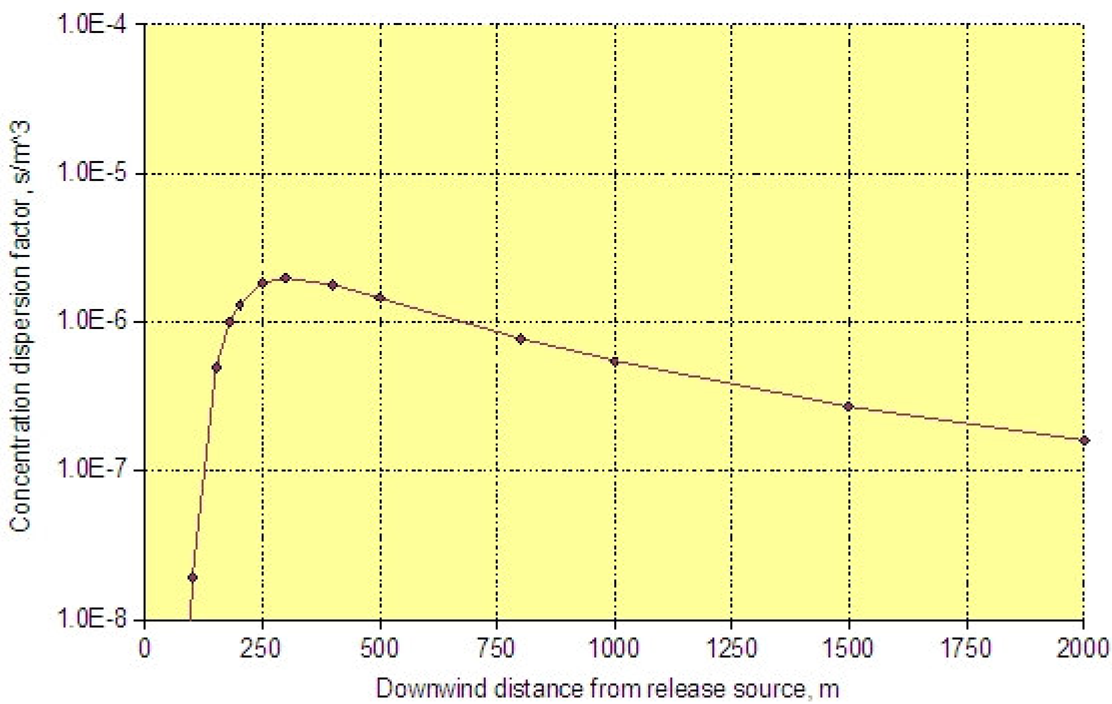


Figure 4.23 Concentration dispersion factor (on-axis ground level concentration for unit release) for releases through the main ventilation stack of SWTF

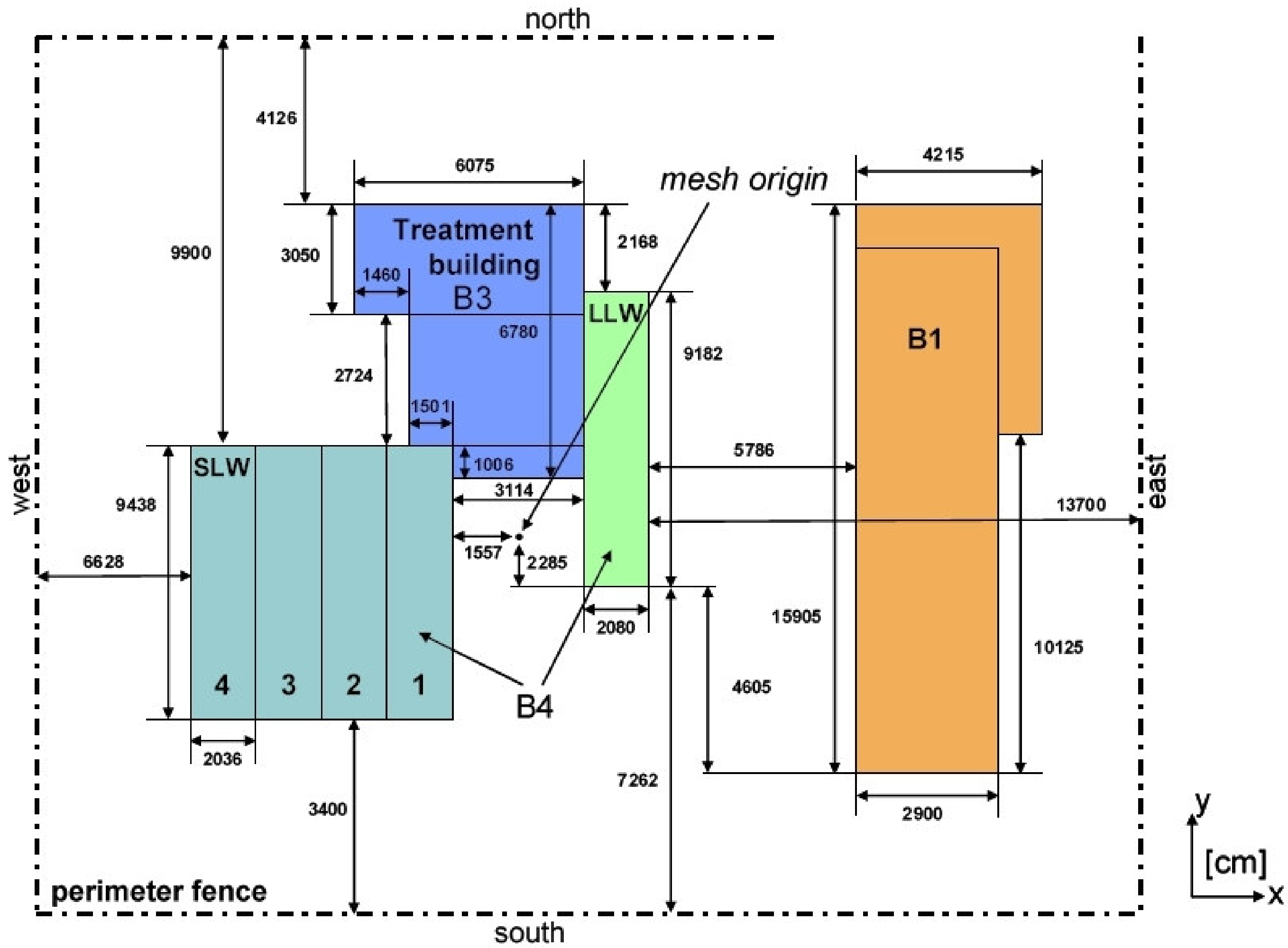


Figure 4.24 Positioning of SWTF (B3), SWSF (SLW and LLW) and ISFSF (B1) on the site and against calculation mesh origin point. Distance values are given in cm

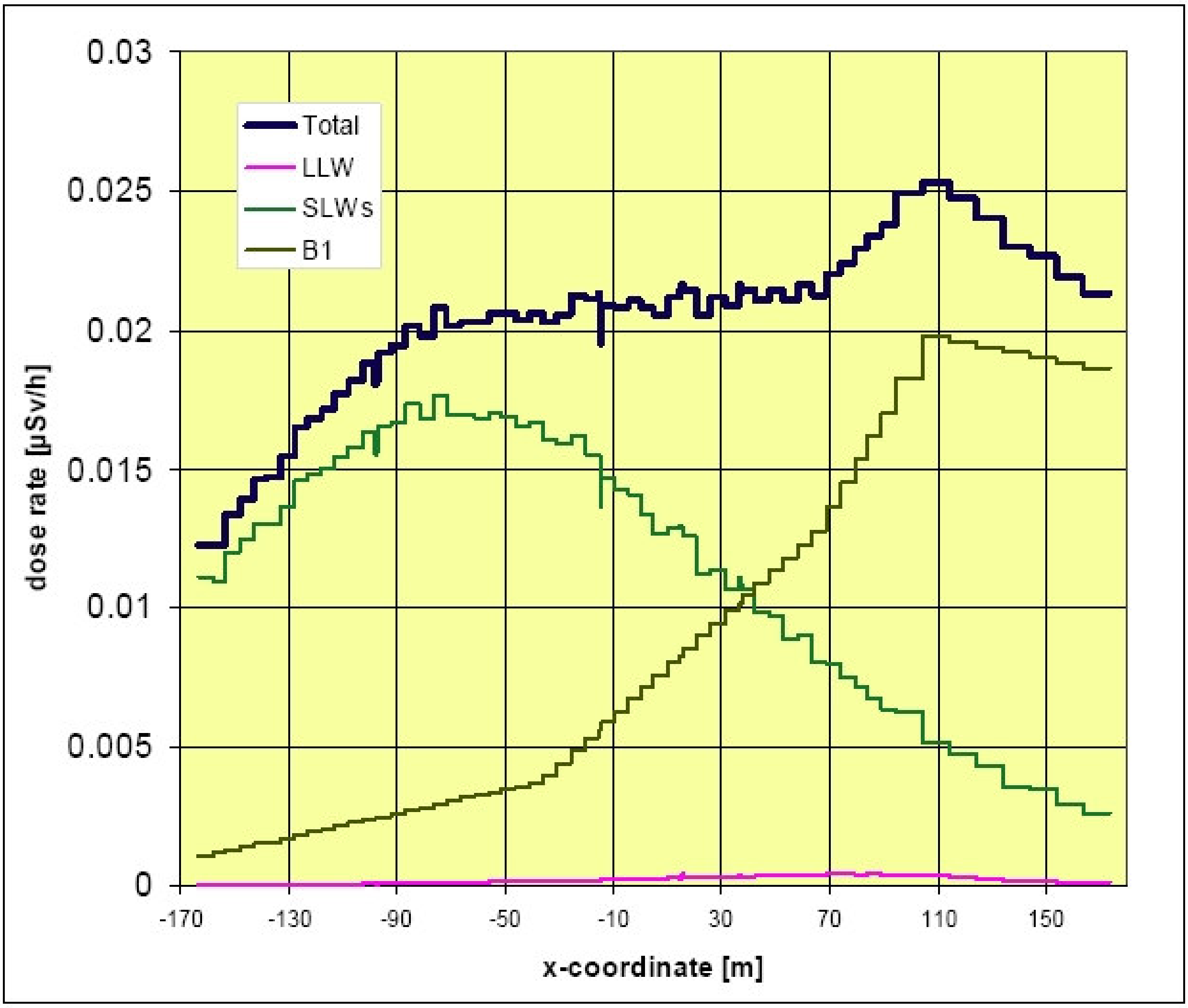


Figure 4.25 Total and resolved dose rates originating from the SWSF and ISFSF buildings along the permanent security fence north side of the SWTSF and ISFSF site. The dose rate maximum is 0.0253 µSv/h. The location of the coordinate origin is shown in Figure 4.24

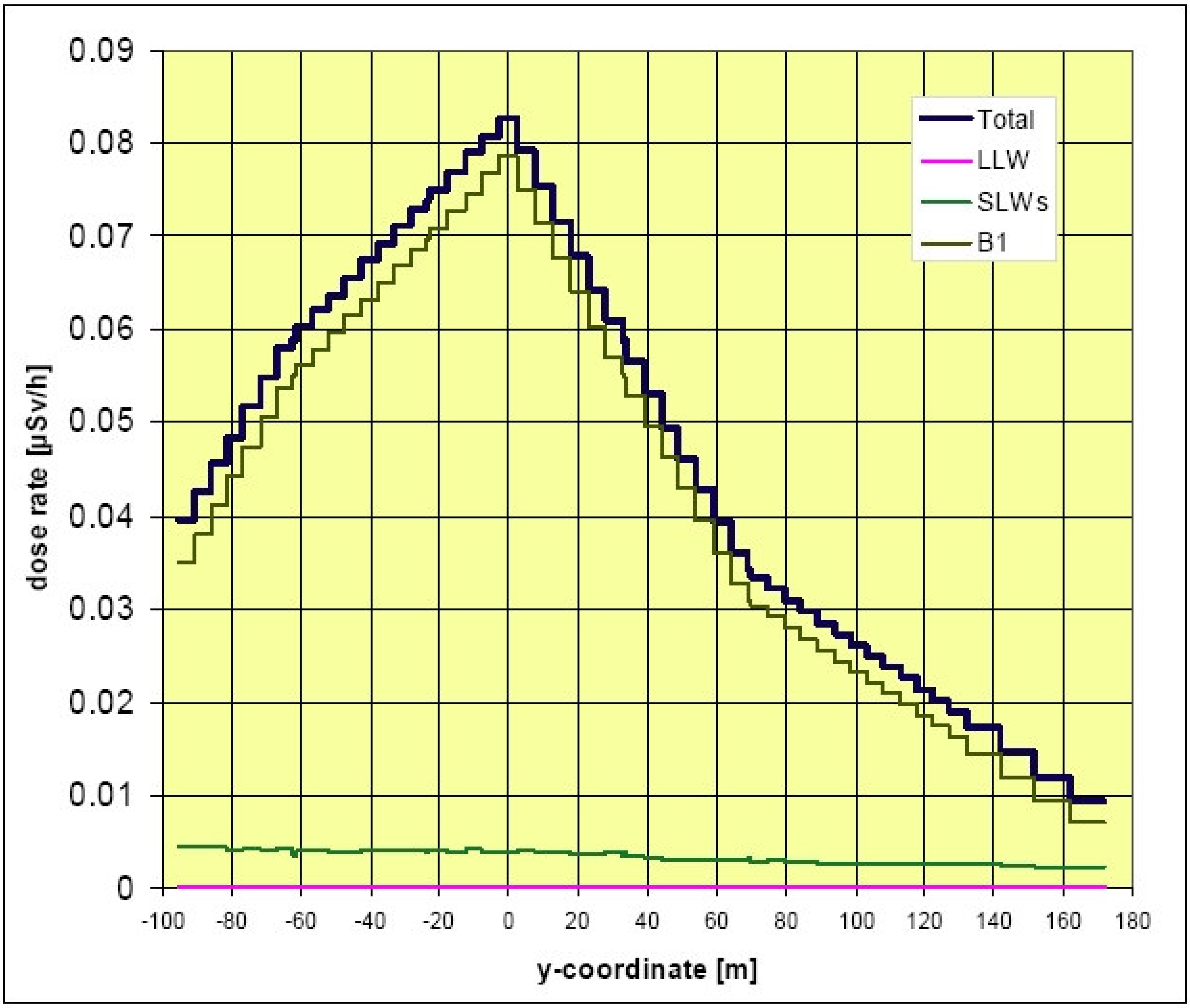


Figure 4.26 Total and resolved dose rates originating from the SWSF and ISFSF buildings along the permanent security fence east side of the SWTSF and ISFSF site. The dose rate maximum is 0.0827 µSv/h. The location of the coordinate origin is shown in Figure 4.24

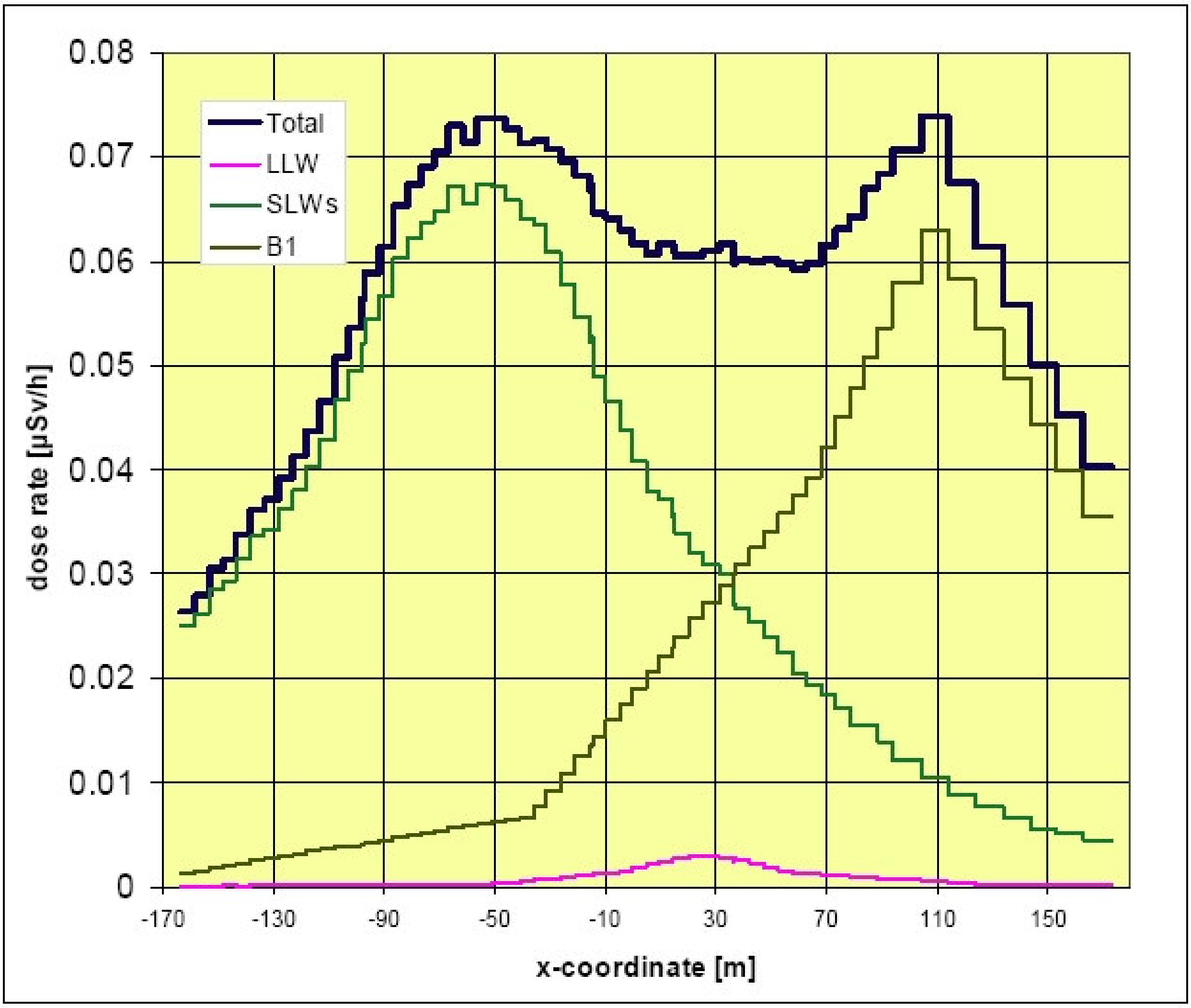


Figure 4.27 Total and resolved dose rates originating from the SWSF and ISFSF buildings along the permanent security fence south side of the SWTSF and ISFSF site. The dose rate maximum is 0.0738 µSv/h. The location of the coordinate origin is shown in Figure 4.24

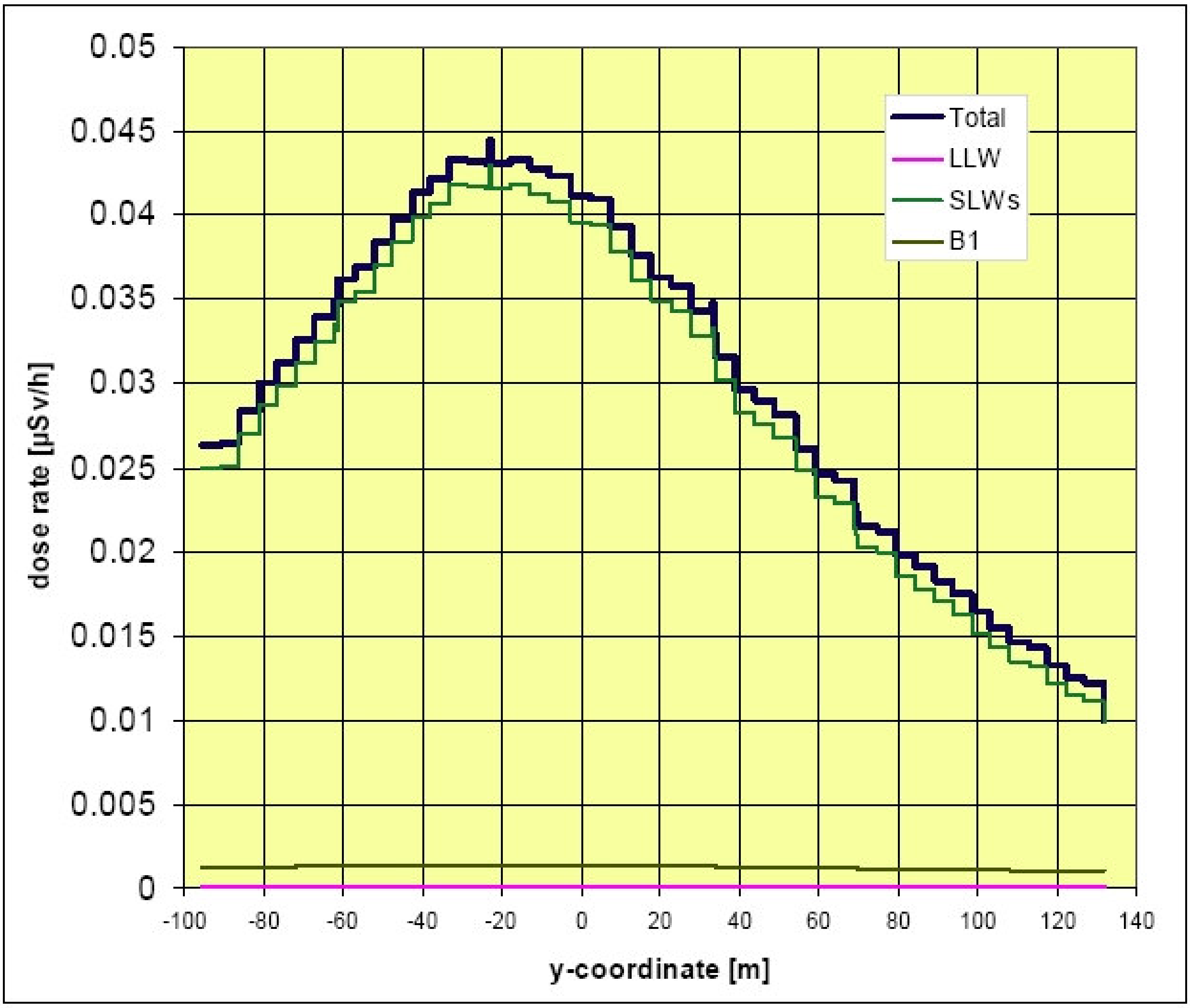


Figure 4.28 Total and resolved dose rates originating from the SWSF and ISFSF buildings along the permanent security fence west side of the SWTSF and ISFSF site. The dose rate maximum is 0.0444 µSv/h. The location of the coordinate origin is shown in Figure 4.24

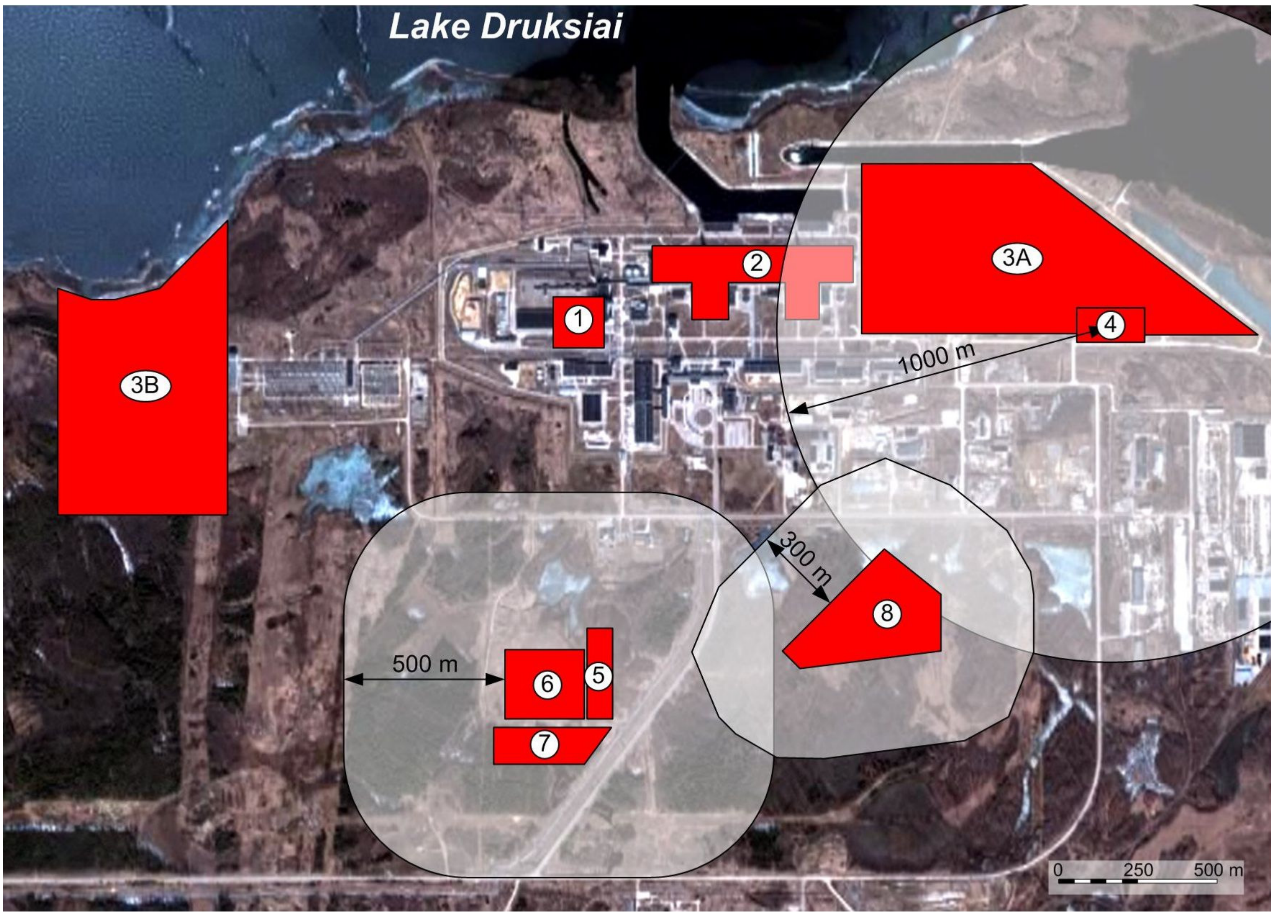


Figure 4.29 Existing and planned nuclear facilities, located in the Ignalina NPP sanitary protection zone of 3 km radius

(1) – Existing bituminized radioactive waste storage facility and new interim storage facility for solidified radioactive waste (spent ion-exchange resins and filter aid (Perlite) deposits). Both storage facilities are located inside the INPP industrial site and presently do not have their separate 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) and (3B) – alternative sites for the newly planed NPP. The SPZ for the new NPP will be proposed during development of EIA documentation for this new NPP.

(4) – Existing SNF storage facility. The design of the storage facility defines a 1 km radius SPZ around this facility. 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 nuclear facilities will be close to each other, their SPZ will overlap and the facilities will have a common security fence. EIA Reports foresee a common SPZ for the both facilities. Approximately a 500 m wide zone starting from the security fence is proposed as the SPZ for the sites. Outside the proposed SPZ the impact of these nuclear facilities can be considered as insignificant. The size of SPZ will be finally determined during the development of Technical designs and SAR.

(7) – One of the proposed sites (southern) for very low-level radioactive waste disposal facility (Landfill). SPZ is not defined; preliminary proposals will be prepared during the development of EIA documents.

(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.

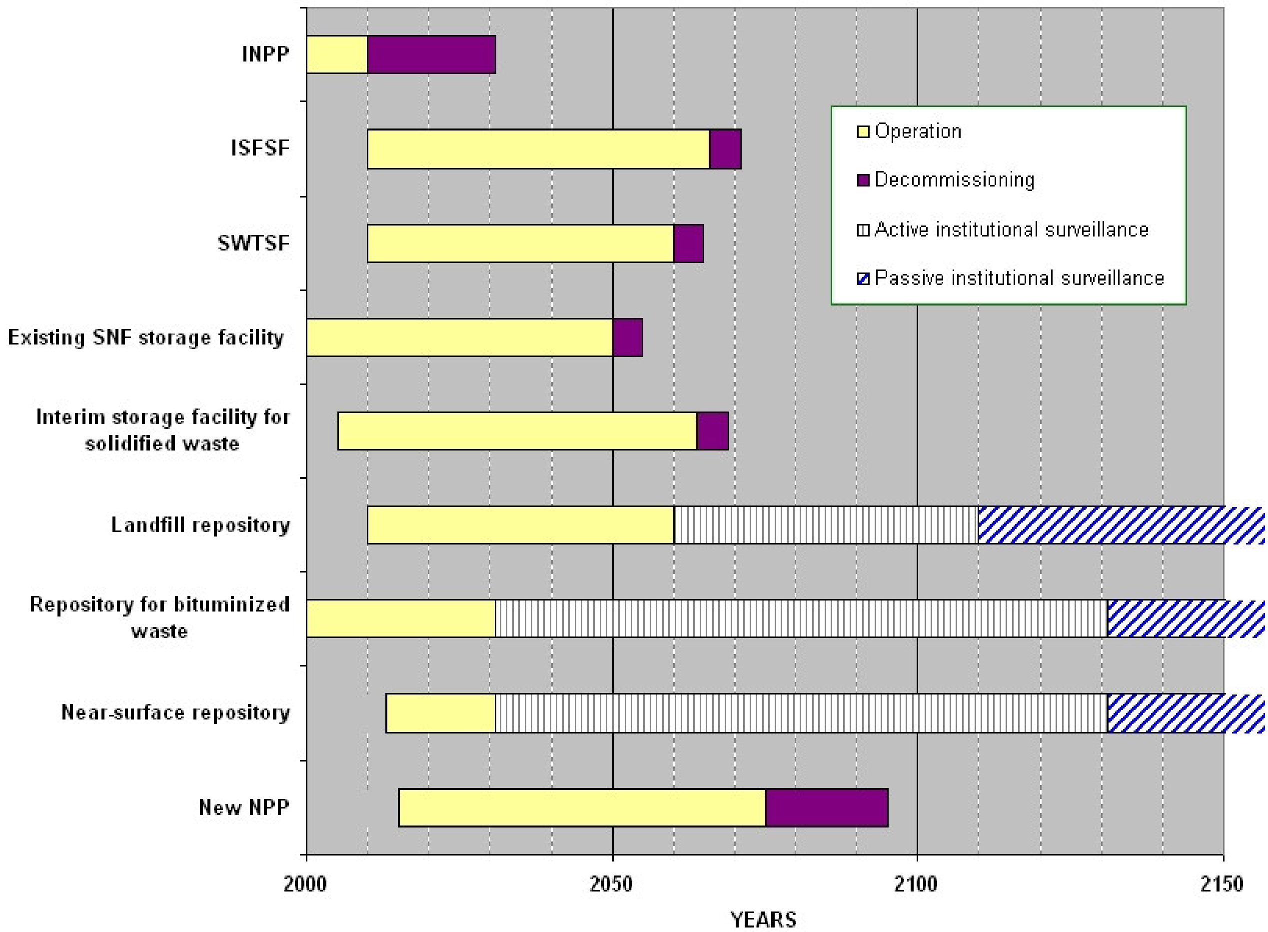


Figure 4.30 Main activity phases of the existing and planned nuclear facilities, located in Ignalina NPP existing sanitary protection zone of 3 km radius

The interim storage facility stored solidified radioactive waste (spent ion-exchange resins and filter aid (Perlite) deposits) packages are planned to be disposed in the near-surface repository for low and intermediate level radioactive waste. Therefore the operation period of the interim storage facility may be shorter than indicated in the Figure.

The new solid radioactive waste treatment facility (SWTSF) will treat waste until about 2030 (i.e., until the end of INPP decommissioning). Later on the waste will only be stored. The SWTSF short-lived waste storage buildings stored radioactive waste packages are planned to be disposed in the near-surface repository for low and intermediate level radioactive waste. Therefore the operation period of SWTSF short-lived waste stores may be shorter than indicated in the Figure.

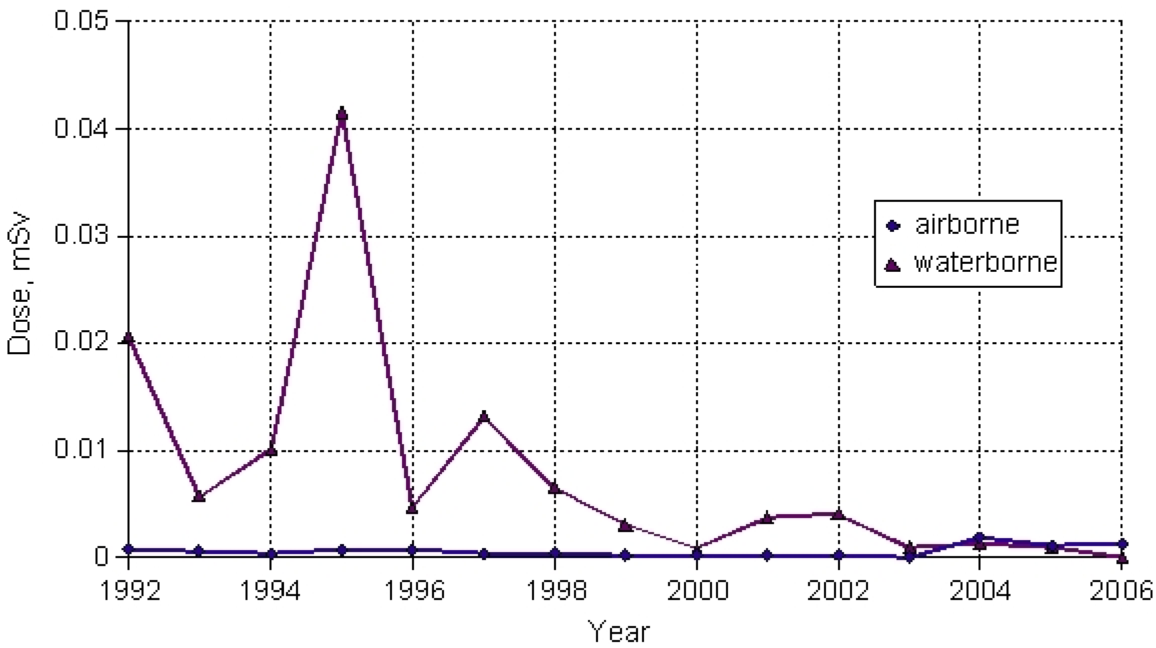


Figure 4.31 Annual effective dose to the critical group member of population due to radioactive releases (airborne emissions and waterborne discharges) from the nuclear facilities located in the SPZ of INPP for time period 1992 – 2006 [80]

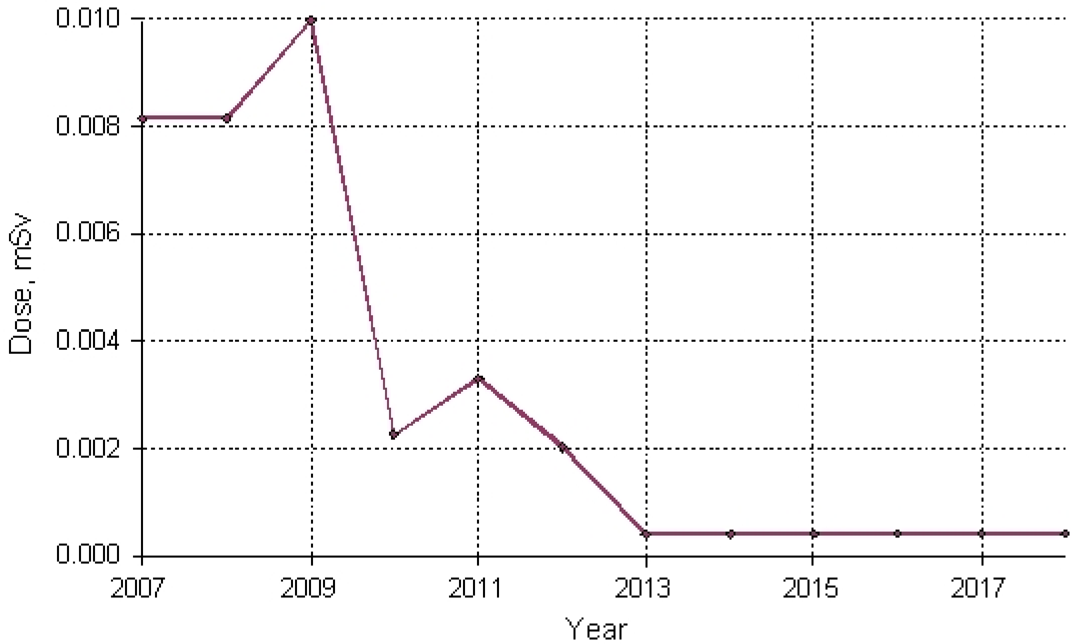


Figure 4.32 Forecast for the dose to the critical group member of population due to radioactive releases (airborne emissions and waterborne discharges) from the nuclear facilities located in the SPZ of INPP

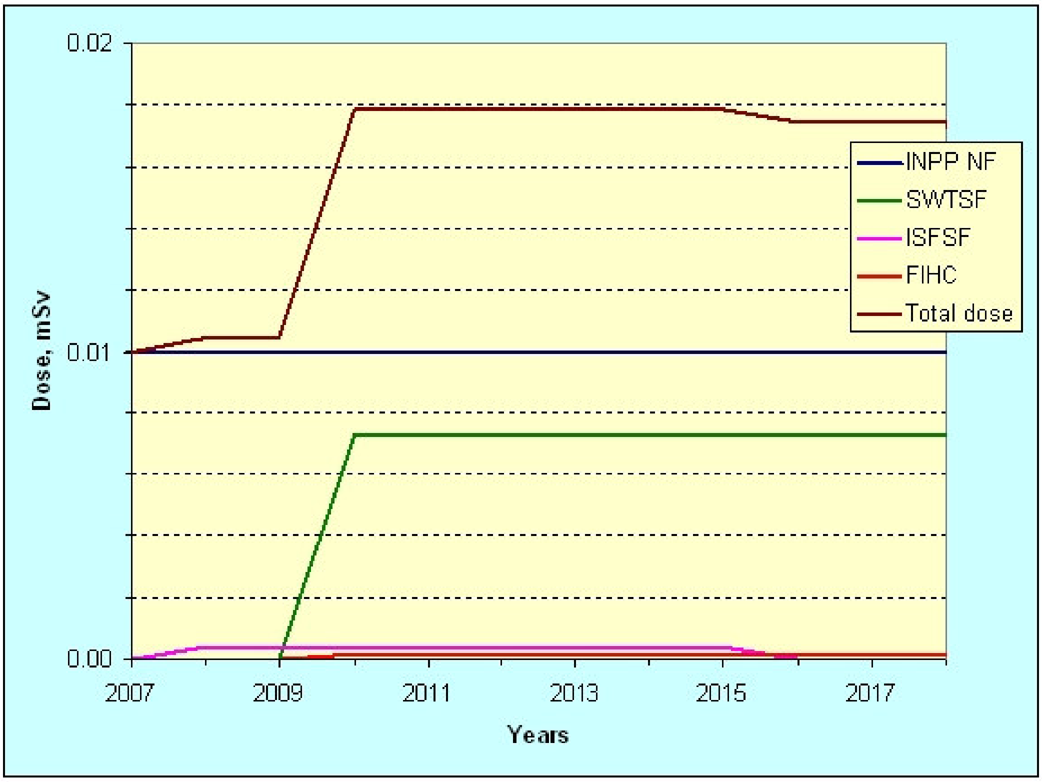


Figure 4.33 Forecast of the maximal annual effective dose to the critical group member of population due to radioactive releases (airborne emissions and waterborne discharges) from the existing and planned nuclear facilities located in the SPZ of INPP

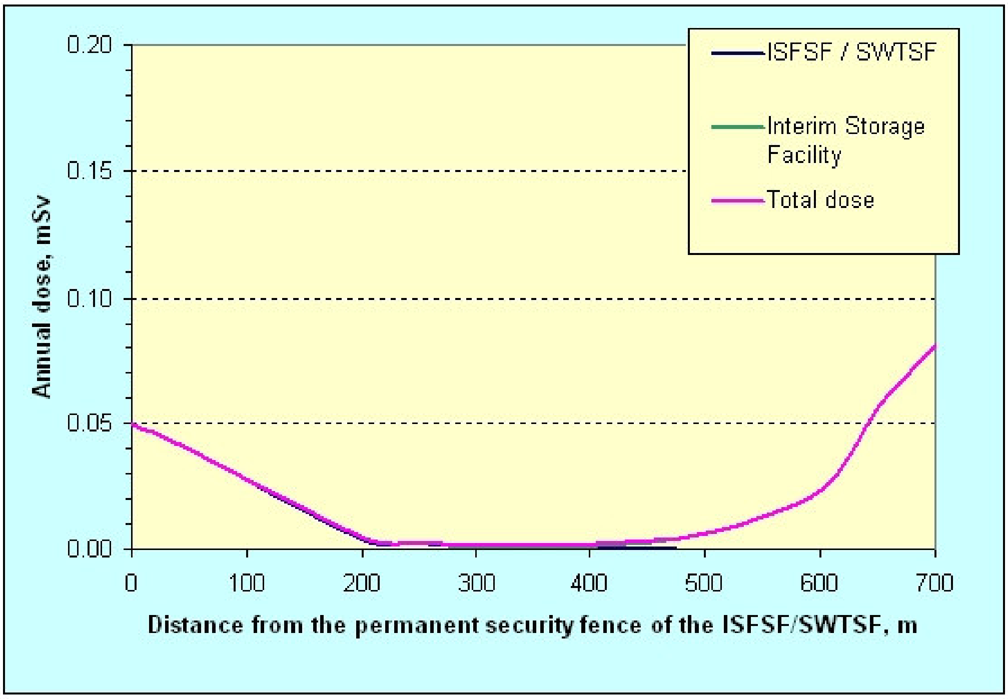


Figure 4.34 Potential annual dose to the member of population due to direct ionizing irradiation from the ISFSF / SWTSF and the Interim Storage Facility. Calculations consider maximally loaded facilities and assume annual exposure duration of 2000 hours

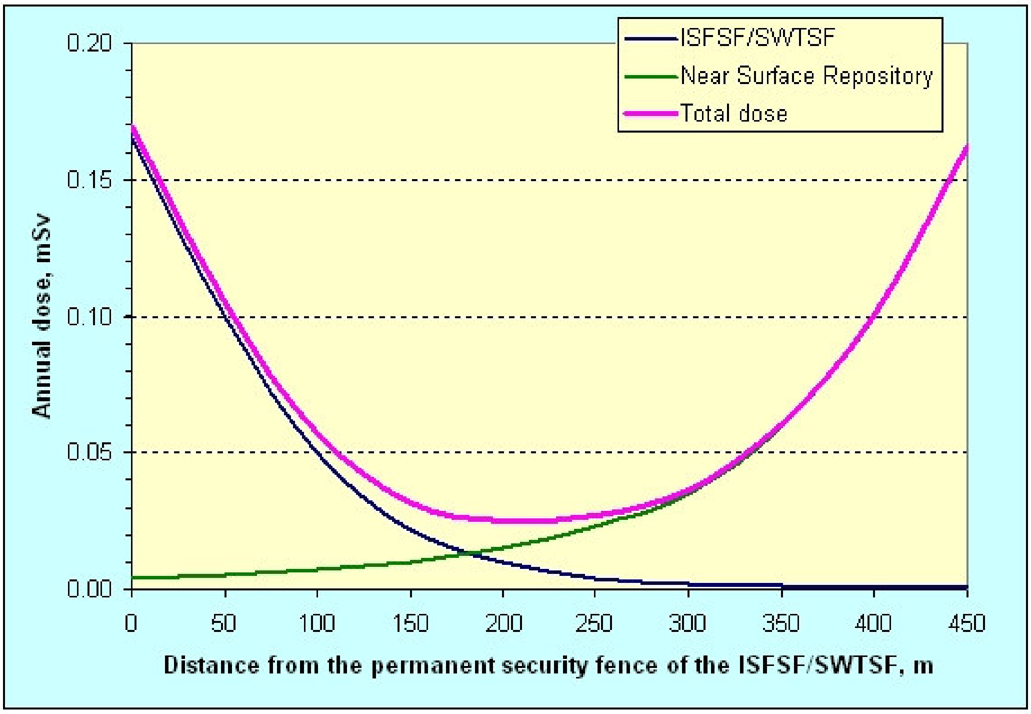


Figure 4.35 Potential annual dose to the member of population due to direct ionizing irradiation from the ISFSF / SWTSF site and the near-surface disposal facility in Stabatiskes site. Calculations assume annual exposure duration of 2000 hours

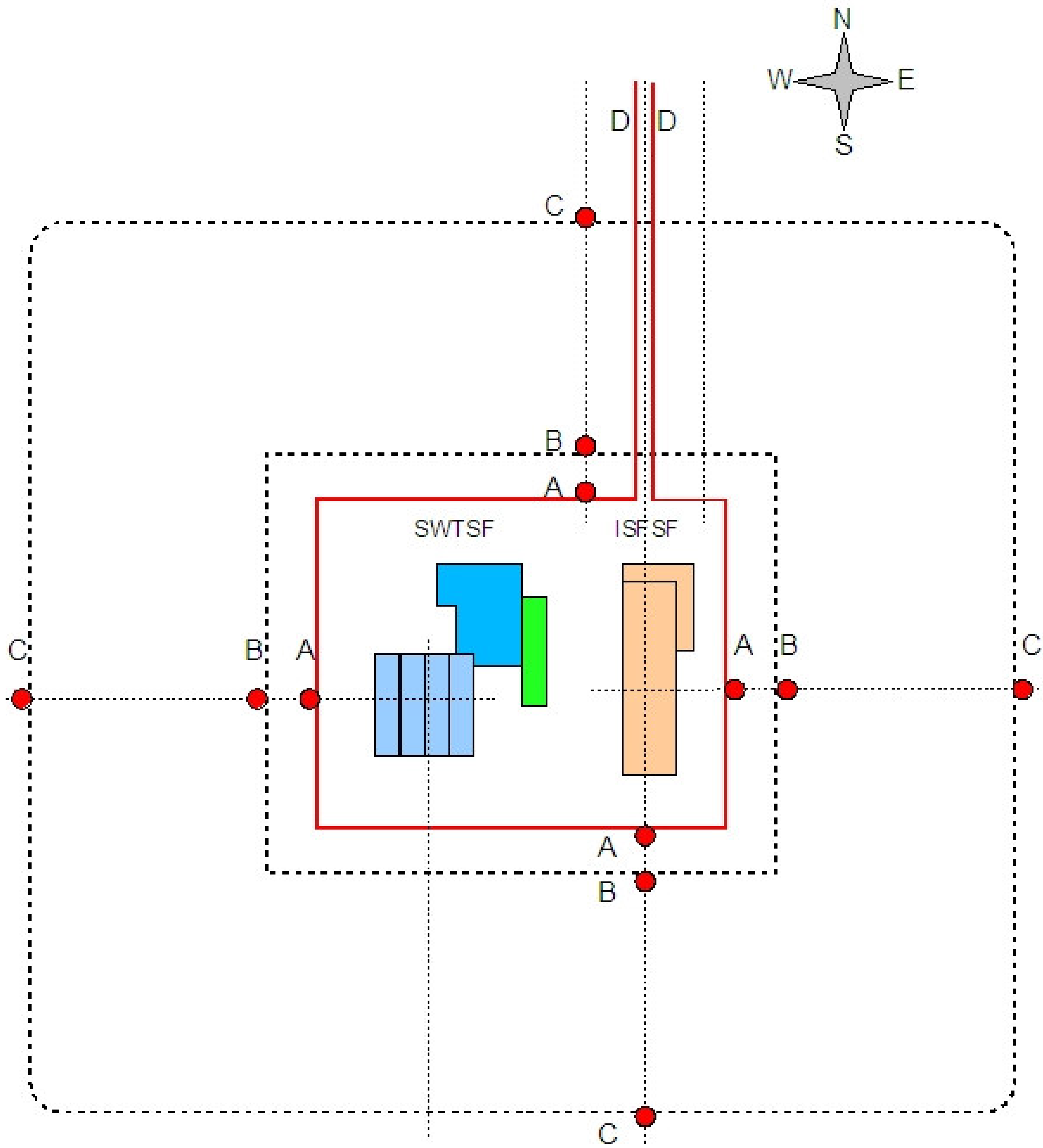


Figure 4.36 Radiological impact assessment locations around SWTSF / ISFSF sites, A – at the permanent SWTSF / ISFSF sites security fence, B – at the SWTSF / ISFSF sites border (at the distance of 50 m of from the permanent security fence), C - at the border of proposed SWTSF / ISFSF sites Sanitary Protected Zone (SPZ). D – waste transfer road connection fence

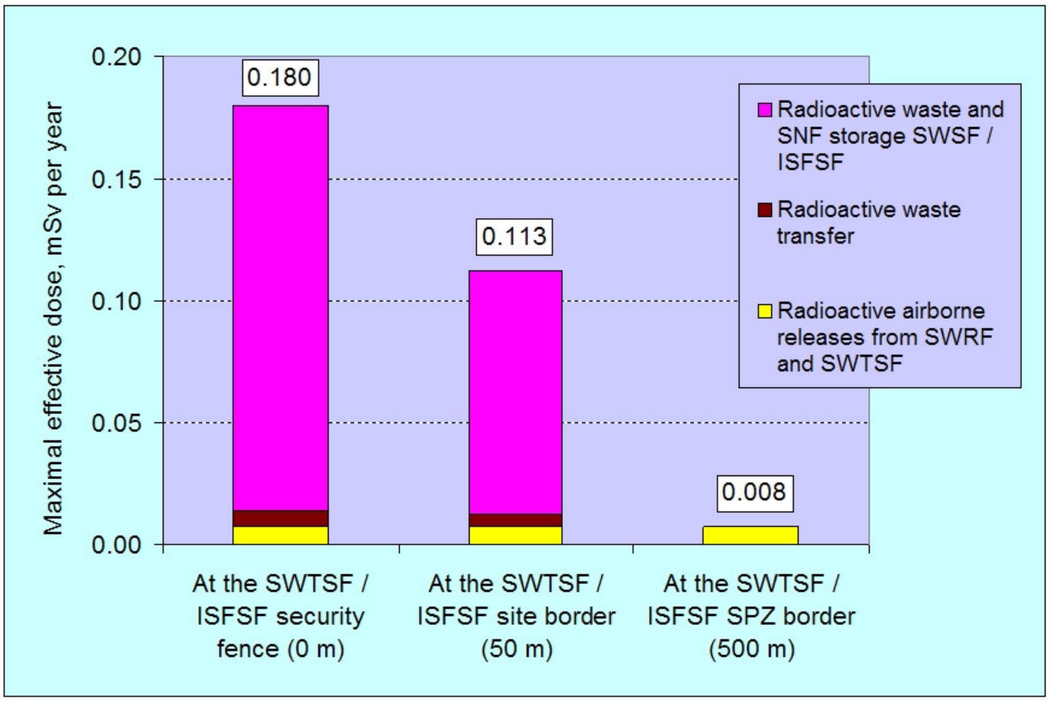


Figure 4.37 Annual exposure of the critical group member of population in the eastern direction from the SWTSF / ISFSF sites due to the proposed economical activity

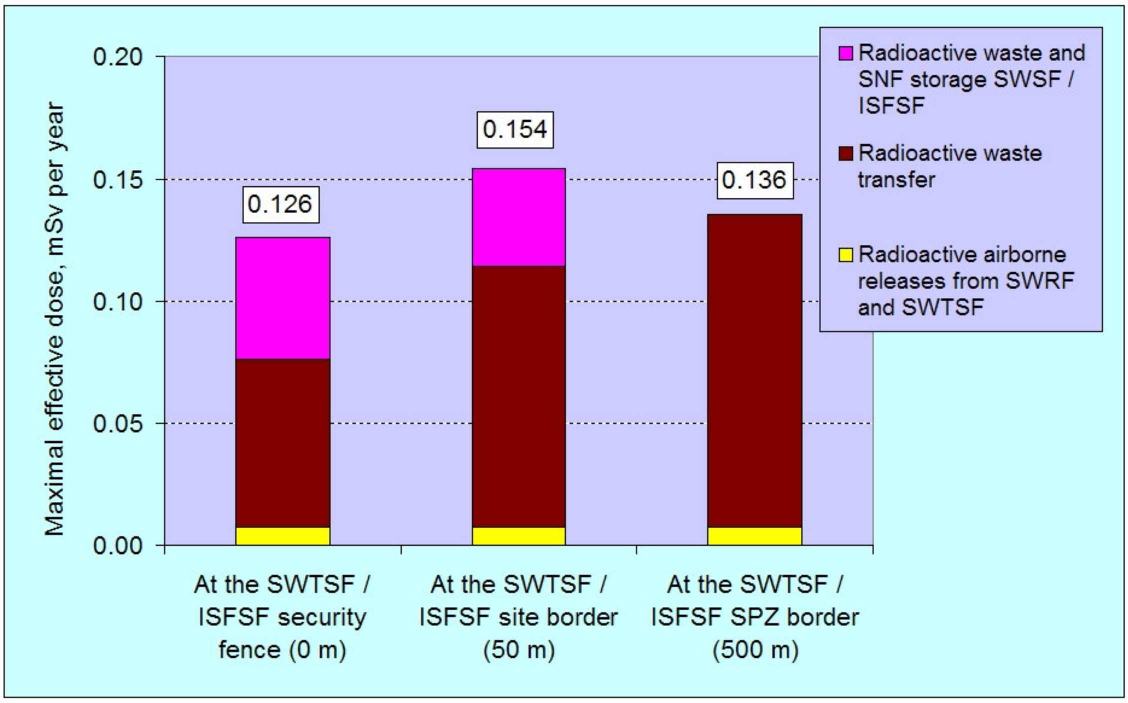


Figure 4.38 Annual exposure of the critical group member of population in the northern direction from the SWTSF / ISFSF sites due to the proposed economical activity

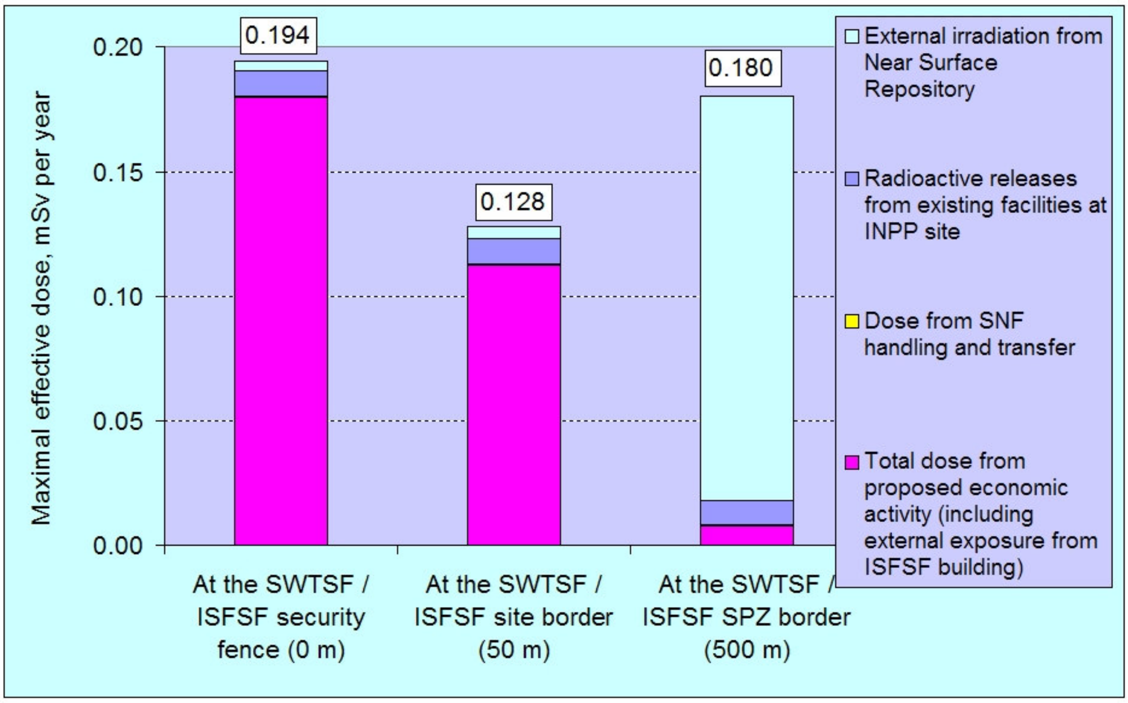


Figure 4.39 Annual exposure of the critical group member of population in the eastern direction from the SWTSF / ISFSF sites due to the proposed economical activity and other existing and planned activities

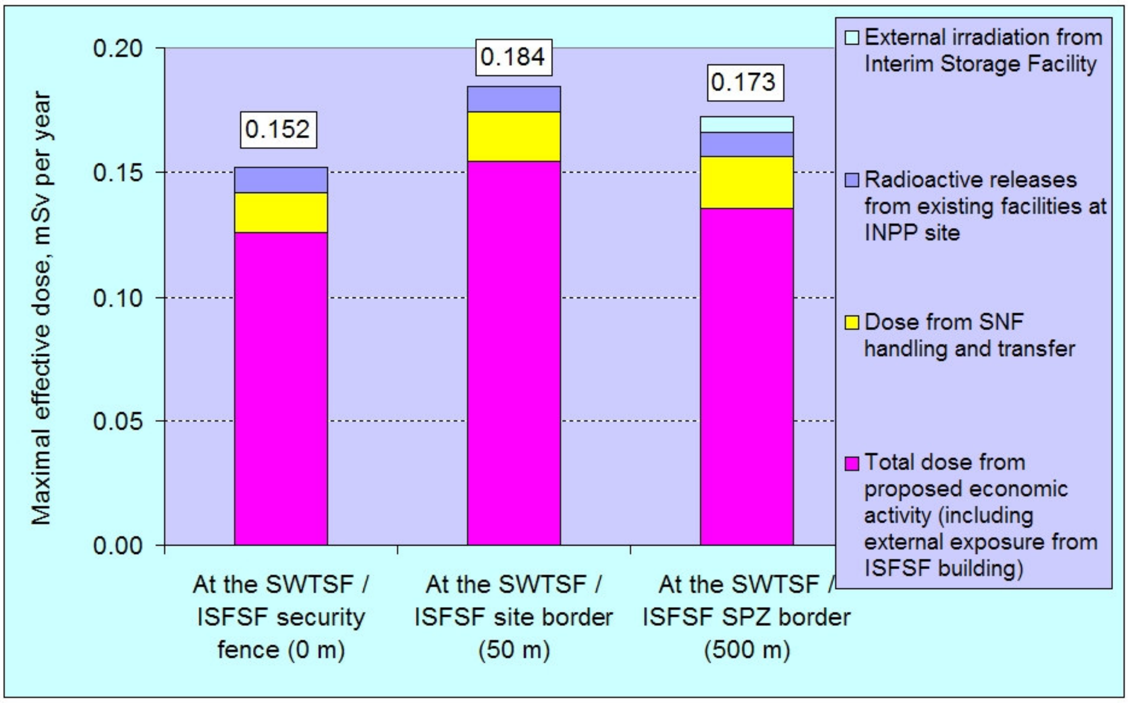


Figure 4.40 Annual exposure of the critical group member of population in the northern direction from the SWTSF/ISFSF sites due to the proposed economical activity and other existing and planned activities

4.10 Cost Estimation

In accordance with the requirements of the "Technical Specification for New Solid Waste Management and Storage Facilities" [8] issued by Ignalina NPP the EIA must include a cost estimation of the environmental impact due to operation of the facilities and the residual effect on the environment.

According to Clause 1 of Article 4 of the Law on a Fee for Environment Pollution [90], the fee for the environment pollution from stationary pollution sources is paid by physical and juridical bodies that must have the Permission on Integrated Prevention and Control of Pollution issued by the authorities with the indicated limit values for pollutant releases into the environment. Ignalina NPP has such Permission [23].

According to Clause 3 of Article 8 of the Law on a Fee for Environment Pollution [90], the fee for the environment pollution from stationary pollution sources is paid in accordance with the amount of pollutants de facto released into the environment during the reporting cycle. So, the calculations presented below indicate only the possible maximal annual fees for the harm to the environment.

The tariffs for specific pollutants are set out in Table 3 of the Methodology for Calculation of a Fee for the Harm to Environment [91].

The possible maximal annual release rates of the air pollutants into the environment from the incineration facility are calculated in chapter 4.2.3.1.2 and presented in Table 4.4.

The possible maximal annual fees for the harm to the environment are presented in Table 4.52 bellow.

Table 4.52 Maximum annual fees for environmental air pollution

Air pollutant	Group	Maximum release, Mg/year	Pollution fee, Lt/Mg	Total cost of pollution, Lt/year
Solid particles (organic and inorganic) except indicated in pollutant group II	-	0.120	830	99
Total organic carbon (TOC)	IV	0.080	98	8
Hydrogen chloride (HCL)	II	0.240	57 000	13 658
Hydrogen fluoride (HF)	II	0.016	57 000	910
Sulphur dioxide (SO_2)	-	0.800	1 400	1 118
Nitrogen oxides (NO_X)	-	1.597	2 650	4 233
Cd + Tl	I	0.0002	1 089 000	217
Hg	I	0.0002	1 089 000	217
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V	I	0.002	1 089 000	2 175
Dioxins and furans	I	4E-10	1 089 000	0
Carbon monoxide (CO)	IV	0.399	98	39
			TOTAL	**22 676**

5 POTENTIAL IMPACT ON NEIGHBORING COUNTRIES

Two countries, i.e. the Republic of Belarus and the Republic of Latvia, are relatively close to the sites of the proposed economic activity. The state border Lithuania–Belarus is in about 5 km to the east and southeast from the INPP Power Units and the SWTSF site. The state border Lithuania–Latvia is in about 8 km to the north from the INPP Power Units and in about 9 km from the SWTSF site.

Other countries are in a distance of at least hundred kilometers away from the sites of the proposed economic activity, cf. Figure 1.1. These countries will not be affected by the proposed economic activity.

5.1 Potential Radiological Impact and Impact Mitigation Measures

By the normal operation of this proposed economic activity the radiological impact on the environment of neighboring countries potentially could be produced by the spread out of airborne activity released during operational processes and due to the direct irradiation from structures and installations containing radioactive material.

No release of activity into the water component of the environment from the proposed economical activity under normal operation conditions is planned, cf. chapter 4.1. A radiological impact on the "water" component of the environment under normal operation conditions of the proposed economical activity is therefore not expected. Survey boreholes (wells) for monitoring the groundwater quality are foreseen around the ISFSF and SWTSF sites as a part of the required environmental monitoring, see chapter 7 "MONITORING".

The proposed economic activity will not create any significant impact on both neighboring countries. As criterion for radiological insignificance the dose limit applicable to exempted practices can be used. Practices and sources within the practices may be exempted if the annual effective dose expected to be incurred by any member of the public due to the exempted practice or source is of the order of 10^{-2} mSv or less [92], [93].

The radiological impact due to the spread out of airborne activity as well as due to direct irradiation depends on the proximity to the impact source.

The annual exposure of a critical group member of the population under normal operation conditions of this proposed economic activity up to the distance where the effective dose can be considered insignificant is presented in chapter 4.9.2.2. A summary of the results is provided in chapter 4.9.2.2.4.3. The assessment results demonstrate that starting from a distance of 500 m and more from the permanent security fence of the SWTSF site the radiological impact can be considered as insignificant. The state borders of both neighboring countries are considerably far. Waste retrieval activities at the SWRF site will not change the existing impact resulting from the present day operation of INPP. Finally it leads to a reduction of the radiation level due to the continuous reduction of the waste volume and the activity stored in the existing waste storage facilities. Therefore no relevant radiological impact can be expected to any member of the population of both neighboring countries.

The expected radiological impact due to potential emergency situations is investigated in chapter 8. Emergency situations are classified and prioritized according to the severity of the expected consequences. Several bounding cases leading to the development of an accident (including air plane crash) are selected and consequences are assessed in more detail, cf. chapter 8.2.

The design basis accidents are the accident conditions against which a nuclear facility is designed according to the established design criteria, and for which the damage to and the release of radioactive material are kept within the authorized limits. The dose assessment results show that the exposure of a member of the population of both neighboring countries in case of design basis accidents will be low. For the majority of potential design basis accidents the annual effective doses from the relevant external and internal exposure pathways are below 0.01 mSv. Exposure therefore can be considered as insignificant. The most severe consequences might be expected in the case of the drop and damage of a G3 waste transfer container leading to spill out of G3 waste in open air conditions. A calculated maximal one year effective dose to a member of the population is about 0.1 mSv. The dose is compatible with the dose constraint which serves as an upper bound on the dose in the optimization of the protection and safety for the radiation source (depending on the specific country practice the dose constraint is usually selected to be within the range of 0.3–0.1 mSv per year).

Beyond design basis accidents are accident conditions more severe than a design basis accident. They require accident management which is defined as the taking of a set of actions during the evolution of a beyond design basis accident:

- To prevent the escalation of the event into a severe accident;
- To mitigate the consequences of a severe accident;
- To achieve a long term safe stable state.

The airplane crash related accidents are of very low probability (below 10^{-7} per year). Therefore they are considered as beyond design basis accidents. The analysis of potential radiological consequences provides the assessment of the exposure to a member of the population due to passing through of a radioactive cloud. These consequences cannot be mitigated due to the short time of activity dispersion in the atmosphere. It is considered that measures are implemented after the accident to assess potential contamination zones and, if necessary, to limit the external irradiation from the activity deposited on the ground and to avoid the ingestion of food products exhibiting high specific activities due to the accidental releases.

The dose assessment results show that in case of beyond design basis accidents the exposure of a member of the population of both neighboring countries due to passing through of a radioactive cloud for most of the beyond design basis accidents will be low. For the majority of the potential design basis accidents the expected dose is about or below 0.01 mSv. Exposure therefore can be considered as insignificant. Just in case of an airplane crash accident on the LLW store G3 waste section a dose rise to 0.3 mSv can be expected.

Therefore it can be stated that the exposure of a member of the population of both neighboring countries due to design and beyond design accidents can be assured to be within the acceptable radiation protections limits (with implementation of the accident consequences mitigation measures for beyond design accidents, if necessary).

The new SWMSF will provide a modern solid radioactive waste management and storage system for existing, future operational and decommissioning waste. The new practice will bring the management of radioactive waste in Lithuania in compliance with the radioactive waste management principles of IAEA and in compliance with good practices in other European Union Member States.

5.2 Potential Non-radiological Impact and Impact Mitigation Measures

The non-radiological impact on the components of the natural and social environment produced by this proposed economic activity will be negligible and could be expected only within a close vicinity of the INPP and SWTSF sites.

It is expected that physical impact of non-radiological kind on the social and economic components of Latvia and Belarus will not occur at all.

The SWMSF will be designed in such a way that there will be no uncontrolled non-radiological discharges into the environment, cf. chapter 4.1.

The household waste water of the SWMSF will be discharged into the INPP existing sanitary-household waste water system from where it is transferred into the State Enterprise “Visagino Energija” waste water treatment plant. The SWMSF household waste water system shall follow the requirements of the normative document [28]. According to clause 6 of [28], the discharge of the sewage water into the environment may be performed only through a discharger for installation of which a permission for construction is issued or a construction works project is coordinated by the order established in regulations, and only then when the order is established, the conditions for the sewerage water discharge are approved (the condition are established in the approved construction works project (according to which the permission for construction is issued) or in the permission for sewage water discharge).

Surface water will consist of the precipitation and irrigation water collected from supervised areas of SWTSF, water from drainage systems of building roofs and other sources, not contaminated by radionuclides. New SWTSF surface water drainage system will be connected to the INPP existing underground storm drain and sewage water system. Radionuclides concentration in the storm drain water and in the groundwater of new observation boreholes, which will be installed around the SWTSF and ISFSF sites (see Chapter 7.4.5 “Groundwater Monitoring”), as well as the chemical content of storm drain water and groundwater will be monitored. The INPP environmental monitoring program will be updated before obtaining Permission on Integrated Prevention and Control of Pollution for the SWMSF. The SWTSF surface water drainage system shall follow the requirements of the normative document [29].

The waterworks for Visaginas city supply is in about 2.5 km to the southwest from the SWTSF site. The water is extracted from the Sventoji - Upininkai aquifer system. The SWTSF / ISFSF sites are outside of the sanitary protection zone [50] of the waterworks of Visaginas town [51]. The SWRF site consequently is more distant. The results of conservatively performed modeling of hypothetic contamination migration show that ISFSF and SWTSF, as local and relatively small objects (in comparison to the waterworks catchment area) can not substantially affect the quality of groundwater of the Visaginas town waterworks [52]. The waterworks in the territories of the Braslav region of Belarus and of the Daugavpils region of Latvia are considerably more distant in comparison with the Visaginas town waterworks.

The non-radioactive airborne emissions will not exceed the permissible releases and limiting concentrations currently prescribed for INPP. The non-radioactive airborne emissions from the waste incineration facility will not exceed the limit values set out in the Directive 2000/76/EC of the European Parliament and of the Council [19]. The ground level concentrations of pollutants will be small and far below the limiting values that are normally allowed in the human living environment [56], cf. chapter 4.2.3.1.2.

In itself, the proposed economic activity will not affect underground (geological) components of the environment. The buildings and infrastructure will decrease the area of permeable surface; therefore it may reduce rain water infiltration. According to the land use in the area and the relatively small surface used by the project, this effect is not expected to have a significant impact on the environment in the territories of Belarus and Latvia.

The construction and operation of the SWMSF will produce no noise that will be perceptible at the territories of Braslav region of Belarus and Daugavpils region of Latvia. There will be no relevant impact created on the biodiversity component of the environment of the Daugavpils region and the reserved zones in the national park “Braslav Lakes”, which preserve in untouched condition typical and unique ecosystems and gene pool of flora and fauna of Belarus.

However, population discontent and distrust is possible. Such a psychological impact is stipulated by changes in the existing nuclear practice (shut down and decommissioning of INPP), which results in the construction of new nuclear objects such as SWMSF and others. A psychological impact can be mitigated explaining the necessity, goals and benefits from the proposed economic activity. The proposed economic activity which intends to introduce advanced and practically proven waste management technologies for converting the existing radioactive waste into a long term stable and storage safe form will increase nuclear safety and reduce the risk of possible accidents as compared with the existing waste management and storage practice. The new SWMSF will be consistent with the current international requirements, principles, standards and guidance for the safe management of radioactive waste.

6 ANALYSIS OF ALTERNATIVES

6.1 Zero Alternative

From the beginning of INPP operation all power plant generated solid radioactive waste is collected and stored in the solid radioactive waste storage buildings that are located in the INPP supervised area. The waste storage buildings (namely buildings No. 155, No. 155/1, No. 157 and No. 157/1) are Soviet type facilities designed for the interim storage of low and intermediate level radioactive waste arising as a consequence of the operation of the NPP. After closure of the Lithuanian institutional radioactive waste storage facility at Maisiagala site (in 1989), all institutional waste from Lithuanian small producers are transported to INPP and stored in the solid radioactive waste storage buildings too. A safety analysis performed in 2000-2003 [94] has shown that the existing solid radioactive waste storage buildings are not acceptable for prolonged (for tens of the years) interim storage, and their operation was licensed for a time period ending in 2010.

The storage capacity of the existing facility has a total storage capacity of 29000 m^3 solid waste, of which around 80% is filled today. The existing storage capabilities are not sufficient to cover INPP decommissioning needs. The necessity for the construction of new storage facilities cannot be eliminated.

In 1998 the Swedish company Svensk Kärnbränslehantering AB (SKB) with participation of the Lithuanian Energy Institute (LEI) and other organizations has performed the long-term safety assessment (for hundreds of the years) of the existing INPP solid radioactive waste storage buildings [95]. The analysis leads to the conclusion that the buildings are neither acceptable for final disposal nor there is any reasonably available engineering solution to convert them into final disposal. The existing radioactive waste sorting, characterization and storage practices do not meet waste disposal requirements. It was recommended that the waste already stored in these buildings should be retrieved and packaged according to internationally accepted methods.

Therefore the option to use the existing storage facilities for INPP decommissioning needs and/or for further waste interim storage is not acceptable neither from the engineering nor from the safety assurance points of view. The stored waste is not properly characterized and conditioned from the present safety assurance point of view and therefore shall be retrieved and reconditioned before disposal off. The existing INPP storage facility shall be decontaminated and decommissioned.

The existing INPP solid radioactive waste predisposal management practice shall be modernized to meet new predisposal waste management requirements [15] and shall be upgraded to consider INPP decommissioning needs [4]. Therefore a safe and efficient decommissioning of INPP is not possible without the SWMSF.

6.2 Timing Alternatives

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

The SWMSF is necessary for decommissioning of INPP [4], and therefore the proposed economic activity cannot be postponed.

Also, the existing solid radioactive waste storage facility is not acceptable for long-term storage and is licensed as an interim storage facility for the time period ending in 2010, cf. section above. There is a feeble possibility to perform a new safety analysis of the existing solid radioactive waste storage buildings, upgrade them if necessary and apply for a new license to operate approximately for another five years. This possible alternative would not be cost and ALARA efficient since the solid waste from operation and decommissioning will be dumped into the existing buildings at first and then nevertheless shall be retrieved instead of bringing it directly for proper treatment, conditioning and long-term storage in the new SWTSF. Therefore the Government of the Republic of Lithuania by its resolution [3] has decided to start the design of the new SWMSF.

6.3 Location Alternatives

The location of the SWRF is predefined by the location of the INPP existing waste storage buildings.

There is no sufficient place to construct the SWTSF within the existing INPP supervised area. Therefore the SWTSF has to be constructed as a new nuclear object in a separate site.

The SWTSF site was selected in a process of screening of the potentially available area starting from around the INPP and using criteria, which, in addition to SWMSF specific needs, also consider other INPP decommissioning aspects. The key points are discussed below.

In addition to the SWTSF a new interim spent nuclear fuel storage facility (ISFSF) has to be constructed for INPP. Due to the insufficient place in the existing INPP supervised area the ISFSF has to be constructed as a new nuclear object in a separate site. From economical and environment protection points of view it is favorable to have a joined SWTSF and ISFSF area thus forming only one new site with a shared perimeter and a common sanitary protection zone. Also, some internal and external services could be shared as well as the external engineered infrastructure.

The SWTSF and ISFSF site was selected close to INPP. Thus the existing INPP sanitary protection zone will envelop the newly created sanitary protection zone for the SWTSF and ISFSF sites. There will be no need for an obligatory resettlement of population, as prescribed by the article 33 of the Law on Nuclear Energy [96]. The land, whose usage for certain activities is presently restricted (as INPP SPZ area) could be efficiently used for the SWMSF. The solution to have the SWTSF site within INPP SPZ is efficient from both social and economical points of view.

It is favorable to have a SWTSF site close to INPP. This minimizes the distance of radioactive material transfer both from cost and potential environment impact points of view. The radioactive waste transfer from INPP to the SWTSF site will be within the existing SPZ and far from permanent public living areas. The proximity to INPP simplifies connection to and usage of the existing INPP systems such as electric, heat power and water supply, sewage collection, communication, etc. Other INPP structures and organizations like fire protection, emergency response etc. could be used in an effective way.

It is beneficial to have a site close to the existing infrastructure (i.e. access roads, potential road connection points). The existing infrastructure could be easily upgraded and renovated. The creation of additional infrastructure facilities would require minimal economical and environmental resources.

The selection of SWTSF and ISFSF sites was carried out in two stages. Initial screening of potential sites and their suitability evaluation were performed at first. The data of existing geological, hydrogeological and seismic investigations, accumulated in archives of INPP and Lithuanian Geological Service, were used. The purpose of investigations was to detail and evaluate characteristics of geological structure, hydrogeological conditions and geological processes relevant to the potential sites, to define categories of seismic stability of the soil layers and their parts at the territory of the sites, to clarify location of known tectonic fractures and distribution of the fractured zones.

During the first stage of investigation, several potential sites have been analyzed in detail, c.f. Figure 6.1. The selection of the SWTSF site nearby the existing spent fuel storage facility site was not possible due to geological considerations and area limitations. The alternative site No.2, located close to the fence of the industrial INPP site was found to be located on the active linear neotectonic zone of sub-longitudinal orientation (c.f. chapter 4.4.5 “Neotectonics” and Figure 4.18) and also did not meet criteria for geological suitability. Therefore, taking into consideration conclusions of the geological analysis, a slightly to the south from the INPP located alternative site No.1 was selected for construction of the SWTSF. The selected site conforms to geological suitability criteria. The SWTSF will not be constructed above the identified tectonic faults zones.

At the second stage, by methods of direct boring, geological sampling, underground water sampling and laboratory analysis, the suitability of selected site for the construction of seismically resistant nuclear object was confirmed [40], [41], [42].

The nearby presence of specific objects like Visaginas town waterworks also has been considered. For this purpose the study [51] was prepared by request of INPP, aiming to identify the compatibility of the sanitary protection zone of the waterworks of Visaginas town with the ISFSF and the SWTSF. The results of detailed investigations and modeling [51] have shown that the ISFSF and the SWTSF sites are outside the SPZ of the waterworks of Visaginas town (c.f. chapter 4.1.5).

6.4 Technology Alternatives

The waste treatment technologies have been selected and justified within the frame of preparation of the Final Decommissioning Plan for Ignalina NPP. Practically proven and widely used radioactive waste management technologies are selected. The proposed technologies are compatible with the waste management practice and technologies used at INPP, meet Lithuanian and IAEA predisposal waste management requirements and are in line with the future planned Lithuanian waste disposal concept. Cost effectiveness also has been considered. Detailed requirements for the technologies have been further developed during the preparation of the Technical Specification [8] for this proposed economic activity. The Technical Specification is coordinated with VATESI. The Technical Specification requirements were a basis for tendering of the Contractor (NUKEM Technologies GmbH), who has to implement the already proposed technologies.

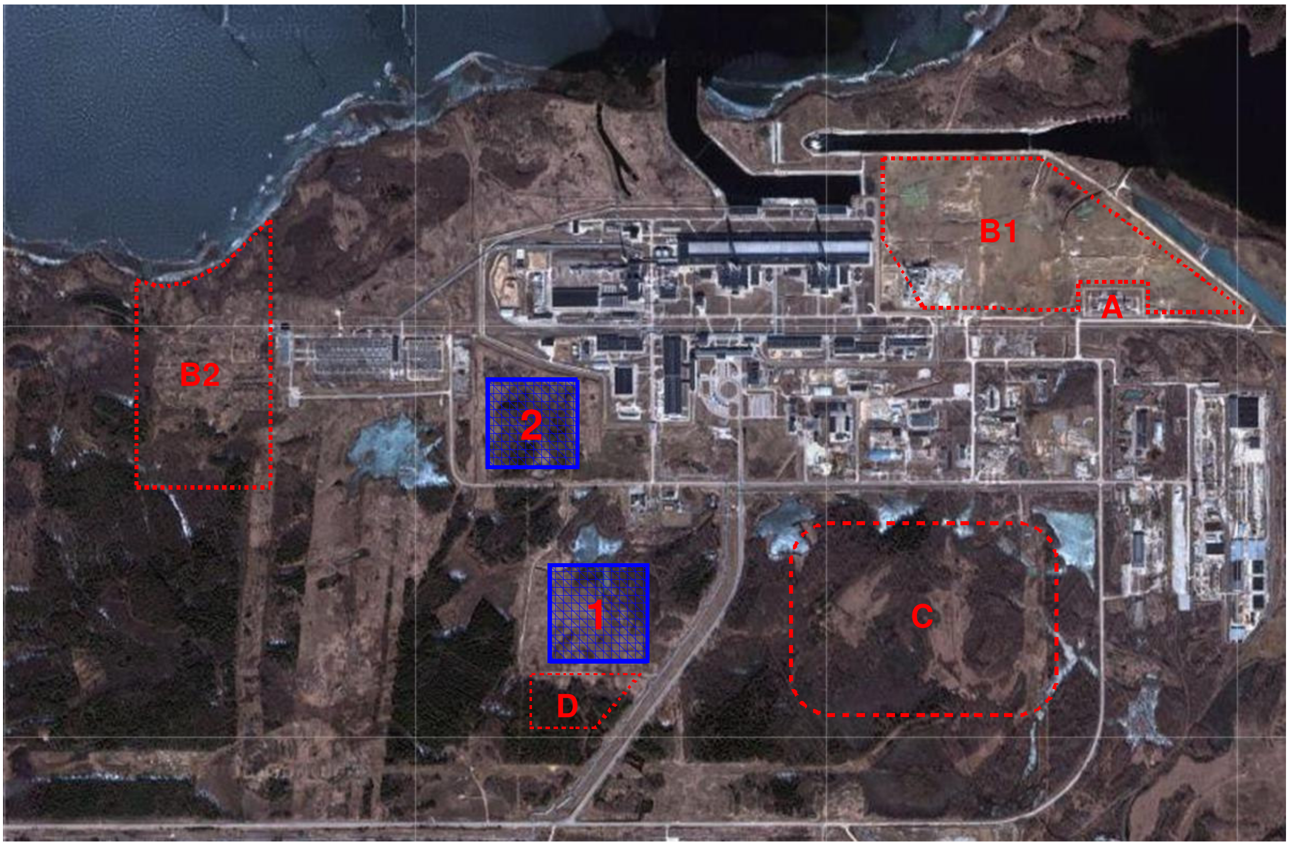


Figure 6.1 Location of alternative sites for the SWTSF

1 –SWTSF alternative site No. 1 (selected for the construction of the SWTSF); 2 - SWTSF alternative site No. 2; A – Existing INPP SNF storage facility; B1 and B2 – alternative sites for the newly planned NPP; C – selected site for the planned short lived low and intermediate level radioactive waste near-surface disposal facility (Stabatiskes site); D - one of the proposed sites (southern) for the very low-level radioactive waste disposal facility (Landfill)

7 MONITORING

7.1 Regulatory Requirements

According to the Article 5 of the Law on Environment Monitoring [97], the following shall be watched, assessed and forecasted during the environment monitoring:

- The condition of environmental air, water, underground entrails, soil and living nature;
- The condition of natural and anthropogenically impacted environmental systems (natural inhabitations, ecosystems) and landscape;
- Physical, radiological, chemical, biological and other anthropogenic impact and its influence on the natural environment.

According to the clauses 2 and 3 of Article 9 of the Law on Environment Monitoring [97], the environment monitoring of economy entities shall be performed in accordance with the environment monitoring program, which shall be prepared by the economy entity, coordinated and approved according to the regulations [98], [65].

7.1.1 Radiological Monitoring of Nuclear Energy Objects

Radiological monitoring of nuclear energy objects shall be performed in accordance with the normative document LAND 42-2007 [65]. The requirements are listed below.

7.1.1.1 General

According to clauses 16 and 17, the operator of nuclear facility may release radionuclides into environment (atmospheric air or / and water bodies) only after the permission for the releases of radioactive material into the environment is obtained. In order to obtain indicated permission, the operator shall apply to the Ministry of Environment and submit application to obtain the permission, plan for release of radionuclides into environment and environment monitoring program.

According to clause 27, operator during operation or decommissioning of nuclear facility shall:

- To limit release of radionuclides into environment as much as possible;
- To perform monitoring of environment pollution as to prove that its activity is performed in accordance with licensed conditions and to be able to assess exposure dose for the critical group members of population;
- To collect and store records on monitoring results and exposure doses as prescribed by the regulations in force.

According to clauses 35 and 41, the radiological monitoring of the nuclear facility is performed in accordance with the radiological monitoring program and shall consist of monitoring of releases and monitoring of environment components. The operator shall perform meteorological and hydrological observations which data are necessary for assessment of radionuclide dispersion in the environment of nuclear facility and for calculation exposure dose for the critical group members of population.

7.1.1.2 Requirements to the Monitoring Program

According to clause 40, the following shall be specified in the monitoring program: monitoring objectives, organization principles, executives, short description of the nuclear facility and its expected impact on environment, principles for selection of monitoring locations and justification, scheme of the site with indicated locations of pollution sources and observation / sampling points, plan for meteorological and hydrological observations, environment components to be monitored, frequency of sampling and analyses, list of methodologies and procedures used for measurements, detection limits, procedures for calibration of mesurenment methods and for quality assurance, data collection, methodologies for dose assessment, criteria for evaluation of monitoring results, terms and conditions for submission of reports on monitoring data and results.

According to clause 39, the monitoring program shall include the monitoring of all radionuclide migration and population exposure pathways, allowing the assessment of annual emissions of activity into atmosphere and water bodies, short operational fluctuations of emissions and effective doses of the critical group members.

7.1.1.3 Requirements to the Monitoring of Releases

7.1.1.3.1 Airborne Releases

According to clause 43, for the assessment of the radionuclide activities of airborne releases reliable systems for sampling from the common ventilation stack or for direct measurement shall be installed. The flow of discharged gases shall be credibly measured at any condition.

According to clause 44, the radioisotope content of airborne releases shall be assessed and the activity of radionuclides (except H-3 and C-14) shall be measured at least once per month.

According to clause 45, the activity of releases in the main physical-chemical forms of H-3 shall be measured at least once per quarter of a year.

According to clause 46, for the assessment of short-term alternation of the releases from nuclear facility the total activity of the releases shall be measured at least once every day (for main radionuclides – hourly). It is recommended that the radionuclides are divided into three groups: radioactive noble gases, radioactive iodine and radioactive aerosols. It shall be measured directly or from integral samples given incessantly.

7.1.1.3.2 Waterborne Releases

According to clause 47, the radioisotope content of waterborne discharges and the activity of radionuclides (including H-3 but except C-14) shall be assessed at least once per month. Stationary systems for the direct measurement or sampling of integral samples shall be installed at the main pathways of permanent discharges (it is recommended to install automatic systems) and the total activity of the waterborne releases at these pathways shall be assessed at least once per day. At less important pathways sampling shall be performed with regularity corresponding to frequency of releases. The flows of waterborne discharges shall be credibly measured in all pathways at any condition.

According to clause 48, if the waterborne releases before discharging into environment are cumulated for a long time, the samples shall be taken and the radioisotope content together with activities of radionuclides of the waterborne discharges shall be evaluated.

7.1.1.3.3 Additional requirements

According to clause 49, the activity of C-14 in airborne and waterborne releases shall be measured or evaluated by calculations, which shall be validated using the measurements performed under various modes of nuclear object operation.

According to clause 50, the activity of the radionuclides in airborne and waterborne releases shall be assessed during short-term increase of releases. If an increase of releases is foreseen (e.g. during start-up or shutdown of a nuclear facility or its elements during maintenance), an additional observation shall be performed. For this reason stationary observation systems or the application of laboratory methods shall be used.

7.1.1.4 Requirements to the Environment Monitoring

According to clause 51, the environment monitoring shall include the measurements of ionizing radiation dose rate, external absorbed dose and activities of radionuclides in various components of the environment.

According to clause 52, the uninterrupted measurements of ionizing radiation shall be performed in representative areas of the nuclear facility site with consideration of local peculiarities, in the sanitary protection zone of the nuclear facility and at some distances from it towards the nearest main settlements. For dose rate measurements automatic telemetric devices shall be used. For the measurements of the external absorbed dose accumulating devices (e.g. thermoluminescent) shall be used.

According to clause 53, samples of environment objects shall be taken at locations where pollutants are released or discharged and at locations of nuclear facility impact zone (which is defined by monitoring program) where the maximal pollution (according to assessments of radionuclides dispersion and territory peculiarities) is expected.

According to clause 54, in case of terrestrial ecosystems the following samples shall be taken: samples of air (gases and aerosols), precipitation, soil, berries and mushrooms and plants from forests, grasses from pastures, food (meat, milk and grain-crops), potable water, underground water (including groundwater), indicatory organisms and materials (characterized with a feature to accumulate the radionuclides).

According to clause 55, in case of aquatic ecosystems the following samples shall be taken: samples of filtered water, suspended matter, sediments, aquatic plants, bottom dwellers, fishes and indicatory organisms and materials.

According to clause 56, the samples shall be taken with a frequency corresponding to the seasonal alternation of components of the environment, and the quantity of gathered data shall be such that it allows assessing the exposure of the members of the critical group (groups).

According to clause 57, for the assessment of the pollution of environmental objects the radioisotope content of samples shall be estimated, and the concentrations of the gamma emitters (Cs-137, Cs-134, Co-60, Mn-54, Zr-95, Nb-95, I-131 etc.) shall be measured. The pollution with beta emitters (Sr-89, Sr-90, H-3 and C-14) and alpha emitters (Pu-239, 240) shall be assessed using the analysis of chosen archetypal samples. Performing the measurements of the concentration of beta and alpha emitters the methods of chemical seduction of elements shall be applied, if necessary.

According to clause 58, if it is known or supposed that the activities or content of airborne and waterborne releases can change, the samples can be taken more frequently, and additional measurements can be performed.

7.1.1.5 Main Requirements to the Applied Methods and Facilities

According to clause 60, the monitoring shall be performed applying such measurement methods and using such devices which allow measuring with a sufficient accuracy the activities of individual isotopes that can lead to doses higher than 0.01 mSv/y.

According to clause 63, the monitoring systems shall be doubled and operated continuously, to allow assessing the activity of releases for any period and comparing with the permissible activity release limits.

According to clause 64, for the data quality assurance the monitoring systems shall be installed, tested, calibrated, operated and renovated in accordance with the nuclear industry standards and the QA program.

7.1.2 Requirements to the Monitoring of Groundwater around the SWTSF Site

The SWMSF will be designed in such a way that there will be no uncontrolled radioactive waterborne discharges into the environment.

Nevertheless observation wells for monitoring of groundwater shall be foreseen around the SWTSF and ISFSF sites as part of the required environmental monitoring. The groundwater monitoring program shall be developed in accordance with the normative document [99] and presented to the Geological Survey of Lithuania for approval. The INPP Environment Monitoring Program [100] can be updated only on the basis of this program.

According to clause 4 of [99], the groundwater monitoring program, developed and approved in accordance with the requirements of this normative document, is the obligatory annex to the application for the issue of a Permission on Integrated Prevention and Control of Pollution [23].

According to clause 12.5 of [99], the monitoring network and its substantiation (documentation of the monitoring network, passports of the monitoring points and observation wells prepared in accordance with the requirements of [101]) shall be given in the groundwater monitoring program.

7.1.3 Requirements to Sewage and Storm Drain Water Monitoring

The SWMSF sewage water system shall be routed outside the territory of the SWMSF and connected to the existing INPP sewage system. The SWMSF sewage water system shall follow the requirements of the normative document [28].

According to clause 6 of [28], the discharge of sewage water into the environment may be performed only through a perfect discharger (e.g. accredited as perfect for use by order established in regulations, having the permission for sewage water discharge etc.) and only when the conditions for the sewage water discharge are approved by competent authorities. The household waste water from the INPP is transferred to SE “Visagino energija” under an agreement.

The SWMSF storm (surface) drain water system shall follow the requirements of the normative document [29]. According to clause 7 of [29], storm (surface) drain water shall be managed separately from sewage water.

According to clause 11 of [29], the new planned potentially polluted territories shall be covered with a water-resistant covering, and surface drain water management systems shall be installed. If it is foreseen that the surface drain water from the potentially polluted territories will be discharged into the environment (or into other surface drain water systems without cleaning facilities) surface drain water cleaning facilities shall be installed. The characteristics of these cleaning facilities (purification indicators) shall conform to the requirements for surface drain water discharge from the actual object.

According to clause 16 of [29], the design of the sewage water and storm drain water management systems shall be performed in accordance with the requirements of STR 2.07.01:2003 [102].

7.2 INPP Current Environment Monitoring System

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 INPP environment monitoring program specifies requirements for:

- Monitoring of water quality in the lake and of groundwater (physical – chemical parameters);
- Monitoring of the radionuclides concentration in the atmospheric air and fallouts;
- Monitoring of the radioactivity of the sewage and drainage water from the INPP site;
- Monitoring of the radionuclide release into the air;
- Meteorological observations;
- Monitoring of the radionuclides concentration in the lake and groundwater;
- Dose and dose rate monitoring in the sanitary protection zone (3 km) and observation area (30 km);
- Monitoring of the radionuclides concentration in fish, algae, soil, grass, sediments, mushrooms, leaves;
- Monitoring of the radionuclides concentration in food products (milk, potatoes, cabbage, meat, grain-crops).

The chemical content of sewage (domestic discharges) from the industrial site of INPP is controlled by "Visagino energija".

The radiological measurements performed according to the INPP current environment monitoring program [100] are summarized in Table 7.1.

The proposed SWMSF is within INPP performed environment monitoring zone. The environment monitoring program currently existing at INPP does not foresee monitoring of the SWMSF. The integration of the SWMSF environment monitoring system into the existing INPP environment monitoring system will be performed during the preparation of the Technical Design.

7.3 Main Results of Radiological Monitoring in the INPP Region

This subsection contains a description of the present radiological conditions of the INPP environment based on monitoring data results [104]. The radiological characteristics at the SWTSF site (adjacent to the ISFSF site) are based on the INPP report [103].

7.3.1 Radioactive Releases into Atmosphere

The annual releases of radioactive inert gases, radioactive aerosols and Iodine-131 from INPP into the atmosphere annually are given in Table 7.2.

As Table 7.2 shows, the radioactive releases from INPP site into the air did not exceed a few percents of the values for the permissible releases.

Calculated annual effective dose to the critical group member of population stipulated by the releases into the atmosphere not exceed 1.90×10^{-6} Sv in year 2004, 1.13×10^{-6} Sv in year 2005, 1.39×10^{-6} Sv in year 2006 and 1.37×10^{-6} Sv in year 2007.

7.3.2 Radionuclides Concentration in the Atmospheric Air

The radionuclide inventory in the atmospheric air of the sanitary protected zone and the monitoring zone was conditioned mainly by Cs-137 and Be-7. The concentration of Cs-137 in the atmospheric air was the same in both the sanitary protected zone and the monitoring zone, and amounted in average to 0.22×10^{-6} Bq/m^3 in year 2004 and 0.25×10^{-6} Bq/m^3 in year 2005. According to the INPP report [103], the average concentration of Cs-137 in the atmospheric air of the SWTSF / ISFSF sites during the year 2005 was 0.21 $\times10^{-6}$ Bq/m^3. Only insignificant concentrations of the INPP-caused radionuclides Mn-54 and Co-60 were detected in the air of the sanitary protected zone and the SWTSF / ISFSF sites.

Concentration of Cs-137 in the atmospheric air of the monitoring zone constituted in average 0.37×10^{-6} Bq/m^3 in year 2006 and and 0.27×10^{-6} Bq/m^3 in year 2007.

The presence of Cs-137 in the atmospheric air is connected with the global pollution of the atmosphere, because such radionuclides as Co-60 and Mn-54 were not found in the atmospheric air of the monitoring zone although their concentration in releases was 1.5 to 2 times higher than the concentration of Cs-137.

7.3.3 Radionuclides Concentration in the Atmospheric Precipitation

Maximum value of INPP-caused radionuclides concentration was in the atmospheric precipitation onto the area adjacent to the Solid Radioactive Waste Storage Facility, landfill of utility type waste and the Chemical Department. In this area, the total value of the radionuclides concentration (excluding K-40 and Be-7) was 8.1×10^4 Bq/(km^2×day) in year 2004, 10.6×10^4 Bq/(km^2×day) in year 2005, 11.1×10^4 Bq/(km^2×day) in year 2006 and 11.6×10^4 Bq/(km^2×day) in year 2007.

Average concentration of radionuclides in the atmospheric precipitation of monitoring zone (excluding K-40 and Be-7) was 0.40×10^4 Bq/(km^2×day) in year 2004, 0.21×10^4 Bq/(km^2×day) in year 2005, 0.22×10^4 Bq/(km^2×day) in year 2006 and 0.33×10^4 Bq/(km^2×day) in year 2007.

According to the INPP report [103], the average concentration of Cs-137 in the atmospheric precipitation at the SWTSF / ISFSF sites during the year 2005 was 10.6×10^4 Bq/(km^2×day).

7.3.4 Radionuclides Discharges in the Aquatic Environment

There are 6 channels running to Lake Druksiai mainly for storm water drain from the INPP site and site surrounding area. The concentrations of Sr-90 are approximately the same in the water of these channels. These concentrations are on one level with the background concentrations. Alpha radionuclides are not found in the silt of the waste water.

Release of tritium through channels into Lake Druksiai was 34×10^{11} Bq in year 2004, 32×10^{11} Bq in year 2005, 5.8×10^{11} Bq in year 2006 and 6.5×10^{11} Bq in year 2006.

According to the INPP report [103], gamma-emitting radionuclides of technogenic origin have not been found in the samples of water taken on March 2006 at the ISFSF site (adjacent to the SWTSF site).

Calculated annual effective dose to the critical group member of population stipulated by all liquid discharges from INPP was 1.42×10^{-6} Sv in year 2004, 0.96×10^{-6} Sv in year 2005, 0.15×10^{-6} Sv in year 2006 and 1.94×10^{-6} Sv in year 2007. The release of tritium constitutes 0.12×10^{-6} Sv in the dose for year 2004, 0.11×10^{-6} Sv in the dose for year 2005 and 0.02×10^{-6} Sv in the dose for years 2006 and 2007.

7.3.5 Radionuclides Concentration in the Water of Observation Wells

Now there are 69 groundwater observation wells – 50 wells in the INPP site and 19 wells around the existing ISFSF. Insignificant amounts of Cs-137, Co-60, Sr-90, Mn-54 and Nb-95 were found in some observation wells in the INPP site. Their activity was on the same level with the background concentration values.

The increase of activity of tritium is observed in water of some observation wells around the existing Solid Radioactive Waste Storage Facility (SRWSF) and landfill of utility type waste since

1996. The yearly average activity of tritium in the observation wells was up to 4100 Bq/l until the year 2006, and up to 6400 Bq/l in the year 2007.

Since 1998 the increase of activity of tritium is also observed in the water of channel separating SRWSF and landfill facility. The yearly average tritium activity in the channel water fluctuates from 6800 to 9800 Bq/l in the years 2002-2006. The yearly average tritium activity was 7950 Bq/l in the year 2007.

The reason seems to be leaching of tritium from the existing SRWSF or / and landfill facility. This proposed economical activity includes retrieval of all radioactive waste from existing SRWSF and cleaning of waste storage compartments.

7.3.6 Radionuclides Content in the Soil, Flora, Bottom Sediment and Phytogenic and Animal Food Products

In recent years the radionuclide content in the soil, flora and bottom sediments remained on the level of the previous years. In phytogenic and animal food products, INPP-caused radionuclides were not found.

In the bottom sediment of Lake Druksiai availability of Pu-239 and Pu-240 was found. The presence of Plutonium is explained by its global spread in components of the ecosystem. The average concentration of isotopes of Plutonium Pu-239 and Pu-240 in the bottom sediments of Lake Druksiai sampled in year 2005, for dry air mixture is 0.18 Bq/kg [104].

According to the INPP report [103], the main contribution to the activity of the soil samples taken at SWTSF / ISFSF sites in March 2006 is introduced by the radionuclides of natural origin K-40, Ra-226 and Th-232. In the soil of the SWTSF / ISFSF sites, the concentrations of the globally scattered radionuclide Cs-137 (1.7 Bq/kg and 30 Bq/m^2) and INPP-caused radionuclide Co-60 (0.73 Bq/kg and 6.6 Bq/m^2) were insignificant.

7.3.7 Gamma Background

Dose rate in the monitoring zone in year 2007 measured by fixed gamma detectors of “Skylink” system varied in range of 0.068-0.160 μSv/hr. The same dose rate in the sanitary protected zone was 0.071-0.180 μSv/hr.

The dose rate was measured at seven points of the ISFSF site (adjacent to the SWTSF site) with the portable dosimeter DRG-01T on the surface of the ground and at the distance of 1 m from the ground. At the same points, uninterrupted dose rate measurements were performed at the distance of 1 m from the ground with the highly sensitive scintillation dosimeter SILENA “SNIP 204G”. The inaccuracy of the dose rate measurements with the dosimeter DRG-01T through Co-60 and with the dosimeter SILENA “SNIP 204G” through Cs-137 is within ± 15 %. The average value of the dose rate measured with the dosimeter DRG-01T is 0.13 μR/hr on the ground surface and 0.11 μR/hr at the distance of 1 m from the ground. The average value of the dose rate measured with the dosimeter SILENA “SNIP 204G” at the distance of 1 m from the ground is 0.08 μSv/hr [103].

There was measured gamma radiation with high sensitivity dosimeter in the vehicle in region by routine route. By these measurements there is no increase of background radiation. Average dose rate in region of INPP was 0.067 μSv/hr in 2007.

There are 27 TLD dosimeters for measuring annual effective dose in region of INPP. Measured average annual dose due to gamma irradiation (including natural background radiation) was 0.80 mSv in year 2004, 0.66 mSv in year 2005, 0.62 mSv in year 2006 and 0.71 mSv in year 2007.

7.3.8 Exposure of Population due to Operation of INPP

Annual effective doses to the critical group member of population stipulated by radioactive releases (airborne emissions into atmosphere and waterborne releases into Lake Druksiai) from the INPP are summarized in Table 7.3.

Calculated annual effective dose to the critical group member of population stipulated by the radioactive releases not exceed 2.5×10^{-6} Sv in year 2004, 2.1×10^{-6} Sv in year 2005, 1.6×10^{-6} Sv in year 2006 and 3.3×10^{-6} Sv in year 2007.

7.4 Radiological Monitoring System of SWMSF

The radiation monitoring system of the SWMSF will be designed to ensure safe and accurate monitoring during both normal and accident conditions. It will be integrated into the INPP radiological monitoring system. It can also be operated in an independent mode. The monitoring system of the SWMSF will meet all requirements of the Lithuanian legislation and regulations.

The first consideration when designing the SWMSF is to ensure the protection of the personnel and the general population. This includes the control of ionizing radiation and the prevention of the spread of contamination. A major part of SWMSF design work will be to examine all structures, systems and components to ensure that they are fabricated, located and tested to ensure tight control of the radiation exposure to the personnel.

A general approach to designing the SWMSF will be to:
- Control access to the areas of potential contamination or radiation within the facilities;
- Monitor and control potential contamination of the areas requiring access;
- Prevent the accumulation of radioactive material in systems;
- Plan for the decontamination of those areas to which access is required;
- Shield personnel from the exposure to radiation. Components and systems which may contain or handle radioactive wastes will be designed to ensure safety under normal operation and accident conditions;
- Minimize work times in radioactive environments.

The measures taken will include:
- The capability to monitor and test safety-related components;
- Shielding capable of protecting personnel under normal and accident conditions;
- Multiple barriers to prevent radioactive releases to the environment;
- Prevention of damage to safety-related items from failure of adjacent non safety-related equipment;
- Waste sampling to confirm it is within acceptance criteria;
- Maintenance operations to be designed following the principle of ALARA;
- Minimization of secondary waste generation.

Shielding will be provided by the concrete walls constructed to contain the processes. In certain key areas it may be appropriate to incorporate steel or lead reinforcement.

The SWMSF will have a comprehensive and reliable radiation monitoring system. It will cover all areas within the buildings, and it will be designed to ensure safe and accurate monitoring during both normal and accident conditions. There will be a back-up system connected to the uninterruptible power supply. Special attention will be paid to the areas, such as the Sorting Cells and Buffer Stores, which contain radioactive materials as part of their normal operation. Additional systems will measure direct radiation levels in and around these areas.

The design will ensure that the consequence of any release of radioactive materials will be ALARA under both normal and accident conditions. Means of measuring the amount of radionuclides in effluents during normal operation and under accident conditions shall be provided, including means of measuring the flow of diluting media, especially air at the exhaust (chimney).

Areas containing radioactive materials shall be provided with systems for measuring the direct radiation level in and around these areas.

The systems designed to monitor the release of radioactive materials and direct radiation shall have means for calibration and operability testing.

In addition to designing and installing shielding and monitoring systems it is important to ensure that the SWMSF is operated safely and correctly. To ensure proper operation, and to minimize the spread of contamination, manual monitoring stations and boot barriers at the entrance and the exit of each area which requires operator access will be installed. The number of access points to the radiologically categorized areas will be limited by the design to ensure effective control of the entry. An example of this approach is the single access control and the changing room in the ground floor of the SWTF, which is used to enter the SWTF and the SWSF buildings.

7.4.1 Radiological Monitoring (Safety)

7.4.1.1 Dosimetry

For monitoring the dose and the dose rates of the people inside the CAA (Controlled Access Area), Direct Readable Digital Dosimeters will be worn by all persons working in this area. These dosimeters are equipped with adjustable dose and dose rate alarm levels, which trigger a visual and acoustic warning signal when exceeded. These dosimeters will be stored and reloaded in the Dosimeter Docking Stations at the CAA entrance and individualized by the personnel with a magnetic card or password. The Evaluation System consists of a Reader Unit and a Computer, the data from which will be sent to the Radiological Control System in the Monitoring Room.

In addition all personnel entering the CAA are subject to individual dose metering monitoring and will have individual TLD Dosimeters.

7.4.1.2 Personnel Contamination Monitoring

Body Surface Contamination Monitors (either a Portal Whole Body Contamination Monitor or a Hand-Foot-Clothing Monitor) will be used for personnel surface contamination measurement. They will be used at the Personnel Exits from the CAA. Again, the data will be sent and stored by the Radiological Control System in the Monitoring Room.

7.4.1.3 Gamma Dose Rate Monitoring

In the SWTF gamma dose rates will be measured using both Stationary and Mobile Detectors. The Stationary Detectors will be positioned in rooms with permanent working places to which access is required (e.g. G2 Sorting Cell). The Mobile Systems will be used to determine the gamma dose rate in various points in the CAA. A Counter Tube (Measuring Probe) will be built into the basic device; Telescopic Probes will be used for points with difficult accessibility, for points located at heights or distances of up to 2 m, and in case of high expected dose rates. Each radiation protection staff staying within the CAA will have a Mobile Gamma Dose Rate Measuring Device. The measured values from both the Mobile and Stationary Detectors will be processed locally and sent to the Radiological Control System in the Monitoring Room.

7.4.1.4 Surface Contamination

Universal Mobile Measuring Systems will be used for the simultaneous measurement of alpha, beta and gamma radiation for the determination of the radioactive surface contamination. When a Counter Tube System is not suitable, manual wipe tests will be taken. Two wipe test measuring positions for the manual evaluation of wipe tests are foreseen in Room 22R011 Radiation Protection / Health Works and in Room 21R127 Laboratory Radiation.

7.4.1.5 Airborne Contamination

Aerosol monitors, both stationary and mobile, will be used to measure activities of radionuclides in the air bonded aerosols. The monitors will also enable the monitoring of average volumetric activity in the air by measuring activity of the radionuclides accumulated in a filter.

7.4.1.6 Waste Characterization

For the evaluation of waste or water samples a Gamma Spectrometer as well as a Low-Level Gamma Counter for liquids will be placed in Room 21R127 Laboratory Radiation.

7.4.2 Off-Gas Monitoring at the SWTSF

Off-gas monitoring is designed to measure and control content and amounts of radionuclides and potentially hazardous chemical compounds in the exhaust air (including off-gas from the incineration process) during normal operation and abnormal conditions and to show that gaseous and aerosol releases to the environment are within permitted limits.

In the case of chemical emissions, the mass concentrations of emissions of the off-gas contaminants HCl, CO, NO_x and SO_2 resulting from the incineration of slightly contaminated wastes, will be monitored continuously before the Stack by approved measurement equipment and evaluated using an approved evaluation computer.

In the case of radiological emissions, the amounts contributed by the incineration off-gas and the room ventilation of the entire facility will be measured in the stack. Determination of volumetric activities of alpha- and beta-active aerosols, iodine and tritium will be carried out continuously using tested and reliable detector arrays.

7.4.2.1 Chemical Emissions Monitoring

Automatic measuring devices will be installed in the incineration facility and measurement methods will be selected in order to ensure monitoring of parameters, conditions and concentrations, expressed in units of mass, that are relevant for specific or general conditions of incineration process and that are necessary for control and performance of environmental monitoring. Monitoring of the incineration operational parameters, CO, NO_X, SO_2, general organic coal, HCl, HF and of general dust content will be performed on permanent basis by sampling and analysis as foreseen by waste incineration requirements [20]. Similarly, at least two measurements per year will be performed for heavy metals, dioxins and furans. During the first 12 months of the operation, these measures will be carried out at least once in three months. Measuring points, at which the concentration of pollutant is determined, are installation locations of sampling probes in the off-gas flow. Sampling to determine the levels of chemical emissions and the reference parameter O_2 is done in a straight, horizontal section of the off-gas line close to the setup location of the analytical equipment room.

The chemical emission monitoring system will be designed in accordance with the requirements set in the Lithuanian regulation in force [20] and in the Directive 2000/76/EC of the European Parliament and of the Council [19].

7.4.2.2 Radiological Emissions Monitoring

The flue stack waste air (comprising of flue gas and room ventilation exhaust air) is continuously monitored for emission of beta/gamma aerosols, iodine and tritium/noble gases. The radiological emission system of the vent stack includes:

- A measuring gas sampler;
- An alpha/beta/gamma aerosol detector array;
- An iodine detector array;
- A tritium/noble gas detector array;
- Evaluation electronics with central data collection.

Gaseous I-129 may be released during incineration. A standard emission monitoring system is used. Noble gases are measured together with C-14.

The measurement of aerosols is performed using an alpha/beta aerosol detector array with fixed filter consisting of:

- A filter band;
- A semi-conductor detector;
- A diaphragm pump;
- Lead shielding.

The detection limit depends on the natural activity concentration. The efficiency of a large-surface filter of 200 mm in diameter, in relation to 4π, is:

- Am-241 (alpha): approx. 25 %;
- Tl-204 (beta): approx. 25 %.

7.4.2.3 Measuring Gas Sampling Device

The sampling location is near the top of the vent stack. Isokinetic sampling is done through one or several suction jets distributed along the cross section of the conduit, which is then transported through a sampling line within the vent stack into a measurement room. In this sampling line the parameters moisture, temperature and flow volume are determined. The secondary samplings for the aerosol detector array, the tritium detector array, the aerosol collector and the iodine collector are installed at the beginning of the sampling line in the measurement room. A ladder is located at the stack for construction, inspection and testing of the measuring gas samplers.

The measurement of beta-emitting radioactive nuclides of noble gases is performed using:

- The noble gas and C-14 activity monitor with a diaphragm pump, lead-shielding;
- The measuring channel, with a measuring vessel and a proportional flow-through counter tube.

Only total noble gas and C-14 activity is provided. Since no noble gas is expected, the measured activity can be assigned to C-14.

7.4.2.4 Alpha / Beta Aerosol Detector Array

This system uses an aerosol monitor for continuous monitoring of the off-gas for the detection of alpha and beta emitters in aerosols.

7.4.2.5 Iodine Detector Array

This system ensures a continuous monitoring for iodine. For this purpose, the iodine detector array is fixed to the sampling line on the suction side just like the other arrays.

Iodine (I-131, I-129) activity is determined by collecting the Iodine on an activated charcoal filter and measuring the gamma radiation by a NaI spectrometer. Discrimination is performed based on the different gamma energies of the isotopes.

7.4.2.6 Tritium / Noble Gas Detector Array

This detector array will monitor for tritium and any radioactive noble gases that accompany it. Again, the detector will be attached to the suction side of the sampling line. The differentiation of tritium and higher energy noble gas nuclides and interfering gamma radiation will be achieved by means of impulse gain discrimination. Spillover effects will be taken into account.

Tritium is a low energy beta emitter. It is measured in a flow-through counter tube in anti-coincidence with a surrounding beta counter tube. This ensures that only low energy beta counts are registered while high energy beta particles (e.g. resulting from noble gases) cause coincident pulses in both inner and outer counter and are suppressed.

7.4.2.7 Central Data Processing

The data processing electronic elements perform the following main tasks:
- Reception and recording of the digital and analogue input signals;
- Output of digital and analogue parameters;
- Reception and recording of monitoring data;
- Communication with the protocol computer.

The following data is recorded and available in the protocol computer:
- Sampling line data;
- Data from the test arrays.

Data transfer to the INPP radiation protection monitoring panel is provided via LAN.

7.4.3 Off-gas Monitoring at the SWRF

The off-gas radioactivity monitoring system at SWRF will be placed externally on the ventilation stack (prior to the air being discharged to the atmosphere) in order to verify the radioactive releases (α-β-γ emitters) to the environment.

The air to be monitored is taken from the ventilation stack by means of a multipoint isokinetic probe. The temperature inside the sample line is maintained, if necessary, above the dew point to avoid local condensation which could deteriorate the sampling efficiency. The flow rate is automatically maintained at a constant level, or variations are taken into account to improve the determination accuracy of the released radioactivity. A fixed monitor (Stack Airborne Radioactivity Monitor) will be placed in the ventilation room.

7.4.4 The Outdoor Radiation Monitoring System

The Outdoor Radiation Monitoring System at the site fence consists of the following devices:
- Online gamma monitors;
- Online neutron monitors;
- TLD.

The data of the online monitors are evaluated periodically and sent to and stored by the Radiological Assessment Control System in the Control Room. The TLDs are evaluated periodically (e.g. monthly) using a TLD reader unit.

The online detectors are positioned at specific points where the dose rate will reach the maximum. The calculations of the skyshine and direct radiation are performed comprising both the facilities ISFSF and SWTSF.

The TLDs are positioned at a predefined distance to each other (e.g. 50 m). When evaluating the TLDs it is possible to create a dose rate profile for the site fence in each direction.

The monitors are positioned as shown in the principle scheme in Figure 7.3.

7.4.5 Groundwater Monitoring

The groundwater monitoring program shall be developed in accordance with the normative document [99] and presented to the Geological Survey of Lithuania (LGS) for approval. For preparation of the groundwater monitoring program, abundant information on the geological-hydrogeological and geotechnical situation, groundwater use and the operation of the existing groundwater monitoring systems in the SWTSF and ISFSF environs shall be studied.

The main operations of the groundwater monitoring will be water level measurements and water sampling for various analyses. Water levels will be measured in all the wells manually (deep wells) and continuously (shallow wells), using special data loggers.

During the groundwater monitoring gamma-spectrometric measurements of the concentrations of the radionuclides H-3, Cs-137, Co-60, Sr-90, potentially to be found in groundwater [80], [49], will be performed.

Monitoring of the chemical content of the groundwater in the observation boreholes will also be performed in accordance with the requirements [99].

The groundwater monitoring in the SWTSF and ISFSF environs will be organized and performed according to the quality assurance and the quality control (QA/QC) procedures introduced by IAEA [49], [105].

7.5 Updating of the INPP Monitoring Program due to Operation of the SWMSF

The updating of the INPP monitoring program [100] due to the operation of the SWMSF is shown in Table 7.4. The required additional monitoring and means of measuring are also shown in Table 7.4.

7.6 Tables and Drawings of the Chapter "Monitoring"

The following Tables are attached to the Chapter "Monitoring":

Table 7.1 Summary of radiological measurements performed according to the INPP environment monitoring program [100];

Table 7.2 Annual releases of radioactive inert gases, radioactive aerosols and Iodine-131 into the atmosphere from INPP [104];

Table 7.3 Annual effective doses to the critical group member of population stipulated by radioactive releases from of INPP [104]

Table 7.4 Updating of the INPP environment monitoring program due to operation of the SWMSF.

The following Figures are attached to the Chapter "Monitoring":

Figure 7.1 Location of thermoluminescent dosimeters around the INPP [100];

Figure 7.2 Sampling positions in Lake Druksiai [100];

Figure 7.3 Layout of site permanent security fence detectors.

Table 7.1 Summary of radiological measurements performed according to the INPP environment monitoring program [100]

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
1.	Liquid discharges into the environment	7	Total β activity	Radiometric	1 per week – service water taken by Reactor Units 1,2; water, discharged by reactor and turbine compartments; water, discharged from Bld. 150; 1 per month – service water after the heat exchangers; At every discharge – water from special laundry.	0.1 to 1.85×10^{8} Bq/l depending on measuring object
			Activity concentration of radionuclides	Spectrometric	1 per month – water, discharged by reactor and turbine compartments; service water after the heat exchangers; water, discharged from Bld. 150, pit of corridor 003 (D1, D2); At every discharge – spent water from Bld. 150.	$0.74\div1.85\times10^{8}$ Bq/l
			Sr-89, Sr-90	Radiometric	1 per month – water, discharged by reactor and turbine compartments.	$0.1\div3\times10^{3}$ Bq/l
			Total α activity	Radiometric	1 per month – water, discharged from Bld. 150.	$0.01\div10^{3}$ Bq/l
2.	Emission of gases and aerosols into atmosphere	7	Total β activity	Radiometric	From 1 time per day to 1 time per quarter depending on filter exposition duration.	from 2.4×10^{-8} to 1.85×10^{7} Bq/l depending on measuring object
			Total α activity	Radiometric	1 per month – releases of gases/aerosols from reactors 1,2 through vent stack.	$0.01\div10^{3}$ Bq/l
			Activity of radioactive noble gases	Spectrometric	1 per week – releases of gases/aerosols from Bld. 150 through installation 153.	$1.85\div3.7\times10^{5}$ Bq/l
			Activity of radioactive aerosols	Spectrometric	1 per day and week – releases of gases/aerosols from reactors 1,2 through vent stack; 1 per month – from Bld. 130, from Bld. 156; 1 per quarter – from Bld. 157.	from 2.5×10^{-6} to 3.7×10^{5} Bq/l depending on measuring object

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
			Activity of radioactive noble gases	Spectrometric	1 per day – releases of gases/aerosols from reactors 1,2 through vent stack; 1 per week – releases due to residual heat during repair of reactors 1,2.	1.85÷3.7×10^5 Bq/l
			Activity of radioactive aerosols	Spectrometric	1 per day and per month – 1 releases of gases/aerosols from reactors 1,2 through vent stack; 1 per week – releases of gases/aerosols from reactors 1,2 through vent stack, releases from Bld. 150 through installation 153, releases due to residual heat during repair of reactors 1, 2.	from 2.5×10^{-6} to 6.7×10^3 Bq/l depending on measuring object
			Sr-89, Sr-90	Radiometric	1 per month – releases of gases/aerosols from reactors 1,2 through vent stack, from Bld. 130, from Bld. 156, from Bld. 159.	0.1÷3×10^3 Bq/l
			I-131	Spectrometric	1 per day, per week, per month – releases of gases/aerosols from reactors 1,2 through vent stack; 1 per week – releases from Bld. 150 through installation 153, releases due to residual heat during repair of reactors 1,2.	from 2.4×10^{-7} to 26 Bq/l depending on measuring object
			H-3, C-14	Radiometric	Releases of gases/aerosols from reactors 1,2 through vent stack. Depending on carrying out of IAEA project LIT/9/005	
3.	Water from heat power station in Bld. 119	2	Total β activity	Radiometric	1 per day – water of heating networks.	0.1÷3×10^3 Bq/l
			Volume activity of radionuclides	Spectrometric	1 per two weeks– water from installation 141; 1 per quarter – water of heating networks.	0.74÷1.85×10^8 Bq/l
4.	The air and atmospheric precipitation	9	Activity of γ nuclide	Spectrometric	3 times per month – atmospheric air at points of permanent surveillance; and 1 per month – atmospheric precipitation at points of permanent surveillance and industrial site.	1.5×10^{-6}÷15 Bq/m^3
			Sr-90	Radiometric	2 times per year (in winter and summer) - atmospheric air at points of permanent surveillance.	3×10^{-5}÷3×10^2 Bq/m^3

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
5.	Aquatic environment of INPP	104	Activity of γ nuclide	Spectrometric after evaporation	20 times per month (on working days) – discharge of technical water and water of intake channel; 1 time per 10 days – sewage water, water of industrial site PLK-1,2, PLK-3, PLK-SFSF; 1 per month – water from channel surrounding landfill of industrial waste, drainage water of INPP industrial site; 1 per quarter (in January, April, July, October) – water of heating networks; 2 times per year (in spring, autumn) – water of surveillance boreholes in the industrial site and area of SFSF; 4 times per year (in February, May, August, November) – potable water from water supply (watering-place), potable water from wells in Tilze and Gaide; 1 per year (in summer) – water of Druksiai lake; 1 per year (in winter) – snow at points of permanent surveillance, sampling points of precipitation of industrial site and SFSF site.	$1\times10^{-3}\div0.3$ Bq/l
			Sr-90	Radiochemical segregation	2 times per year (in spring, autumn) – discharge of technical water and water of intake channel, sewage water, water of surveillance boreholes in the industrial site and area of SFSF; 1 per year (in summer) – water of Druksiai lake; 1 per year (in winter) – water of heating networks, water from channel surrounding landfill of industrial waste, snow at points of permanent surveillance, sampling points of precipitation of industrial site and SFSF site, water of industrial site PLK-1,2, PLK-3, PLK-SFSF, drainage water of INPP industrial site.	0.3 Bq/l
			Activity of Pu isotopes	Radiochemical segregation	2 times per year (in spring, autumn) – discharge of technical water and water of intake channel.	1×10^{-2} Bq/l

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
			H-3	Without concentration, by filtering	1 per month – discharge of technical water and water of intake channel, sewage water, sampling points of precipitation of industrial site and SFSF site, water of industrial site PLK-1,2, PLK-3, PLK-SFSF; 1 per quarter – water from channel surrounding landfill of industrial waste; 2 times per year (in spring, autumn) – water of surveillance boreholes in the industrial site and area of SFSF; 4 times per year (in February, May, August, November) – potable water from wells in Tilze and Gaide.	3 Bq/l
			Total α activity	Concentrated sample	4 times per year (in February, May, August, November) – potable water from water supply (watering-place), potable water from wells in Tilze and Gaide.	0,1 Bq/l
			Total β activity	Concentrated sample	4 times per year (in February, May, August, November) – potable water from water supply (watering-place), potable water from wells in Tilze and Gaide.	0,01 Bq/l
6.	Monitoring of radiation dose and dose rate	86 Location of TLD is presented in Figure 7.1.	γ radiation dose rate	Radiometric	4 times per year (in February, May, August, November) – in the dump of construction materials and on the roads. 1 times per quarter – dose rate from SPD-1, SPD-2 equipment, clothes, shoes and machinery;	from 2×10^{-8} to 10 Sv/h depending on measuring object
					Constantly – SkyLink system.	$2\times10^{-8}\div10$ Sv/h
			γ radiation dose	Radiometric, TLD	2 times per year (in spring, autumn) – dose at locations of TLD in SPZ and SA.	$2.5\times10^{-4}\div5$ Sv
7.	Sludge from storage area	1	Activity of γ nuclide	Without concentration	1 per month	15 Bq/kg

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
			Activity of Pu isotopes	Radiochemical segregation	2 times per year (in spring, autumn)	300 Bq/kg
8.	Bottom sediments of Druksiai lake	10 Sampling points in Lake Druksiai are indicated in Figure 7.2.	Activity of γ nuclide	Dried, concentrated sample. Spectroscopic	1 per quarter – in discharge channel of industrial site PLK-1, PLK-3, SFSF site, PLK-SFSF, downstream purification plant.	3 Bq/kg
			Gamma nuclide content of upper layer (2 cm)	Dried, concentrated sample. Spectroscopic	1 per year (in summer) – at sampling points of Druksiai lake.	15 Bq/kg
			Sr-90 in upper layer (2 cm)	Burning and radiochemical segregation	1 per year (in summer) – at sampling points of Druksiai lake.	30 Bq/kg
			Distribution profile of gamma nuclides (3-10 cm)	Radiochemical segregation	1 time in 5 years – at sampling points of Druksiai lake.	15 Bq/kg
			Distribution profile of Pu isotopes (3-10 cm)	Radiochemical segregation	1 time in 5 years – at sampling points of Druksiai lake.	300 Bq/kg
9.	Aquatic vegetation of Druksiai lake	11 Sampling points in Lake Druksiai are indicated in Figure 7.2.	Activity of γ nuclide	During drying Spectroscopic	1 times per quarter – in discharge channel of industrial site PLK-1, PLK-3, SFSF site, PLK-SFSF, downstream purification plant; 1 per year (in summer) – at sampling points of Druksiai lake.	3 Bq/kg
			Sr-90	Burning and radiochemical segregation	1 per year (in autumn) – in discharge channel, downstream purification plant; 1 time in summer– at sampling points of Druksiai lake.	3 Bq/kg

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
10.	Foodstuff, plants, soil	34	Activity of γ nuclide	Concentrated /not concentrated sample depending on measuring object	1 per month – milk in Tilze; 1 per month (from May to October) – pasture grass at points of permanent surveillance an in Grikeniskiu peninsula; 2 times per year (in spring, autumn) – fish of Druksiai lake; 1 per year (in summer) – organisms of aquatic environments (mollusks); 1 per year (in August) – cabbage in Tilze; 1 per year (in September) – potatoes in Tilze; 1 per year (in autumn) – soil at points of permanent surveillance an in Grikeniskiu peninsula, mushrooms and moss at locations of Vilaragis, Grikeniskes, Tilze, Gaide, Visaginas, roe deer meat in the radius of 10 km around INPP, grain crops (rye and oats) in Tilze, meat (pork, beef) in Tilze and at location of Turmantas.	3 Bq/kg
			Sr-90	Radiochemical segregation	1 per month (from May to October) – pasture grass at points of permanent surveillance an in Grikeniskiu peninsula; 1 per year (in spring) – fish of Druksiai lake; 1 per year (in summer) – organisms of aquatic environments (mollusks); 1 per year (in August) – cabbage in Tilze; 1 per year (in autumn) - milk in Tilze.	3 Bq/kg
					1 per year (in autumn) – soil at points of permanent surveillance an in Grikeniskiu peninsula.	30 Bq/kg
			Activity of α nuclides	Radiochemical segregation	1 per year (in summer) – organisms of aquatic environments (mollusks).	3 Bq/kg

*) In the table indicated detective limit and it is the lowest measuring activity of the sample with 95% trustiness. The lower activities may measure with lower trustiness. Also, samples of the same type may by different composition (for e.g. samples of soil may be different consists of granulometric) therefore detective limits of samples will be different. In the table there are conservative (maximum) meanings of the detective limits.

In the table:

Bld. 150 – is liquid radioactive waste treatment and bitumising building in INPP;

D1, D2 – INPP 1 and 2 reactors control, electrical and deaerator rooms;

Installation 153 - venting stack of the radioactive waste reprocessing building 150;

Bld. 130 – repair building in INPP;

Bld. 156 – special laundry in INPP;

Bld. 157 – intermediate- and high-level waste storage in INPP;

Bld. 159 – cars wash building in INPP;

PLK-1,2, PLK-3 – industrial drainage outputs from INPP to lake Druksiai;

PLK-SFSF – industrial drainage output from SFSF site to lake Druksiai;

SPD-1,2 – militarized fire stations of INPP.

Table 7.2 Annual releases of radioactive inert gases, radioactive aerosols and Iodine-131 into the atmosphere from INPP [104]

Year	Radioactive inert gases, Bq*		Radioactive aerosols, Bq*		Radioactive Iodine-131, Bq**	
	Total	% of PR***	Total	% of PR***	Total	% of PR***
1992	7.03×10^{14}	4.15	2.15×10^{9}	0.42	1.18×10^{9}	0.35
1993	4.85×10^{14}	2.87	1.46×10^{9}	0.29	5.29×10^{8}	0.16
1994	2.9×10^{14}	1.72	8.23×10^{9}	1.62	2.93×10^{9}	0.87
1995	2.83×10^{14}	1.68	4.18×10^{9}	0.83	7.22×10^{9}	2.14
1996	1.59×10^{14}	0.94	7.79×10^{9}	1.53	1.15×10^{10}	3.39
1997	9.97×10^{13}	0.59	1.31×10^{9}	0.26	6.28×10^{9}	1.86
1998	1.23×10^{14}	0.73	8.46×10^{8}	0.17	6.94×10^{9}	2.06
1999	7.06×10^{13}	0.42	8.00×10^{8}	0.16	2.72×10^{9}	0.81
2000	6.13×10^{13}	0.36	1.59×10^{9}	0.31	2.64×10^{9}	0.78
2001	9.64×10^{13}	0.57	1.34×10^{9}	0.26	1.95×10^{9}	0.58
2002	1.01×10^{14}	0.60	9.08×10^{8}	0.18	2.49×10^{9}	0.74
2003	6.72×10^{13}	0.40	8.30×10^{8}	0.16	1.42×10^{9}	0.42
2004	6.16×10^{13}	0.36	8.65×10^{8}	0.17	1.06×10^{10}	3.14
2005	7.44×10^{13}	0.44	5.87×10^{8}	0.12	6.67×10^{9}	1.98
2006	3.12×10^{13}	0.22	6.92×10^{8}	0.07	7.70×10^{9}	0.78
2007	7.76×10^{13}	0.56	7.82×10^{8}	0.08	8.49×10^{9}	0.86

* - Data of operational twenty four hours control as per device RKS-07 including beta and gamma nuclides.

** - Total activity value of Iodine-131 including molecular, organic and aerosol fractions.

*** - Permissible releases (PR):

1. From 1992 till 2000, permissible releases were defined by the "Permission on the Use of Natural Resources" (registered number INPP 0-654).
2. From 2001 till 2005, permissible releases were defined by the "Permission on the Use of Natural Resources" (registered number INPP V-12).
3. From 2006 permissible releases are defined by the "Permission on the Release of Radioactive Substances into the Environment" (No. 1, 2005-12-16).

Table 7.3 Annual effective doses to the critical group member of population stipulated by radioactive releases from of INPP [104]

Year	Annual effective dose, Sv		
	Due to radioactive airborne releases into atmosphere	**Due to radioactive waterborne releases into Lake Druksiai**	**Total due to airborne and waterborne releases**
1992	0.83×10^{-6}	20.6×10^{-6}	21.4×10^{-6}
1993	0.57×10^{-6}	5.74×10^{-6}	6.31×10^{-6}
1994	0.52×10^{-6}	10.1×10^{-6}	10.6×10^{-6}
1995	0.80×10^{-6}	41.5×10^{-6}	42.3×10^{-6}
1996	0.84×10^{-6}	4.78×10^{-6}	5.62×10^{-6}
1997	0.47×10^{-6}	13.2×10^{-6}	13.7×10^{-6}
1998	0.51×10^{-6}	6.50×10^{-6}	7.01×10^{-6}
1999	0.23×10^{-6}	3.13×10^{-6}	3.36×10^{-6}
2000	0.28×10^{-6}	0.89×10^{-6}	1.13×10^{-6}
2001	0.22×10^{-6}	3.79×10^{-6}	4.01×10^{-6}
2002	0.22×10^{-6}	4.08×10^{-6}	4.30×10^{-6}
2003	0.15×10^{-6}	1.04×10^{-6}	1.19×10^{-6}
2004	1.89×10^{-6}	1.42×10^{-6}	2.50×10^{-6}
2005	1.13×10^{-6}	0.96×10^{-6}	2.09×10^{-6}
2006	1.39×10^{-6}	0.15×10^{-6}	1.54×10^{-6}
2007	1.39×10^{-6}	1.94×10^{-6}	3.33×10^{-6}

Table 7.4 Updating of the INPP environment monitoring program due to operation of the SWMSF

No.	Monitoring Object	Requirements	Required additional monitoring	Comments
1	Meteorological observations in the INPP region	Clause 41 of [65] (see chapter 7.1.1.1)	Not required	It is taken into consideration that meteorological observations are already realized by INPP. The existing monitoring system allows to measure meteorological parameters up to a height of 40 m and calculate radionuclides propagation for all operating conditions and measured meteorological conditions. The system is sufficient for meteorological monitoring of ISFSF as the effective release height will be below 200 m. For in-time evaluation of radiological impact to the population and the environment during operation and accidents all the data from the radiation monitoring system are directly sent to the INPP central monitoring board in building 101/1 using data line of the ISFSF assessment and control system. As a part of contract SWTSF the data will be integrated to the existing INPP monitoring system providing capability for overall assessment of radiation safety at nuclear facilities and environment.
2	Radioactive releases from the INPP	Clauses 43 to 46 of [65] (see chapter 7.1.1.3)	Additional monitoring of the radioactive releases from the SWMSF	Means of measuring the amount of radionuclides in effluents during normal operation and under accident conditions will be provided, including means of measuring the flow of diluting media, especially air at the exhaust (chimney). The systems designed to monitor the release of radioactive materials will have means for calibration and operability testing.
3	Radionuclides concentration in the air	Clause 54 of [65] (see chapter 7.1.1.3)	Additional monitoring of the radionuclides concentration in the air at the SWMSF site	Additional monitoring will be performed periodically by sampling and sample measurement in the laboratory.
4	Radionuclides concentration in the precipitation	Clause 54 of [65] (see chapter 7.1.1.3)	Additional monitoring of radionuclide concentrations in the atmospheric precipitation at the SWTSF site	Additional monitoring will be performed periodically by sampling and sample measurement in the laboratory.

No.	Monitoring Object	Requirements	Required additional monitoring	Comments
5	Radionuclides concentration in the aquatic environment	Clause 55 of [65] (see chapter 7.1.1.3)	Not required	It is taking into consideration that monitoring of radiological parameters of the lake Druksiai, monitoring of the water quality of the lake Druksiai and monitoring of discharges to the lake Druksiai are already realized by INPP
6	Radionuclides concentration in the water of the observation wells	Clauses 4 and 12.5 of [99] (see chapter 7.1.2). Clause 54 of [65] (see chapter 7.1.1.3).	Additional monitoring of the radionuclides concentration in the water of the observation wells around the SWTSF site	Observation wells for groundwater monitoring will be installed around the ISFSF and SWTSF sites in accordance with the Groundwater Monitoring Program
7	Chemical content of the water of the observation wells	Clause 12 of the document [99]	Additional monitoring of the chemical content of the water in the observation wells around the SWTSF site	Observation wells for groundwater monitoring will be installed around the ISFSF and SWTSF sites in accordance with the Groundwater Monitoring Program
8	Radionuclides concentration in the soil	Clause 54 of [65] (see chapter 7.1.1.3)	Additional monitoring of the soil samples from the SWMSF site	After the shutdown of Unit 2 (31/12/2009), there will be, practically, no releases of SL nuclides into the environment. Further, taking into account the age of the accumulated solid waste when the retrieval and processing activities will start, the contribution of the SL nuclides (Mn-54, Co-58, Fe-55, Cs-134.) to the global releases will be quite low. Actually, the spectrum of the nuclides to be analyzed in the soil samples (and in the environment at large) will progressively change after 2010. This must be taken into account in the monitoring program.
9	Radionuclides concentration in the bottom sediments	Clause 55 of [65] (see chapter 7.1.1.3)	Not required	It is taking into consideration that necessary measurements are already realized by INPP.
10	Radionuclides concentration in the plants and food products	Clause 54 of [65] (see chapter 7.1.1.3)	Not required	It is taking into consideration that necessary measurements are already realized by INPP.
11	Dose rate, dose	Clause 51 of [65] (see chapter 7.1.1.3)	Additional monitoring of the dose rate and dose around the SWMSF	The online detectors will be positioned at specific points where the dose rate will reach the maximum. The TLD will be positioned at a predefined distance to each other (e.g. 50 m). When evaluating the TLD it is possible to create a dose rate profile for the site fence in each direction.

No.	Monitoring Object	Requirements	Required additional monitoring	Comments
12	Chemical emissions from the SWTF		Emission of contaminants CO, NO, SO_2 and HCl will be monitored by means of sampling and analysis.	The measurement locations for the determination of contaminant concentration will be the installation points of the sampling probes in the off-gas line. Sampling to determine the levels of chemical emissions and the reference parameter O_2 will be done in a straight, horizontal section of the off-gas line close to the setup location of the analytical equipment.

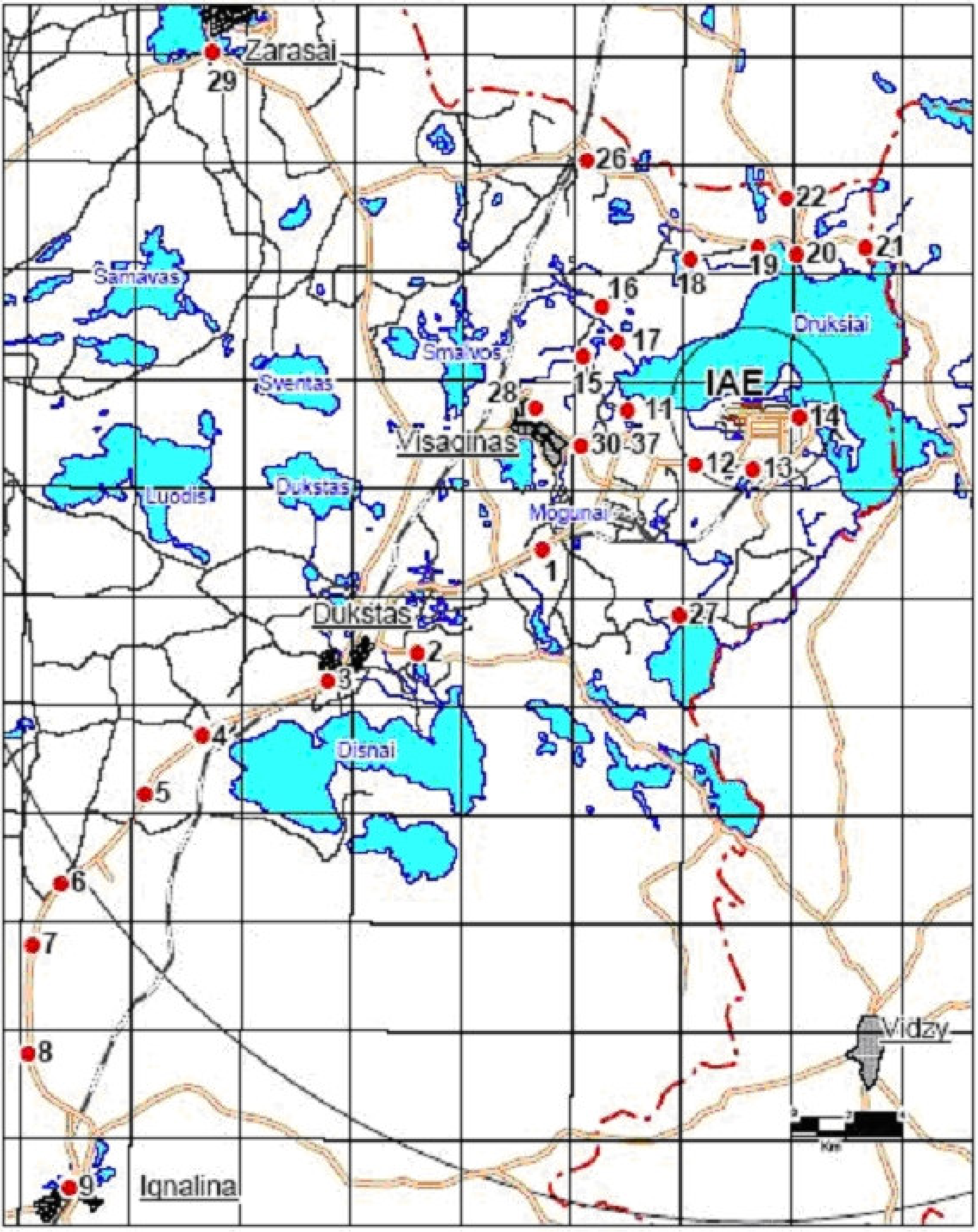


Figure 7.1 Location of thermoluminescent dosimeters around the INPP [100]

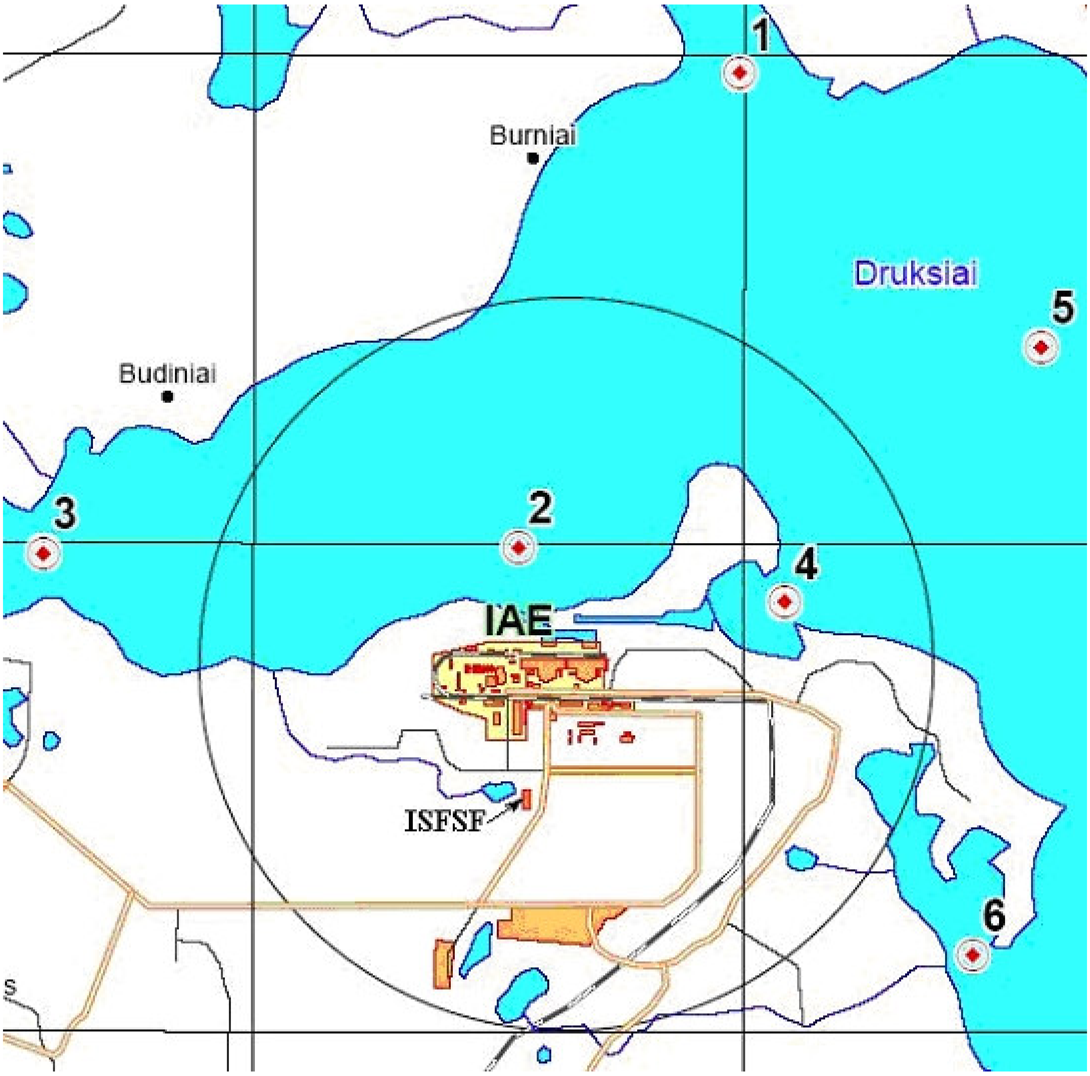


Figure 7.2 Sampling positions in Lake Druksiai [100]

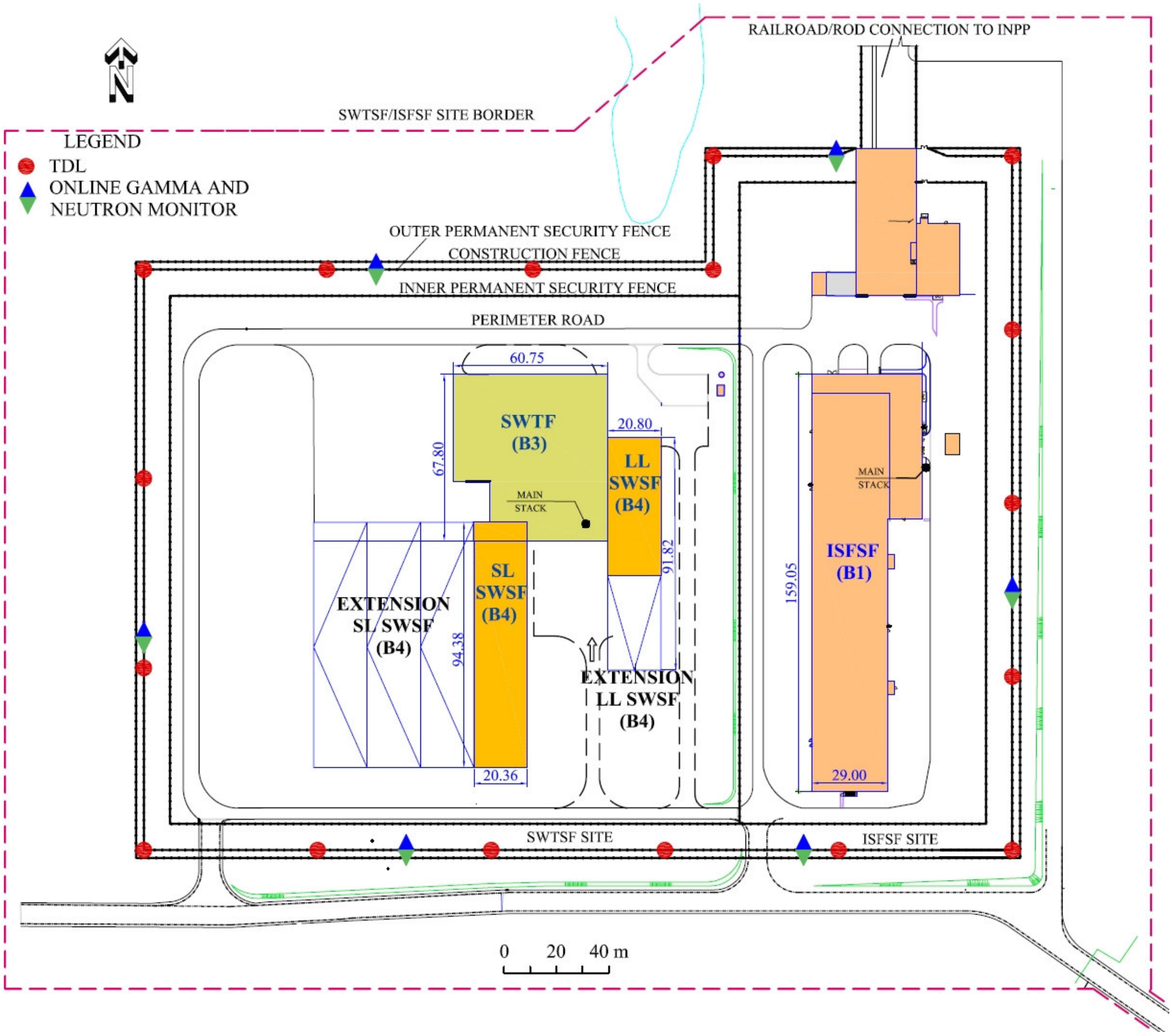


Figure 7.3 Layout of site permanent security fence detectors

8 RISK ANALYSIS AND ASSESSMENT

8.1 Risk Analysis

Emergency situations (emergencies) potentially resulting from the proposed economic activity which could lead to an environmental impact are addressed in this chapter of the EIA Report with the purpose to demonstrate that the proposed economic activity by virtue of its nature and environmental impacts may be carried out in the chosen sites. Therefore, hazards and factors, which could potentially cause an impact on the environment, are subjects of investigation and assessment.

Emergency situations, which could lead to a radiological impact on personnel and/or population, are of primary concern. For this proposed economical activity most of the potential emergency situations related to radioactive material management can lead to radiological and non-radiological or only non-radiological consequences, for example a drop of a radioactive waste transfer container. In case of a light accident only non-radiological consequences like a stop in operation are expected. In case of the drop of a container from a considerable height the damage of the container might be relevant. Accidents with non-radiological consequences as a rule lead to a considerable lower impact and therefore are enveloped by the consequences of radiological accidents.

A risk analysis addresses other events which do not necessarily lead to radiological consequences however could be expected during the proposed economic activity or could be considered as typical for the proposed design concept.

Internal and external events potentially leading to emergency situations are analyzed. Equipment and component failures, whose possibility and consequences strongly depend on the design solutions to be implemented during the design stage, are identified to a reasonable extent. Possible consequences are investigated and mitigation measures are discussed. However a detailed analysis of such emergency situations shall be addressed in the preliminary SAR, which has to be based on the Technical Design documentation.

The risk analysis of potential emergency situations is performed in accordance with the requirements of the Recommendations for the Assessment of the Potential Accident Risk of the Proposed Economic Activity [106]. The risk analysis as presented in this EIA Report shall be considered as preliminary and does not substitute the necessity for a more sophisticated and detailed risk analysis which has to be based on actual design solutions. A detailed risk and reliability analysis (like HAZOP or similar) shall be performed during the Technical Design and shall be considered in the Safety Analysis Report.

The results of the risk analysis are presented in Table 8.1. The table structure and the content follow the recommendations of the normative document [106]. The requirements for the classification of the consequences of a potential accident (for life, environment and property), the accident development speed and the probability of accident occurrence are explained in Table 8.2. More detailed explanations can be found in [106].

In addition, a practical example is provided explaining in detail how the accident seriousness (classes L, E, P, S) and the risk level (classes Pb, Pr) have been defined, cf. Table 8.3.

8.2 Assessment of Emergency Situations

This chapter includes the assessment of the consequences of the selected potential emergency situations assuming that they result into accident conditions. Accident conditions are more severe deviations from normal operation than anticipated operational occurrences and include design basis accidents and beyond design basis accidents.

A design basis accident includes accident conditions against which a nuclear facility is designed according to the established design criteria, and for which the damage to and release of radioactive material are kept within authorized limits. The Lithuanian regulations in force do not define permissible dose limits for population in case of radiological accident. The Lithuanian hygienic norm HN 99:2000 [107] defines protective actions and levels of their applicability as to avert or reduce accident exposure. Sheltering as immediate protective action is applied when avertable dose is greater than 10 mSv. Evacuation as immediate protective action is applied when avertable dose is greater than 50 mSv. The temporary relocation of population is applied when avertable dose in 30 days is greater than 30 mSv. The relocation is terminated when avertable dose in 30 days becomes less than 10 mSv. Permanent resettlement of population is applied when avertable dose in lifetime is greater than 1000 mSv.

The IAEA Safety Guide [108] specifies a design target for design basis accidents. It is required that there is only a minor radiological impact outside the site boundary or the exclusion area. Typically it corresponds to very restrictive dose levels so as to preclude the need for evacuation (corresponds to 50 mSv dose according to [107]).

In this EIA the dose limits for the members of population as defined in the Lithuanian hygienic norm HN 73:2001 [114], c.f. chapter 4.9.2.2.4.1, are used as the design criteria for limiting of exposure of the population under design basis accidents. These dose limits normally are not applicable for accident exposure. Dose limits define levels of long-term and permanently acting irradiation, which does not cause negative health effects. Dose limits are significantly lower levels for application of protective actions [107] or internationally recommended radiation protection targets for design basis accidents [108]. However, correspondence of accident dose to the dose limits demonstrates that accident exposure is low and will not cause negative health effects to the members of population.

A beyond design basis accident includes more severe accident conditions than in the case of a design basis accident. They require accident management which is defined as the taking of a set of actions during the evolution of a beyond design basis accident:

- To prevent the escalation of the event into a severe accident;
- To mitigate the consequences of a severe accident;
- To achieve a long term safe stable state.

Basing on the risk analysis, c.f. chapter 8.1, the following design basis accidents have been selected for more detailed investigation of their potential impact on the environment:

- Drop of a G2 transfer container while downloading it from RU2 (located on the top of the existing storage building 157 or 157/1) to the waste transfer truck (located on ground level);
- Drop of a G3 transfer container while downloading it from RU3 (located on the top of the existing storage building 157) to the waste transfer truck (located on ground level);
- Damage of a liquid radioactive waste transfer tank during the transfer of liquid radioactive waste from the SWTF to the INPP LWTF;
- Fire in the SWTF G2 sorting cell and waste preparation area during the treatment of combustible waste;
- Fire in the SWTF incinerator buffer store which is filled up with combustible waste packages prepared for incineration;

Basing on the risk analysis, the following beyond design basis accidents have been selected for more detailed investigation of their potential impact on the environment:

- An airplane crash on the SWTF incinerator buffer store which is filled up with combustible waste packages prepared for incineration;
- An airplane crash on the SLW store filled up with cemented waste packages;
- An airplane crash on the LLW store, graphite waste section;
- An airplane crash on the LLW store, G3 waste section.

The assessment methodology and the results of the assessment are presented in the sub-chapters below. The results of the assessment are also used to substantiate the conclusions of the risk analysis provided in chapter 8.1.

8.2.1 Methodology for assessment of public exposure

8.2.1.1 Methodology for assessment of public exposure due to release of airborne activity

In the case of accidents with release of airborne activity the calculation of the atmospheric dispersion of the released radioactive material and the calculation of public exposure are based on the methodology provided in the German incident guideline [109] which is in accordance with the European [92] and international normative documents [93]. This methodology has been successively used in assessing potential emergency consequences for the new INPP cement solidification facility and for the solidified waste interim storage project [110]. The dispersion modeling methodology used by [109] is described and recommended by the IAEA Safety Series publication [111].

The dispersion and deposition of airborne material is calculated, using the short-term two-dimensional Gaussian distribution formula for a source which also may be elevated to a certain height above the ground. The Gaussian distribution central axis activity concentration is used for the assessment of the maximal potential radiological consequences. The effects of the plume rise due to the vertical impulse or the heat contents of the emitted air (i.e. in case of fire) can be taken into account. Building wake effects are assumed according to the geometry of the buildings if the release point is within the building wake influence zone. The terrain in the vicinity of INPP up to a distance of several ten kilometers is sufficiently flat so it can be stated that the dispersion is not influenced by the orography.

In general, the accident can happen at any time and during unfavorable weather conditions. The most unfavorable factors for fallout and washout are defined to be representative for the investigated situation. The calculations are performed assuming no rain and heavy rain conditions (rain fallout is 5 mm/h), and for all different atmospheric stability conditions from class A (unstable conditions) to F (very stable conditions). The used wind speed data for the height of 10 m are presented in Table 8.4. The wind speed is corrected using the power-law function if the emission source is elevated to a certain height above 10 m.

Under these dispersion conditions 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 exhaust air plume (gamma submersion);
- Exposure due to beta radiation inside the exhaust air plume (beta submersion);
- Exposure due to gamma ground radiation of the radioactive fallout and washout (ground radiation);

Internal exposure:

- Exposure due to radioactive intake by respiration (inhalation);

- Exposure due to radioactive intake by the 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 design basis accidents considers the specificity of the existing INPP and planned SWTSF/ISFSF sites sanitary protection zones. It is postulated that accident consequences mitigation measures are implemented only within the SPZ with the purpose to reduce the potential ingestion dose. Both the production and the consumption of the food products produced within the SPZ are terminated within 24 h after occurrence of the accident. The annual presence of a member of the population within the SPZ is assumed to be the same as in case of normal operation conditions and is limited to 2000 h per year. No restrictions are imposed outside the boundary of the SPZ. The design basis accident consequences are calculated assuming no changes in the daily life outside the SPZ border. The annual exposure time is assumed to be 8760 h per year. The production and the consumption of food products are not specially limited.

The probability of an airplane crash accident is very low (below 10^{-7} cf. [34]) therefore such an event can be classified as beyond design basis accident [112], [113]. The analysis of potential radiological consequences as minimum shall provide the assessment of the exposure to a member of the population due to passing through of a radioactive cloud. These consequences cannot be mitigated due to the short time of the activity dispersion in the atmosphere. The measures shall be implemented immediately after the accident (especially within the SPZ) to assess contamination zones and to mitigate potential consequences due to external irradiation from activity deposited on the ground and from the ingestion of contaminated food products. Therefore it is considered that mitigation measures are taken to avoid ingestion of the food products exhibiting high specific activities due to the accidental releases.

Under the above described dispersion conditions the effective dose for beyond 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 exhaust air plume (gamma submersion);
- Exposure due to beta radiation inside the exhaust air plume (beta submersion);

Internal exposure:
- Exposure due to radioactive intake by respiration (inhalation).

The main parameters used for the assessment of the human exposure under design and beyond design accidents are summarized in Table 8.5.

The dose factors for inhalation and ingestion are taken from the Lithuanian hygienic norm HN 73:2001 [114]. These dose factors are in accordance with the European [92] and international regulations [115], [116]. Types of lung absorption rates for specific radionuclides were selected following the recommendations of [117].

The assessment of airborne release fractions are based on the methodology described in chapter 4.2.3.2.1. The summary of the release of airborne activity from selected design basis and beyond design basis accidents potentially relevant during the operation of the SWMSF is presented in Table 8.6. The intercomparison of the airborne activity releases resulting from selected accidents is presented in Figure 8.1 (basing on data from Table 8.6).

Particular accident specific parameters are detailed in the separate chapters 8.2.2 and 8.2.3 on the assessment of potential radiological consequences.

8.2.1.2 Methodology for assessment of public exposure due to release of waterborne activity

The radiation exposure of the critical group members of the population in the environment of INPP resulting from the determined release of radioactive effluents into the Lake Druksiai are calculated using the dose conversion factors as recommended by the Lithuanian normative document LAND 42-2007 [65]. These nuclide specific conversion factors give a relation between a nuclide specific long-term activity release and the dose caused to a critical group member of the population at the location of the highest predicted exposure.

For the modeling of the radionuclides transfer within the aquatic ecosystem, the dilution, sedimentation, bio-accumulation and accumulation in the soil of the lake coastal zone are taken into account. A conservative approach was applied to maximize the dose calculation factors in the case of lack of site specific data. Fishermen and gardeners (for transuranic radionuclides) were defined as the critical population groups. The critical group member dose assessment includes:

- In the case of fishermen - an external dose, resulting from the radionuclides in the lake water and in the coastal zone sediments, as well as an internal dose resulted by the fish used for food;
- In the case of gardeners – an external dose, resulting from the exposure from the radionuclides deposited in the irrigated soil, as well as an internal dose due to consumption of the food from the irrigated garden and the inhalation of re-suspended particles.

While determining the dose conversions factors and the discharge limits [65] the assumption is made that the discharge of radionuclides is continuous. However, the methodology covers the short term anticipated operational transients on condition that the daily releases do not exceed 1% of the defined annual release limit. The other investigations of the shorter time radioactive waterborne releases into the environment of Lake Druksiai [118], [119] report lower dose conversion factors.

The particular parameters of the radioactive liquid release accident are detailed in chapter 8.2.2.3.

8.2.2 Radiological Consequences of Design Basis Accidents

8.2.2.1 Drop of the G2 waste transfer container

The accident conditions consider the drop and damage of a G2 transfer container filled with group G2 waste. An accident may occur at the SWRF site while downloading a waste container by use of the crane from RU2 (located on the top of the existing storage building 157 or 157/1) to the waste transfer truck (located on ground level). The maximal expected drop height is about 11 m, while the safe containers drop height is lower. G2 containers, as well as G1 containers and G3 containers, will be designed following the IP2 standard, and they must withstand a drop of 1.2 m. Accident considerations assume total damage of the waste container and spill out of the entire G2 waste content on the ground. As a consequence, the accident results in the generation of airborne activity which is dispersed outside the INPP site, thus resulting in the exposure of a member of the population. The emission occurs at ground surface and is influenced by the structure of the nearby waste storage building.

The dose calculation summary is presented in Table 8.7. The calculated maximal one year effective dose to a member of the population is below 0.003 mSv, and is below the annual effective dose limit of 1 mSv. The calculated maximal consecutive five years effective dose to a member of the population is below 0.005 mSv.

At the distance of 5.5 km from the release source (state border of the Republic of Belarus) and further (state border of the Republic of Latvia) the expected annual effective dose is about 0.001 mSv, and from a radiological point of view can be considered as insignificant.

The consequences of the G1 waste transfer container drop accident are enveloped by the consequences of the above considered accident. Both G1 and G2 containers have the same waste filling capacity, and G2 waste is more active then G1 waste.

8.2.2.2 Drop of the G3 waste transfer container

The accident conditions consider the drop and damage of a G3 transfer container filled with group G3 waste. An accident may occur at the SWRF site while downloading a waste container by use of the crane from RU3 (located on the top of the existing storage building 157) to the waste transfer truck (located on ground level). The maximal expected drop height is about 11 m, while the safe container drop height is lower. G3 containers will be designed following the IP2 standard, and they must withstand a drop of 1.2 m. Accident considerations assume total damage of the waste container and spill out of the entire waste content on the ground. As a consequence, the accident results in the generation of airborne activity which is dispersed outside the INPP site, thus resulting in exposure of a member of the population. The emission occurs at ground surface and is influenced by the structure of the nearby waste storage building.

The dose calculation summary is presented in Table 8.8. The calculated maximal one year effective dose to a member of the population is below 0.3 mSv, and is below the annual dose limit of 1 mSv. The calculated maximal consecutive five years effective dose to a member of the population is below 0.7 mSv.

At the distance of 5.5 km from the release source (state border of the Republic of Belarus) and further (state border of the Republic of Latvia) the expected annual effective dose is about 0.1 mSv. The dose is below the internationally recognized dose limit (1 mSv/a) by factor of 10. The accident resulting dose can still be considered as reasonably low. The dose is compatible with the dose constraint which serves as an upper bound for the dose in the optimization of protection and safety for the radiation source (depending on the specific country practice, the dose constraint is usually selected to be within the range of 0.3 – 0.1 mSv per year).

8.2.2.3 Liquid waste transfer accident

The accident conditions consider the damage of a liquid radioactive waste transfer tank during the transfer of liquid radioactive waste from the SWTF to the INPP LWTF. The accident assumes that the liquid radioactive waste transfer tank is filled with the neutralized scrubber solution from the flue gas treatment of the incineration facility. This liquid waste is considered to be the most active liquid waste produced at the SWTSF. As a conservative condition the accident considerations assume spill out of the entire waste tank content on the ground surface.

Two bounding activity migration scenarios are investigated. The first bounding scenario assumes that liquid waste is spilled out on to the surface (e.g. concreted site surface, asphalted road etc.) which prevents from the quick liquid sorption into the soil, and the liquid remains on the ground surface. As a consequence the situation leads to the generation of airborne activity which is dispersed into the atmosphere and results in the exposure of a member of the population by the airborne pathway.

The dose calculation summary of this scenario is presented in Table 8.9. The calculated maximal one year effective dose to a member of the population is below 0.001 mSv, and from a radiological point of view can be considered as insignificant.

The second bounding scenario assumes that liquid waste gets into the existing INPP or newly constructed SWTSF site and the road connection rain water drainage system. In this case the activity may be directly discharged into Lake Druksiai (through the discharge point of the rain water collection system).

The dose calculation summary of this scenario is presented in Table 8.10. The released activity is calculated basing on the waste specific activity data provided in Table 3.3 and the planned capacity of the waste transfer tank ($2m^3$).

As it is indicated in chapter 8.2.1.2 the annual exposure of a member of the critical group of the population is defined basing on the dose conversion factors as recommended by the Lithuanian normative document LAND 42-2007 [65]. The document does not provide the dose conversion factors for some of the radionuclides which are identified in the potential releases. These radionuclides are Fe-55, Ni-59, Ni-63, Nb-94, Tc-99 and the transuranics U-235 and U-238.

The dose conversion factor of Fe-59 is selected as representative for the estimation of the potential exposure due to Fe-55. The committed effective dose per unit intake by ingestion and inhalation for Fe-59 is several times higher than the same factors for Fe-55 [114].

The dose conversion factor of Pu-239 is selected as representative for the estimation of the potential exposure due to U-235 and U-238. The committed effective dose per unit intake by ingestion and inhalation for Pu-239 is several times higher than the same factors for U-235 and U-238 [114].

For other radionuclides a dose conversion factor of 10^{-14} Sv/Bq is used as the most conservative option with respect to all the dose conversion factor values reported in [65].

As it can be seen from the dose estimation results, c.f. Table 8.10, the annual effective dose to a member of the critical group of the population is below 0.005 mSv, and from a radiological point of view can be considered as insignificant.

A scenario is possible where the liquid waste (probably just a part of the liquid, as the waste will be transported on predefined and surface coated roads) is spilled onto the soil and sinks into the deeper soil layers. The radionuclides will be absorbed by the soil (especially the transuranic elements which are characterized by their good sorption properties) and will remain in the soil, thus forming a contaminated soil layer. Accident consequences mitigation measures shall be implemented in short time to remove the contaminated soil and thus prevent from further radionuclides migration into the environment.

Radionuclides with weak sorption properties may reach the groundwater aquifers. The description of the actual hydrogeological conditions, c.f. chapter 4.1.2, indicates that the upper laying aquifers are mainly discharged into Lake Druksiai. These radionuclides will be diluted by the groundwater flow and after some time (with the decay of short lived radionuclides) will reach Lake Druksiai. The results of conservatively performed modeling of hypothetic contamination migration, c.f. chapter 4.1.5, shows that only negligible amounts of contamination could reach the aquifer of the waterworks of Visaginas town. Considering the implementation of impact mitigation measures, the radiological consequences of this scenario are enveloped by the above considered bounding scenario with direct discharge of activity into Lake Druksiai.

8.2.2.4 Fire in the SWTF G2 sorting cell and waste preparation area

The accident conditions consider a fire in the SWTF G2 sorting cell and waste preparation area during the treatment of G2 combustible waste. The accident considerations assume that the total amount of daily waste throughput is burnt out. As the accident takes place within the internal and ventilated premises of the SWTF, the release of the activity into the environment is reduced by the filtering capability of the ventilation system. The filters are installed in separated premises and cannot be directly affected by the fire whose impact is limited by the premises of the sorting cell and the combustible waste preparation room. However, it is considered that due to the smoke and fume particles generated by the fire the design filtering capability of the existing ventilation system may be reduced by several orders. Also, a special consideration is made regarding to the release of C-14 from the waste. It is assumed that all radioactive carbon during the fire is transformed into gaseous carbon oxides and is released into atmosphere without retention in HEPA filters. The emission occurs through the main ventilation stack of the SWTSF. The effective emission height is 50 m.

The dose calculation summary is presented in Table 8.11. The calculated maximal one year effective dose to a member of the population is below 0.003 mSv, and is below the annual effective dose limit of 1 mSv. The calculated maximal consecutive five years effective dose to a member of the population is below 0.005 mSv.

At a distance of 5.5 km from the release source (state border of the Republic of Belarus) and further (state border of the Republic of Latvia) the expected annual effective dose is below 0.001 mSv, and from a radiological point of view can be considered as insignificant.

Accident consequences also envelope the consequences of the case of G1 or mixed G1 and G2 waste fire as the activity of these waste streams will be lover in comparison with the activity of a pure G2 waste stream.

8.2.2.5 Fire in the incinerator buffer store

The accident conditions consider a fire in the incinerator buffer store which is completely filled up with combustible G2 waste packages prepared for incineration. The accident considerations assume that all the maximally available amount of waste is burnt out. As the accident takes place within the internal and ventilated premise of the SWTF, the release of activity into the environment is reduced by the filtering capability of the ventilation system. Filters are installed in separated premises and cannot be directly affected by the fire whose impact is limited by the incinerator buffer store. However, it is considered that due to the smoke and fume particles generated by the fire the design filtering capability of the existing ventilation system may be reduced by several orders. Also, a special consideration is made regarding to the release of C-14 from the waste. It is assumed that all radioactive carbon during the fire is transformed into gaseous carbon oxides and is released into atmosphere without retention in HEPA filters. The emission occurs through the main ventilation stack of the SWTSF. The effective emission height is 50 m.

The dose calculation summary is presented in Table 8.12. The calculated maximal one year effective dose to a member of the population is below 0.06 mSv, and is below the annual effective dose limit of 1 mSv. The calculated maximal consecutive five years effective dose to a member of the population is about 0.1 mSv.

At a distance of 5.5 km from the release source (state border of the Republic of Belarus) and further (state border of the Republic of Latvia) the expected annual effective dose is about 0.01 mSv. The dose is of the same value as the internationally recognized dose limit applicable to exempted practices. The exposure from a radiological point of view can still be considered as insignificant.

Accident consequences also envelope the consequences of the case of G1 or mixed G1 and G2 waste fire as the activity of these waste streams will be lover in comparison with the activity of a pure G2 waste stream.

8.2.3 Radiological Consequences of Beyond Design Basis Accidents

8.2.3.1 Airplane crash on the SWTF incinerator buffer store

The accident conditions consider an airplane crash on the SWTF incinerator buffer store which is completely filled up with combustible G2 waste packages prepared for incineration. The accident considerations assume that the airplane penetrates the facility roof and causes fire within the store resulting in burn out of all maximally available waste amounts. As the building structure is broken, the existing ventilation system is assumed to be damaged, and confinement from the environment is lost. The activity is released directly into the environment without any filtration.

The heat released during the fire may result in enhancement of the effective emission height. However, this option was conservatively not taken into account. It also may be relevant that accident mitigation measures will lead to fire suppression and to the reduction of the emission height. Therefore the physical emission height is set to be equal to the roof height of the incineration buffer store (14 m). The influence of the SWRF building structure onto the atmospheric dispersion is also considered.

The dose calculation summary is presented in Table 8.13. The calculated maximal effective dose to a member of the population due to passing through of a radioactive cloud is below 0.4 mSv. At a distance of 5.5 km from the release source (state border of the Republic of Belarus) and further (state border of the Republic of Latvia) the expected effective dose is below 0.01 mSv.

Accident consequences also envelope the consequences of the case of G1 or mixed G1 and G2 waste fire as the activity of these waste streams will be lower in comparison with the activity of a pure G2 waste stream.

8.2.3.2 Airplane crash on the SLW store

The accident conditions consider an airplane crash on the SLW store filled up with cemented waste packages. The accident considerations assume that the airplane partially destroys the facility roof, penetrates into the facility and directly hits 10 waste containers filled with compacted ash from G2 combustible waste (maximally expected activity). One container is totally destroyed, and other containers are damaged partially (to about 50%). The waste packages are covered by debris from the damaged roof structure. Due to the airplane fuel fire the waste is subjected to a thermal load which results in additional generation of airborne activity. The waste itself is not combustible. As the building structure is broken, the existing ventilation system is assumed to be damaged, and confinement from the environment is lost. The activity is released directly into the environment without any filtration.

The physical emission height is set to be equal to the roof height of the SLW store (14 m). The influence of the SLW store building structure onto the atmospheric dispersion is also considered.

The dose calculation summary is presented in Table 8.14. The calculated maximal effective dose to a member of the population due to passing through of a radioactive cloud is below 0.06 mSv. At a distance of 5.5 km from the release source (state border of the Republic of Belarus) and further (state border of the Republic of Latvia) the expected effective dose is below 0.001 mSv.

8.2.3.3 Airplane crash on the LLW store’s graphite waste section

The accident conditions consider an airplane crash on the LLW store’s graphite waste section. The accident considerations assume that the airplane partially destroys the facility roof, penetrates into the facility and directly hits 10 steel waste storage containers filled with graphite waste. One container is totally destroyed, and other containers are damaged partially (to about 50%). The waste containers are covered by debris from the damaged roof structure. Due to the airplane fuel fire the waste is subjected to thermal load which results in additional generation of airborne activity and burn-up of the graphite waste from a completely damaged container. As the building structure is broken, the existing ventilation system is assumed to be damaged and confinement from the environment is lost. Activity is released directly into the environment without any filtration.

The physical emission height is set to be equal to the roof height of the LLW store (14 m). The influence of the LLW store building structure onto the atmospheric dispersion is also considered.

The dose calculation summary is presented in Table 8.15. The calculated maximal effective dose to a member of the population due to passing through of a radioactive cloud is below 0.6 mSv. At a distance of 5.5 km from the release source (state border of the Republic of Belarus) and further (state border of the Republic of Latvia) the expected effective dose is below 0.01 mSv.

8.2.3.4 Airplane crash on the LLW store's G3 waste section

The accident conditions consider an airplane crash on the LLW store's G3 waste section. The accident considerations assume that the airplane partially destroys the facility roof, penetrates into the facility and directly hits 10 steel waste storage containers filled with metallic G3 waste. One container is totally destroyed and other containers are damaged partially (to about 50%). The waste containers are covered by debris from the damaged roof structure. Due to the airplane fuel fire the waste is subjected to thermal load which results in additional generation of airborne activity. The waste itself is not combustible. As the building structure is broken, the existing ventilation system is assumed to be damaged and confinement from the environment is lost. Activity is released directly into the environment without any filtration.

The physical emission height is set to be equal to the roof height of the LLW store (14 m). The influence of the LLW store building structure onto the atmospheric dispersion is also considered.

The dose calculation summary is presented in Table 8.16. The calculated maximal effective dose to a member of the population due to passing through of a radioactive cloud is below 2.2 mSv. This dose is above the annual dose limit. However, the limit for the effective dose which is allowed in special circumstances (5 mSv, c.f. chapter 4.9.2.2.4.1) is not exceeded. The measures shall be implemented immediately after the accident (especially within the SPZ) to assess potential contamination zones and mitigate consequences due to external irradiation from the activity deposited on ground and ingestion of contaminated food products.

At a distance of 5.5 km from the release source (state border of the Republic of Belarus) and further (state border of the Republic of Latvia) the expected effective dose is below 0.03 mSv.

8.3 Summary of Potential Impact due to Emergency Situations

The dose assessment results show that the exposure of a member of the population in case of design basis accidents is expected to be within the acceptable radiation protections limits. For the majority of potential design basis accidents the annual effective dose from the relevant external and internal exposure pathways (c.f. chapter 8.2.1.1) is at least by one order below the annual dose limit (1 mSv, c.f. chapter 4.9.2.2.4.1), Figure 8.1. The most severe consequences might be expected in case of the damage of a G3 waste transfer container and spill out of the G3 waste in open air conditions. The calculated maximal one year effective dose to a member of the population is below 0.3 mSv and is also below the annual dose limit of 1 mSv.

For more distant locations from the accident place (state borders of the Republics Belarus and Latvia) the exposure of a member of the population can be considered as insignificant. As criterion for the radiological insignificance the dose limit applicable to exempted practices can be used. Practices and sources within practices may be exempted if the annual effective dose expected to be incurred by any member of the public due to the exempted practice or source is of the order of 10^{-2} mSv or less [92], [93].

The airplane crash related accidents are of very low probability (below 10^{-7} per year). Therefore they are considered as beyond design basis accidents. The dose assessment results show that in case of beyond design basis accidents appropriate measures shall be implemented immediately after the accident (especially within the existing SPZ of INPP) to assess the contamination zones and mitigate potential consequences due to external irradiation from activity deposited on the ground and from ingestion of contaminated food products. The exposure of a member of the population due to passing through of a radioactive cloud for most of the beyond design basis accidents is below the annual dose limit (1 mSv), Figure 8.3. The most severe consequences can be expected in the case of an airplane crash on the LLW store's G3 waste section. The calculated maximal effective dose to a member of the population due to passing through of a radioactive cloud at the SWTSF site permanent security fence is below 2.2 mSv. This dose is above the annual dose limit. However, the limit for an effective dose which is allowed in special circumstances (5 mSv) is not exceeded. The exposure decreases with increasing distance from the accident location. At the border of the existing INPP SPZ and further the dose falls below 0.01 mSv, Figure 8.4.

For more distant locations from the accident place (state borders of the Republics Belarus and Latvia) the exposure of a member of the population due to passing through of a radioactive cloud for most of the potential beyond design basis accidents can be considered as insignificant. The doses are about or below 0.01 mSv. Just in case of an airplane crash on the LLW store G3 waste section accident a dose rise to 0.3 mSv can be expected.

Therefore it can be stated that the exposure of a member of the population due to design and beyond design accidents (with implementation of accident consequences mitigation measures) can be assured to be within acceptable radiation protections limits.

8.4 Tables and Drawings of the Chapter "Risk Analysis and Assessment"

The following Tables are attached to the Chapter "Risk Analysis and Assessment":

Table 8.1 Risk analysis of potential emergency situations resulting from proposed economic activity;

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 requirements [106];

Table 8.3 Practical example: preliminary risk evaluation for the G3 waste transfer container drop accident;

Table 8.4 Wind speed parameters for specific atmospheric stability class;

Table 8.5 Main parameters used for assessment of exposure to a member of the population during accident conditions;

Table 8.6 Release of airborne activity resulting from selected design basis and beyond design basis accidents potentially relevant during operation of SWMSF;

Table 8.7 Exposure of a member of the population due to radioactive airborne release in case of the G2 waste transfer container drop accident;

Table 8.8 Exposure of a member of the population due to radioactive airborne release in case of the G3 waste transfer container drop accident;

Table 8.9 Exposure of a member of the population due to radioactive airborne release in case of the liquid waste transfer accident;

Table 8.10 Exposure of a member of the critical group of population due to radioactive effluent release into the Lake Druksiai in case of the liquid waste transfer accident;

Table 8.11 Exposure of a member of the population due to radioactive airborne release in case of internal fire in the G2 sorting cell and waste preparation area accident;

The following Figures are attached to the Chapter “Risk Analysis and Assessment”:

Table 8.1 Risk analysis of potential emergency situations resulting from proposed economic activity

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU1	Intervention into existing waste storage compartments	Combustible waste inside compartment	Intervention activity induced fire of combustible waste	Building structure, waste inside, environment	Release of airborne activity, exposure of personnel and population	1	3	2	3	**4**	**B**	Safe design of intervention technology	The breaking through the reinforced concrete wall will be done by cutting with a diamond saw whereas the slabs will be handled either with a diamond saw or with an electrical or compressed air operated hammer. The cladding of building 155/1 will not be cut by the saw because the sparkles caused by cutting could cause fire. The reinforced concrete wall therefore will be cut to a certain safe depth rest will be broken by a push. After removal of the reinforced concrete the steel cladding inside will be cut with the hydraulic shear of the Remote Operated Vehicle (ROV).

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU1 and LSF	G1 waste retrieval, presorting, packing and / or loading into container	G1 waste within waste storage compartment, RU1 and LSF	Loss of power supply	None	Pause in operation	1	1	1	5	**4**	**A**	Waste handling equipment is designed to stop in safe hold-on position in case of power loss. Manual restart of operation after power supply is recovered.	Waste handling operations are stopped.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU1 and LSF	G1 waste retrieval, presorting, packing and / or loading into container	G1 waste within waste storage compartment, RU1 and LSF	Stop of ventilation system (i.e. due to loss of power supply etc.)	Environment in case of activity release	Loss of dynamic confinement. Potentiality for release of airborne activity, exposure of personnel and population	1	1	1	3	**4**	**A**	Stop of waste handling. Close of waste retrieval compartment. Personnel leave to safe location.	Under operating conditions reduced pressure conditions are assured. In case of loss of ventilation airflow is directed from outside to RU1 and LSF. The physical confinement is still assured (RU1 and LSF are sealed from atmosphere), therefore air infiltration rate is low and pressure rise is slow. Internal pressure will rise until it comes into equilibrium with external ambient conditions. The waste retrieval and handling activity will be stopped thus minimizing any generation and movement of airborne activity. If the ventilation system cannot be restored in short time, the waste compartments are also be closed. Waste in storage compartment will remain under normal storage conditions. Potentiality for activity spread outside the units is minimal.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU1 and LSF	G1 waste retrieval, presorting, packing and / or loading into container	G1 waste within waste storage compartment, RU1 and LSF	Loss of filtering capability	Environment	Release of airborne activity, exposure of personnel and population	1	2	1	3	**3**	**B**	Redundant design of filtering system (2×100% or 3×50%). Preventing control of filters clogging (pressure drop control)	
RU1 and LSF	G1 waste retrieval, presorting, packing and / or loading into container	G1 waste within waste storage compartment, RU1 and LSF	Fire (especially during handling of combustible waste)	Combustible waste, equipment inside, environment in case of activity release	Damage to equipment, pause in operation. Release of airborne activity, exposure of personnel and population.	2	1	1	5	**3**	**A**	Preventive equipment maintenance. RU1 and LSF are equipped with manual fire extinguishes. Fire safe design for existing waste retrieval equipment and systems.	Limited amount of waste inside RU1 and LSF. Bulk amount of waste is of very low level activity (i.e. of class A waste activity). After packing waste is immediately transferred either into Landfill repository (class A waste suitable for disposal off into Landfill repository) or into SWTF for further treatment (G1 non class A waste)
RU1 and LSF	G1 waste retrieval, presorting, packing and / or loading into container	G1 waste within RU1 and LSF	Earthquake	RU1 and LSF building structure and equipment inside	Damage to building structure and equipment inside. Stop in operation. Loss of activity confinement. Release of activity.	3	3	3	5	**3**	**B**	Safe design against earthquake induced loads.	The building structure and other safety important systems and components will be designed against design basis earthquake.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU1 and LSF	G1 waste retrieval, presorting, packing and / or loading into container	G1 waste within RU1 and LSF	Flooding of facility	Waste inside, environment in case of activity release	Water ingress, submersion of waste, contamination of ingresses water	1	1	1	3	**2**	**A**	Safe design against heavy rainfall and rapid thaw (snow).	Storm water drainage system will be designed on the site. Site flooding due to water level rise in lake Druksiai is not probable, cf. chapter 4.1.1. Waste retrieval will be performed within relatively short time (10 years).
RU2	G2 or G1 waste retrieval, presorting, loading into container	G2 or G1 waste within waste storage compartment and RU2	Loss of power supply	None	Pause in operation	1	1	1	5	**4**	**A**	Waste handling equipment is designed to stop in safe hold-on position in case of power loss. Manual restart of operation after power supply is recovered.	Waste handling operations are stopped.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU2	G2 or G1 waste retrieval, presorting, loading into container	G2 or G1 waste within waste storage compartment and RU2	Stop of ventilation system (i.e. due to loss of power supply etc.)	Personnel, Environment in case of activity release	Loss of dynamic confinement. Potentiality for release of airborne activity, exposure of personnel and population	1	1	1	3	**4**	**A**	Stop of waste handling. Close of waste retrieval compartment. Personnel leave to safe location.	Under operating conditions reduced pressure conditions are assured. In case of loss of ventilation airflow is directed from outside to RU. The physical confinement is still assured (RU2 is sealed from atmosphere), therefore air infiltration rate is low and pressure rise is slow. Internal pressure will rise until it comes into equilibrium with external ambient conditions. The waste retrieval and handling activity will be stopped thus minimizing any generation and movement of airborne activity. If the ventilation system cannot be restored in short time, the waste compartments are also be closed. Waste in storage compartment will remain under normal storage conditions. Potentiality for activity spread outside the units is minimal.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU2	G2 or G1 waste retrieval, presorting, loading into container	G2 or G1 waste within waste storage compartment and RU2	Loss of filtering capability	Environment	Release of airborne activity, exposure of personnel and population	1	2	1	3	**3**	**B**	Redundant design of filtering system (2×100% or 3×50%). Preventing control of filters clogging (pressure drop control)	
RU2	G2 or G1 waste retrieval, presorting, loading into container	G2 or G1 waste within waste storage compartment and RU2	Fire (especially during handling of combustible waste)	Combustible waste, equipment inside, environment in case of activity release	Damage to equipment, pause in operation Release of airborne activity, exposure of personnel and population	1	2	1	5	**3**	**A**	Preventive equipment maintenance. Fire safe design for existing waste retrieval equipment and systems. Existing combustible waste storage compartments are equipped with fire detection and extinguish system.	Low fire load within RU2.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU2	Loading of waste transfer container with the waste	G2 or G1 waste	Uncontrolled spread out of contamination	External surface of waste transfer container, environment	Contamination of external surfaces of waste transfer container, spread out of contamination outside RU	2	2	1	5	**3**	**B**	Contamination preventing design of waste loading equipment thus limiting potential spread out of contamination (use of double lid lock system). Check on / decontamination of external surfaces potential for contamination before transfer of waste containers outside of RU2.	
RU2	G2 or G1 container transfer from RU2 down to the truck	G2 or G1 waste within container	Drop of container from crane, damage to container, release of radioactivity	Waste container, environment in case of activity release	Damage to waste container, release of activity, exposure of personnel and population	2	2	1	5	**3**	**B**		Existing INPP crane will be used in accordance with existing operational safety requirements Evaluation of radiological consequences on environment is provided in chapters 8.2 and 8.3.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU2	G2 or G1 container transfer from RU2 down to the truck	G2 or G1 waste within container	Extreme weather conditions leading to load swinging, collision of container against wall, damage to container and building	Waste container, waste storage facility	Damage to waste container, damage to building structure	2	1	1	5	**5**	**A**	Stop of operation under extreme weather conditions.	In accordance with existing INPP safety requirements no waste transfer operations are performed under extreme weather conditions. Crane is fixed at the safe stop position outside waste storage buildings. Appropriate fixing of RU2 on the top of building, considering wind induced loads, is assured by design.
RU2	G2 or G1 waste retrieval, presorting, loading into container	G2 or G1 waste within RU2	Earthquake	RU2, equipment inside	Damage to RU2 and equipment inside. Stop in operation. Loss of activity confinement. Release of activity.	3	3	2	5	**3**	**B**	Safe design against earthquake induced loads (appropriate fixing of RU2 on the top of building etc.).	Mass of RU2 is negligible as compared to the mass of building structure. Installation of RU2 will not weaken the waste storage building structure.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU3	G3 waste retrieval, loading into container	G3 waste within waste storage compartment	Loss of power supply	None	Stop in operation	1	1	1	5	**4**	**A**	Waste handling equipment is designed to stop in safe hold-on position in case of power loss. Manual restart of operation after power supply is recovered.	Waste retrieval operations and loading into container are performed within closed waste storage compartment. Waste handling operations are stopped.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU3	G3 waste retrieval, loading into container	G3 waste within waste storage compartment	Stop of ventilation system (i.e. due to loss of power supply etc.)	None	Stop in operation	1	1	1	3	**4**	**A**	Stop of waste handling.	Under operating conditions reduced pressure conditions are assured. In case of loss of ventilation airflow is directed from outside to RU3. The physical confinement is still assured (RU3 is sealed from atmosphere, operations of waste retrieval and loading into container are performed within closed waste storage compartment), therefore air infiltration rate is low and pressure rise is slow. Internal pressure will rise until it comes into equilibrium with external ambient conditions. The waste retrieval and handling activity will be stooped thus minimizing any generation and movement of airborne activity. Waste remains under normal storage conditions.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU3	G3 waste retrieval, loading into container	G3 waste within waste storage compartment	Loss of filtering capability	Environment	Release of airborne activity, exposure of personnel and population	1	2	1	3	**3**	**B**	Redundant design of filtering system (2×100% or 3×50%) Preventing control of filters clogging (pressure drop control)	
RU3	G3 container transfer from RU3 down to the truck	G3 waste within container	Drop of container from crane, damage to container, release of radioactivity	Waste container, environment	Damage to waste container, release of activity, exposure of personnel and population	2	2	1	5	**3**	**B**		Existing INPP crane will be used in accordance with existing operational safety requirements. Evaluation of radiological consequences on environment is provided in chapters 8.2 and 8.3.
RU3	G3 container transfer from RU3 down to the truck	G3 waste within container	Extreme weather conditions leading to load swinging, collision of container against wall, damage to container and building	Waste container, waste storage facility	Damage to waste container, damage to building structure	2	1	1	5	**5**	**A**	Stop of operation under extreme weather conditions.	In accordance with existing INPP safety requirements no waste transfer operations are performed under extreme weather conditions. Crane is fixed at the safe stop position outside waste storage buildings. Appropriate fixing of RU3 on the top of building, considering wind induced loads, is assured by design.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
RU3	G3 waste retrieval, presorting, loading into container	G3 waste within storage compartment	Earthquake	RU3, equipment inside	Damage to RU3 and equipment inside. Stop in operation. Loss of activity confinement. Release of activity.	3	3	2	5	**3**	**B**	Safe design against earthquake induced loads (appropriate fixing of RU3 and waste retrieval equipment on the top of building).	Mass of RU3 is negligible as compared to the mass of building structure. Installation of RU3 will not weaken the waste storage building structure.
Radioactive waste transfer	G1 waste transfer from RU2 to RU1	G1 waste within transfer container	Transfer accident, damage of container	Waste container, truck	Damage to container, damage to truck, pause in operation	1	2	1	5	**3**	**A**	Proper fixing of waste container on the truck will be assured by design. Waste transfer will be performed within SWRF site inside controlled area. Low transfer speed. Truck speed limit is 10 km/h. Waste transfer will not be performed (or limited) within extreme weather conditions.	Truck speed limit is 10 km/h. Potential container drop height is below safe drop limit therefore damage of container is not probable.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
Radioactive waste transfer	G1 non class A waste transfer from RU1 to SWTF	G1 non class A waste within transfer container	Transfer accident, damage of container	Waste container, truck	Damage to container, damage to truck, pause in operation	1	2	1	5	**3**	**A**	Proper fixing of waste container on the truck will be assured by design. Low transfer speed. Truck speed limit is 10 km/h. Waste transfer will not be performed (or limited) within extreme weather conditions.	Waste transfer will be performed within predefined and fenced from publicity road. No waste transfer on public roads will be performed. Potential container drop height is below safe drop limit therefore damage of container is not probable.
Radioactive waste transfer	G2 waste transfer from RU2 to SWTF	G2 waste within transfer container	Transfer accident, damage of container	Waste container, truck	Damage to container, damage to truck, pause in operation	2	2	1	5	**3**	**B**	Proper fixing of waste container on the truck will be assured by design. Low transfer speed. Truck speed limit is 10 km/h. Waste transfer will not be performed (or limited) within extreme weather conditions.	Waste transfer will be performed within predefined and fenced from publicity road. No waste transfer on public roads will be performed. Potential container drop height is below safe drop limit therefore damage of container is not probable.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
Radioactive waste transfer	G3 waste transfer from RU2 to SWTF	G3 waste within transfer container	Transfer accident, damage of container	Waste container, truck	Damage to container, damage to truck, pause in operation	2	2	1	5	**3**	**B**	Proper fixing of waste container on the truck will be assured by design. Low transfer speed. Truck speed limit is 10 km/h. Waste transfer will not be performed (or limited) within extreme weather conditions.	Waste transfer will be performed within predefined and fenced from publicity road. No waste transfer on public roads will be performed. Potential container drop height is below safe drop limit therefore damage of container is not probable.
Radioactive waste transfer	Liquid waste transfer from SWTF to INPP	Liquid waste within transfer tank	Transfer accident, damage of container	Waste tank, truck, environment in case of waste leaking	Damage to tank, damage to truck, contamination of environment, exposure of personnel and population	2	2	1	5	**3**	**B**	Safe design (double walls) design of liquid waste tank. Proper fixing of waste tank on the truck will be assured by design. Low transfer speed. Truck speed limit is 10 km/h. Waste transfer will not be performed (or limited) within extreme weather conditions.	Waste transfer will be performed within predefined and fenced from publicity road. No waste transfer on public roads will be performed. Evaluation of radiological consequences on environment is provided in chapters 8.2 and 8.3.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWTF			Loss of power supply or other services	None	Pause in operation	1	1	1	5	**4**	**A**	Waste handling equipment is designed to stop in safe hold-on position in case of power loss. Manual restart of operation after power supply is recovered.	Waste handling operations are stopped.
SWTF	Radioactive waste unloading on arrival, loading of waste storage containers with treated waste	Waste inside containers	Uncontrolled spread out of contamination	Internal premises of SWTSF, equipment	Spread out of contamination, contamination of external surfaces of waste transfer and storage containers	2	2	1	5	**3**	**B**	Contamination preventing design of waste loading / unloading equipment thus limiting potential spread out of contamination (use of double lid lock system). Check on / decontamination of external surfaces potential for contamination before transfer of emptied waste containers back to RU or treated waste containers for storage.	

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWTF	Waste treatment activity	Waste inside	Failure of waste handling equipment in non accessible or limited access areas	Personnel	Stop of operation, exposure of personnel during recovery actions	2	1	1	5	**4**	**A**	Preventive equipment maintenance. Waste handling equipment is designed to stop in safe hold-on position. Redundant design Safe recovery strategy and means shall be defined by design	

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWTF	Waste transfer in-between treatment facilities	Waste inside containers, drums	Collision / drop incidents	Waste packages, equipment	Spill of waste inside closed premises of SWTF, damage to waste packages, equipment, contamination of closed SWTF premises and equipment	2	1	1	5	**4**	**A**	Safe design of waste handling equipment (i.e. conveyors with guidelines, end stops, etc.) Interlocks in-between moving objects and potential obstacles (closed doors, other potentially moving object), predefined and controlled stopping positions. Design limiting operations with lifting height above safe load drop height. Limited transportation length of open waste packages before lidding. Stability of waste packages on trolleys and conveyors under seismic event induced loads Safe recovery strategy and means shall be defined by design.	

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWTF	Waste treatment activity	Combustible material at various processing areas (i.e. equipment cables etc.)	Fire impacting ventilation system filters.	Filters of ventilation system	Damage to ventilation system, release of activity into environment, exposure of population.	1	2	1	5	**3**	**A**	Fire impact protective design, e.g. use of non combustible fibber glass filter material. Use of fire dampers to isolate compartments in fire from ventilation system.	Fire dampers are closed automatically in case of loss of power or fire, thus preventing potential fire spread into ventilation system.
SWTF	Waste treatment activity	Combustible material at various processing areas (i.e. equipment cables etc.)	Fire resulting in smoke at the personnel escapes routes.	Personnel	Difficulties in personnel evacuation.	2	1	1	4	**3**	**A**	Design of smoke removal system for the .personnel escape routes.	
SWTF	Combustible waste sorting in G2 sorting cell and preparation for incineration in the preparation room	Combustible waste in the sorting cell and preparation area	Waste fire, impact on ventilation system	Waste, ventilation system, environment	Damage to ventilation system, release of activity into environment, exposure of personnel and population	2	2	2	5	**3**	**B**	Fire impact protective design (as separate, closed and fire resistant compartments). Automatic fire detection system. Fire fighting system. Fire spread protective design – ventilation system inlets and outlets equipped with fire dampers.	Fire load in the G2 sorting cell is low. In case of fire compartments can be isolated from the environment and the release / spread of activity can be limited. Evaluation of radiological consequences on environment is provided in chapters 8.2 and 8.3.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWTF	Storage of combustible waste in the buffer storage	Combustible waste, maximal load 15000 kg	Waste fire, impact on ventilation system	Waste, ventilation system, environment	Damage to ventilation system, release of activity into environment, exposure of personnel and population	2	2	2	5	**3**	**B**	Fire impact protective design (as separate, closed and fire resistant compartment). Automatic fire detection system. Fire fighting system. Fire spread protective design – ventilation system inlets and outlets equipped with fire dampers.	In case of fire the compartment can be isolated from the environment and the release / spread of activity can be limited. Evaluation of radiological consequences on environment is provided in chapters 8.2 and 8.3.
SWTF	Liquid radioactive waste collection and storage	Secondary liquid radioactive waste	Leakage of radioactive liquids	Internal premises of SWTF	Spread out of contamination	1	1	1	3	**2**	**B**	Safe design – multibarrier design concept (trays for leakage collection), design against overfilling	Limited amount of liquid waste, 5 and 2 m^3 volume tanks. Once waste is collected it is transferred to INPP for appropriate treatment. Liquid waste collection and storage system is confined with SWTF structure.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWTF	Waste treatment	Waste inside	Earthquake	Building structure, waste treatment equipment, safety important systems and components.	Damage to facility, damage to equipment, stop in operation, loss of activity confinement, release of activity into environment, exposure of personnel and population	3	3	3	5	**3**	**C**	Safe design of building structure and safety important installations against earthquake induced loads.	Building structure and safety important systems and components will be designed to retain serviceability after design basis earthquake. Waste confinement (stability of building structure) will be assured after beyond design basis earthquake.
SWTF	Waste treatment	Waste inside treatment facilities, combustible waste within incinerator buffer store, 15000 kg	Airplane crash, loss of confinement, fire	Building structure, waste inside, environment	Damage to facility, loss of shielding and containment, kerosene fire, fire of combustible waste, release of activity, exposure of population	3	3	3	5	**1**	**C**	Extremely low probability, less than 1×10^{-7} per year.	Beyond design basis accident. Evaluation of radiological consequences on environment is provided in chapters 8.2 and 8.3.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWSF, SL waste store	Waste loading	Cemented waste package(s)	Collision or/and drop of waste package	Waste package(s)	Damage to cemented waste package(s)	1	1	1	5	**3**	**A**	Safe design of waste package lifting equipment. Safe design of waste transfer (i.e. defined fixed positions for containers; position sensors for containers; crane movement restricted to defined corridors etc)	Activity is confined within cemented matrix. Accident if occur will take place within closed containment assuring no direct release of activity into environment. Air circulation system with filters will be installed. No urgent recovery measures are necessary – recovery actions can be planned and taken considering actual situation.
SWSF, SL waste store	Waste storage	Cemented waste packages inside	Flooding of facility	Waste inside, environment in case of activity release	Water ingress, submersion of waste packages, contamination of ingresses water	1	1	1	3	**2**	**A**	Safe design against heavy rainfall and rapid thaw (snow). Contamination preventing design of waste loading operations thus limiting potential contamination of waste packages (use of double lid system). Check on / decontamination of external surfaces potential for contamination before transfer of waste packages for storage.	Storm water drainage system will be designed on the site. Site flooding due to water level rise in lake Druksiai is not probable, cf. chapter 4.1.1. Activity is confined within cemented matrix.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWSF, SL waste store	Waste storage	Cemented waste packages inside	Earthquake	Building structure, waste inside	Damage to facility, fall of waste packages stack, damage to waste packages, loss of shielding	3	3	3	5	**3**	**C**	Safe design of building structure and waste stacking against earthquake induced loads.	The building structure and components will be designed to retain serviceability after design basis earthquake. Waste confinement (stability of building structure) will be assured after beyond design basis earthquake.
SWSF, SL waste store	Waste storage	Cemented waste packages inside	Airplane crash, loss of confinement, kerosene fire	Building structure, waste inside, environment	Damage to facility, loss of shielding and containment, damage to waste packages, kerosene fire, release of activity, exposure of population	3	3	4	5	**1**	**C**	Extremely low probability, less than 1×10^{-7} per year.	Beyond design basis accident. Activity is confined within cemented matrix. Waste is not combustible. Evaluation of radiological consequences on environment is provided in chapters 8.2 and 8.3.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWSF, LL waste store	Waste loading	Waste in steel container(s)	Collision or/and drop of waste container	Waste container(s)	Damage to waste container(s), spill out of waste	1	1	1	5	**3**	**A**	Safe design of waste container lifting equipment. Safe design of waste transfer (i.e. defined fixed positions for containers; position sensors for containers; crane movement restricted to defined corridors etc)	Accident if occur will take place within closed containment assuring no direct release of activity into environment. Air circulation system with filters will be installed. No urgent recovery measures are necessary – recovery actions can be planned and taken considering actual situation.
SWSF, LL waste store	Waste storage	Waste in steel containers	Flooding of facility	Waste inside, environment in case of activity release	Water ingress, submersion of waste containers, contamination of ingresses water	1	1	1	3	**2**	**A**	Safe design against heavy rainfall and rapid thaw (snow). Contamination preventing design of waste loading operations thus limiting potential contamination of waste containers (use of double lid lock system). Check on / decontamination of external surfaces potential for contamination before transfer of waste containers for storage.	Storm water drainage system will be designed on the site. Site flooding due to water level rise in lake Druksiai is not probable, cf. chapter 4.1.1. Activity is confined within steel container.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
SWSF, LL waste store	Waste storage	Waste in steel containers	Earthquake	Building structure, waste inside	Damage to facility, fall of waste containers stack, damage to waste containers, loss of shielding and waste confinement, release of activity into environment, exposure of personnel and population.	4	4	4	5	**3**	**D**	Safe design of building structure and waste stacking against earthquake induced loads.	The building structure and components will be designed to retain serviceability after design basis earthquake. Waste confinement (stability of building structure) will be assured after beyond design basis earthquake.
SWSF, LL waste store	Waste storage	Waste in steel containers	Airplane crash, loss of confinement, fire	Building structure, waste inside, environment	Damage to facility, loss of shielding and containment, damage to containers, kerosene fire, graphite waste fire, release of activity, exposure of population	3	3	4	5	**1**	**C**	Extremely low probability, less than 1×10^{-7} per year. Reduced penetration probability due to thick walls and roof.	Beyond design basis accident. Most active G3 waste is not combustible (i.e. metal). Evaluation of radiological consequences on environment is provided in chapters 8.2 and 8.3.

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 requirements [106]

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 injures, serious discomfort
4	Very serious	A few (more than 5) deaths, several or several tenths serious injures, up to 500 evacuated
5	Catastrophic	Several deaths, hundredths of serious injures, 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

Table 8.3 Practical example: preliminary risk evaluation for the G3 waste transfer container drop accident

Parameter	Discussion / Evaluation	Conclusion / Classification
Accident probability	The existing G3 waste compartments of the building 157 will contain about 930 m^3 of the waste by the end of the year 2010. The waste is loaded for about 20 years. No accidents associated with a container drop and crash have been occurred. The proposed economic activity will use the same crane and similar procedure for the downloading of the new G3 waste container from the roof of building to the waste transfer truck. It is planned to retrieve waste from the storage compartments within a period of T = 5 years. The effective volume of the new G3 waste container is 0.15 m^3. In total N = 6200 waste container down loadings could be expected. The probability of an accident depends on various factors like equipment design, equipment maintenance and supervision, managerial measures (supervisory tasks, operational procedures and limitations, measures to reduce human error factor etc.). The probability of an accident cannot be precisely assessed at the stage of conceptual design. Typical value for the nuclear design general lifting equipment is usually about 1E-5 per single operation. The calculations assume a 5 times higher accident probability: P_1 = 5E-5 per single operation. The accident probability for the whole G3 waste retrieval activity lifetime is: $P_A = P_1 \times N$ = 5E-5×6200 = 0.31 The annual accident probability: $P_{AY} = P_A/T$ = 0.31/5 = 0.062 The accident frequency, (years of operation to accident) $P_F = 1/P_A$ = 1/0.062 = 16.1 The accident is beyond operation time frame.	Accident is beyond SWRF operation time frame. Accident probability class (Pb) – 3 (i.e. quite probable, once every 10 – 100 years).
Accident seriousness to the life and health	The dose to a member of the population is assessed in chapter 8.2.2.2. The highest exposure is expected close to the security fence of INPP. The annual dose (which includes external and internal exposure pathways) is below 0.3 mSv and does not exceed the annual dose limit of 1 mSv. The consecutive five years (after accident) annual dose is as well below 1 mSv. The consequences to a member of the population can be classified as unimportant (temporary slight discomfort). The considerable higher exposure can be expected for personnel who is directly involved into container downloading activity (when accident takes place). To avoid high doses the personnel shall immediately leave accident place. The accident consequences management activity will also contribute to the exposure of a limited number of personnel	Class of consequences for life and health (L) – 2 (limited, a few injures, long lasting discomfort)

Parameter	Discussion / Evaluation	Conclusion / Classification
	which will be directly involved into this activity. The exposure shall be limited using appropriate shielding and managerial means. The accident consequences management activity can be planned and prepared in advance. The consequences to a limited number of personnel can be classified from limited (a few injures, long lasting discomfort) to serious (a few serious injures, serious discomfort).	
Accident seriousness for the environment	Local contamination at the accident place (within the INPP controlled area) is expected. However the amount of the spilled waste will be small (at most 0.15 m^3). The waste is solid; most of the activity is confined within material (activated metals). No widespread of heavy contamination is expected. Accident consequences mitigation measures shall be implemented in a short time to collect (or at least to shield) the spilled waste, because it is also necessary to reduce the increased radiation fields. The consequences can be classified as limited (simple contamination, localized effect)	Class of consequences for environment (E) – 2 (limited, simple contamination, localized effect)
Accident seriousness for property	The container might be damaged. The waste retrieval activity will be stopped. It will be necessary to collect the spilled waste and to decontaminate the environment. Accident consequences mitigation measures shall be prepared in advance and be implemented in a short time after accident. The consequences for property can be classified as unimportant or limited.	Classification of consequences for property (P) – 1 (unimportant, total cost damage is less than 100000 Lt).
Accident development speed	No warning is assumed.	Accident development speed class (S) – 5 (no warning)
Prioritization of consequences	The accident seriousness classes L and E are defined as limited. Class P is of low value, accident probability Pb is beyond the operation time frame. Therefore a limited priority is considered.	Prioritization of consequences (Pr) – B (limited)
Preventive measures	Occurrence of the accident and the consequences can be limited (or prevented) by the design (e.g. the necessity to use of a shock absorber might be considered by the design). The accident consequences mitigation measures and means shall be planned in advance.	

Table 8.4 Wind speed parameters for specific 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

Table 8.5 Main parameters used for assessment of exposure to a member of the population during accident conditions

Parameter	Value	Remark
Adult breathing rate, m^3/s	3.8E-04	Conservative value for short time exposure
Annual exposure duration within SPZ, h	2000	
Annual exposure duration outside SPZ, h	8760	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
Time span from accident emission and termination of consumption of food products produced within SPZ, h	24	
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
Surface dry weight of the pasture soil (10 cm depth), kg/m^2	120	Generic value
Surface dry weight of the plough land (plowshare depth of 20 cm), kg/m^2	280	Generic value

Table 8.6 Release of airborne activity resulting from selected design basis and beyond design basis accidents potentially relevant during operation of SWMSF

Abbreviations in the Table: MAR – material at the risk, ARR – activity release rate, ARF – activity release fraction, DF – decontamination factor. Terms are explained in the chapter 4.2.3.2.1.

No	Postulated Accident	Units im-pacted	MAR kg	Waste Type	Specific Activity Bq/kg	MAR Bq	Impact	ARR 1/h	Time weeks	Time h	ARF	DR	Released Fraction	DF	Airborne Release Bq
1	Drop and damage of G2 transfer	1	1236	G2 non	5.86E+07	7.25E+10	Solid Spill				2.00E-03	1.0	2.00E-03		
	container in open air conditions			combustible			Resuspension	4.00E-05	1.0	168	6.72E-03	1.0	6.72E-03		
	at SWRF						Total						8.72E-03	1.0	6.32E+08
2	Drop and damage of G3 transfer	1	155	G3	7.23E+10	1.12E+13	Solid Spill				2.00E-03	1.0	2.00E-03		
	container in open air conditions						Resuspension	4.00E-05	1.0	168	6.72E-03	1.0	6.72E-03		
	at SWRF						Total						8.72E-03	1.0	9.76E+10
3	Damage of liquid waste transfer	1	2200	Scrubber	4.87E+06	1.07E+10	Resuspension	4.00E-07	1.0	168	6.72E-05	1.0	6.72E-05		
	tank in open air conditions			solution			Total						6.72E-05	1.0	7.20E+05
4	Fire in SWTF G2 sorting cell		713	G2	9.08E+07	6.47E+10	Combustion				1.00E+00	1.0	1.00E+00		
	and waste preparation area			combustible											
							Total						1.00E+00	1.00E+02	6.81E+08
5	Fire in SWTF incineration		15000	G2	9.08E+07	1.36E+12	Combustion				1.00E+00	1.0	1.00E+00		
	buffer store			combustible											
							Total						1.00E+00	1.00E+02	1.43E+10
6	Airplane crash on SWTF		15000	G2	9.08E+07	1.36E+12	Combustion				1.00E+00	1.0	1.00E+00		
	incineration buffer store			combustible											
							Total				1.00E+00		1.00E+00	1.0	1.36E+12
7	Airplane crash on	10	12000	G2	2.34E+09	2.81E+13	Solid Spill				2.00E-03	0.1	2.00E-04		
	SLW store			compacted			Resuspension	4.00E-06	2.0	336	1.34E-03	0.5	6.72E-04		
				ash			Thermal load				6.00E-03	0.5	3.00E-03		
							Total						3.87E-03	1.0	1.09E+11
8	Airplane crash on	10	29625	Graphite	1.84E+10	5.45E+14	Solid Spill				2.00E-03	0.1	2.00E-04		
	LLW store						Combustion				1.00E+00	0.1	1.00E-01		
							Resuspension	4.00E-06	2.0	336	1.34E-03	0.5	6.72E-04		
							Thermal load				6.00E-03	0.5	3.00E-03		
							Total						1.04E-01	1.0	5.66E+13
9	Airplane crash on	10	25800	G3	7.23E+10	1.87E+15	Solid Spill				2.00E-03	0.1	2.00E-04		
	LLW store						Resuspension	4.00E-06	2.0	336	1.34E-03	0.5	6.72E-04		
							Thermal load				6.00E-03	0.5	3.00E-03		
							Total						3.87E-03	1.0	7.22E+12

Table 8.7 Exposure of a member of the population due to radioactive airborne release in case of the G2 waste transfer container drop accident

Exposure type	Critical weather conditions	Distance from release point, m				Remark
		200 [1])	2200 [2])	5500 [3])	8000 [4])	
		Effective dose, Sv				
One year exposure	F stability class, rain	2.60E-06	2.17E-06	1.03E-06	7.67E-07	Design basis accident at the SWRF site. Dose includes external and internal exposure pathways
Five consecutive years exposure		4.67E-06	3.46E-06	1.66E-06	1.25E-06	

[1]) At the INPP security fence;

[2]) At the border of INPP SPZ;

[3]) At the state border of Republic of Belarus, distance to Visaginas city is at least 6000 m;

[4]) At the state border of Republic of Latvia.

Table 8.8 Exposure of a member of the population due to radioactive airborne release in case of the G3 waste transfer container drop accident

Exposure type	Critical weather conditions	Distance from release point, m				Remark
		200 [1])	2200 [2])	5500 [3])	8000 [4])	
		Effective dose, Sv				
One year exposure	F stability class, rain	2.99E-04	2.53E-04	1.19E-04	8.91E-05	Design basis accident at the SWRF site. Dose includes external and internal exposure pathways
Five consecutive years exposure		6.36E-04	4.61E-04	2.21E-04	1.66E-04	

[1]), [2]), [3]), [4]) c.f. remarks below Table 8.7

Table 8.9 Exposure of a member of the population due to radioactive airborne release in case of the liquid waste transfer accident

Exposure type	Critical weather conditions	Distance from release point, m				Remark
		10 [1])	1800 [2])	5500 [3])	8000 [4])	
		Effective dose, Sv				
One year exposure	F stability class, rain	1.10E-07	2.73E-09	1.09E-09	8.17E-10	Design basis accident. Dose includes external and internal exposure pathways
Five consecutive years exposure		1.86E-07	4.43E-09	1.81E-09	1.36E-09	

[1]) Close to the waste transfer road connection fence;

[2]), [3]), [4]) c.f. remarks below Table 8.7.

Table 8.10 Exposure of a member of the critical group of population due to radioactive effluent release into the Lake Druksiai in case of the liquid waste transfer accident

Radionuclide	Accident released activity, Bq	Dose Conversion Factor [65], Sv/Bq	Annual effective dose, Sv
C-14	5.54E+06	3.1E-15	1.72E-08
Mn-54	2.01E+09	8.2E-17	1.64E-07
Fe-55	5.54E+09	1.7E-17 [1])	9.42E-08
Co-58	1.65E+09	2.6E-17	4.29E-08
Co-60	1.18E+09	1.2E-15	1.42E-06
Ni-59	1.18E+06	1.0E-14 [3])	1.18E-08
Ni-63	2.83E+08	1.0E-14 [3])	2.83E-06
Nb-94	2.24E+06	1.0E-14 [3])	2.24E-08
Sr-90	1.05E+05	1.9E-15	2.00E-10
Tc-99	7.00E+03	1.0E-14 [3])	7.00E-11
I-129	6.30E+01	3.6E-15	2.27E-13
Cs-134	2.45E+07	7.4E-15	1.81E-07
Cs-137	1.75E+07	2.4E-15	4.20E-08
U-235	4.73E-03	5.3E-16 [2])	2.50E-18
U-238	1.40E-01	5.3E-16 [2])	7.42E-17
Pu-238	2.98E+02	8.5E-17	2.53E-14
Pu-239	7.70E+01	5.2E-16	4.00E-14
Pu-240	1.93E+02	5.3E-16	1.02E-13
Pu-241	2.80E+04	1.4E-16	3.92E-12
Am-241	4.20E+02	1.1E-15	4.62E-13
Cm-244	8.23E+01	4.7E-16	3.87E-14
Total	**1.07E+10**		**4.82E-06**

1) DCF of F-59 is selected;

2) DCF of Pu-239 is selected;

3) Conservative option respect to all dose conversion factor values reported in [65].

Table 8.11 Exposure of a member of the population due to radioactive airborne release in case of internal fire in the G2 sorting cell and waste preparation area accident

Exposure type	Critical weather conditions	Distance from release point, m				Remark
		100 [1])	1700 [2])	5500 [3])	9000 [4])	
		Effective dose, Sv				
One year exposure	A and F stability classes, rain	2.61E-06	1.41E-06	5.29E-07	3.56E-07	Design basis accident at the SWTF. Dose includes external and internal exposure pathways.
Five consecutive years exposure		4.92E-06	2.33E-06	8.76E-07	5.84E-07	

[1]) At the SWTSF/ISFSF security fence;

[2]), [3]), [4]) c.f. remarks below Table 8.7.

Table 8.12 Exposure of a member of the population due to radioactive airborne release in case of internal fire in the incinerator buffer store accident

Exposure type	Critical weather conditions	Distance from release point, m				Remark
		100 [1])	1700 [2])	5500 [3])	9000 [4])	
		Effective dose, Sv				
One year exposure	A and F stability classes, rain	5.51E-05	2.96E-05	1.11E-05	7.49E-06	Design basis accident at the SWTF. Dose includes external and internal exposure pathways.
Five consecutive years exposure		1.04E-04	4.91E-05	1.84E-05	1.23E-05	

[1]), [2]), [3]), [4]) c.f. remarks below Table 8.11.

Table 8.13 Exposure of a member of the population due to radioactive airborne release in case of airplane crash on the incinerator buffer store accident

Exposure type	Critical weather conditions	Distance from release point, m				Remark
		100 [1])	1700 [2])	5500 [3])	9000 [4])	
		Effective dose, Sv				
Passing through cloud exposure	F stability class, no rain	3.40E-04	2.09E-05	8.31E-06	6.76E-06	Beyond design basis accident at the SWTF. Dose includes passing through cloud external and inhalation exposure.
	F stability class, rain	3.35E-04	1.78E-05	6.76E-06	5.71E-06	

[1]), [2]), [3]), [4]) c.f. remarks below Table 8.11.

Table 8.14 Exposure of a member of the population due to radioactive airborne release in case of airplane crash on the SLW store accident

Exposure type	Critical weather conditions	Distance from release point, m				Remark
		35 [1])	1700 [2])	5500 [3])	9000 [4])	
		Effective dose, Sv				
Passing through cloud exposure	F stability class, no rain	5.52E-05	1.66E-06	6.63E-07	5.39E-07	Beyond design basis accident at the SWSF. Dose includes passing through cloud external and inhalation exposure.
	F stability class, rain	5.50E-05	1.42E-06	5.39E-07	4.56E-07	

[1]), [2]), [3]), [4]) c.f. remarks below Table 8.11.

Table 8.15 Exposure of a member of the population due to radioactive airborne release in case of airplane crash on the LLW store, graphite waste section accident

Exposure type	Critical weather conditions	Distance from release point, m				Remark
		70 [1])	1700 [2])	5500 [3])	9000 [4])	
		Effective dose, Sv				
Passing through cloud exposure	F stability class, no rain	5.68E-04	2.05E-05	4.63E-06	2.67E-06	Beyond design basis accident at the SWSF. Dose includes passing through cloud external and inhalation exposure.
	F stability class, rain	5.63E-04	1.66E-05	2.67E-06	1.36E-06	

[1]), [2]), [3]), [4]) c.f. remarks below Table 8.11.

Table 8.16 Exposure of a member of the population due to radioactive airborne release in case of airplane crash on the LLW store, G3 waste section accident

Exposure type	Critical weather conditions	Distance from release point, m				Remark
		70 [1])	1700 [2])	5500 [3])	9000 [4])	
		Effective dose, Sv				
Passing through cloud exposure	F stability class, no rain	2.17E-03	9.00E-05	3.00E-05	2.26E-05	Beyond design basis accident at the SWSF. Dose includes passing through cloud external and inhalation exposure.
	F stability class, rain	2.15E-03	7.55E-05	2.26E-05	1.76E-05	

[1]), [2]), [3]), [4]) c.f. remarks below Table 8.11.

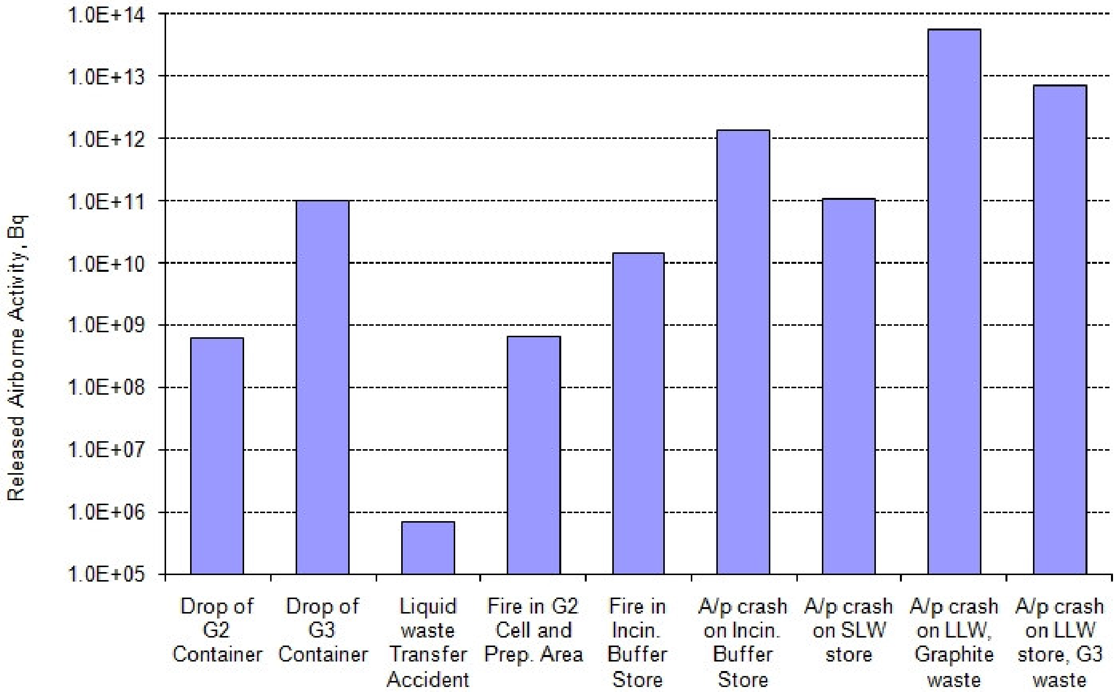


Figure 8.1 Release of airborne activity resulting from the selected design basis and beyond design basis accidents potentially relevant during operation of the SWMSF

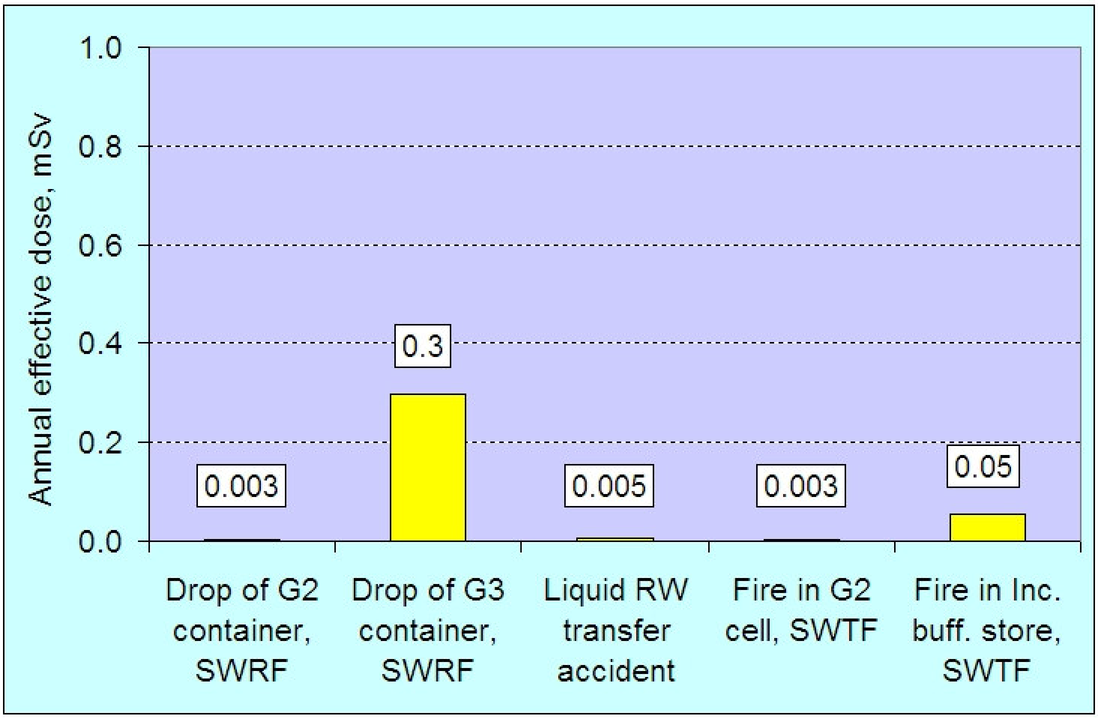


Figure 8.2 Annual effective dose to the critical group member in case of design basis accidents

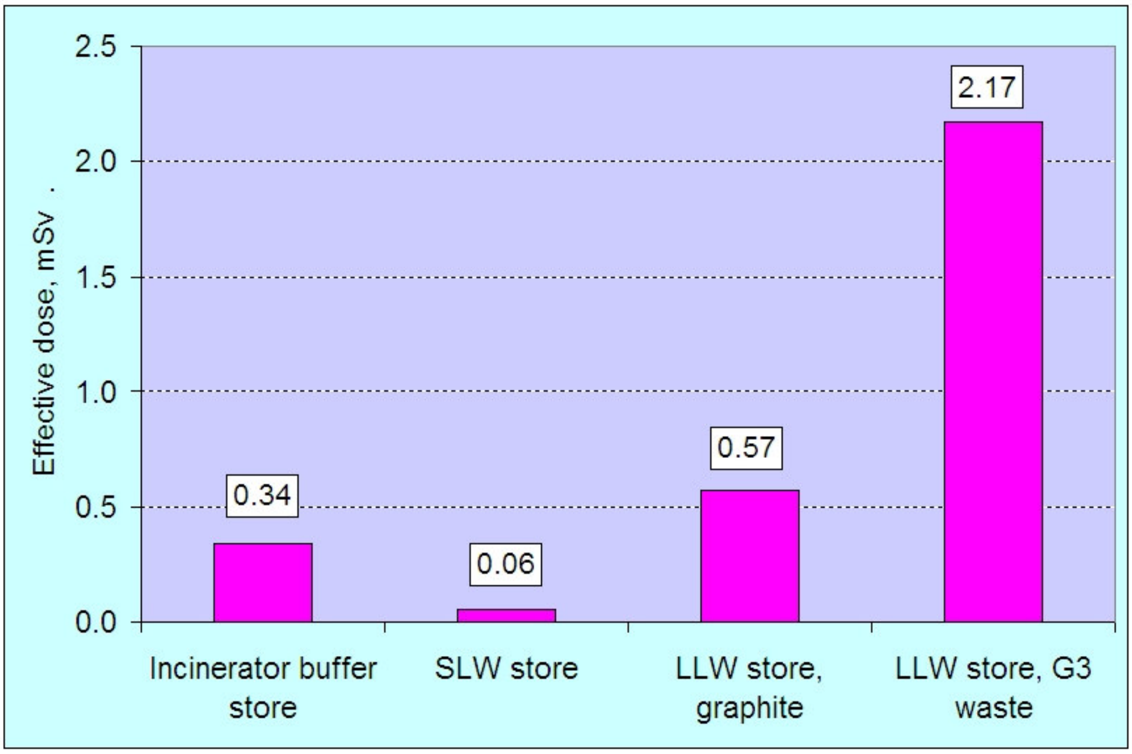


Figure 8.3 Dose to the member of population at the SWTSF site permanent security fence incase of beyond design basis accidents

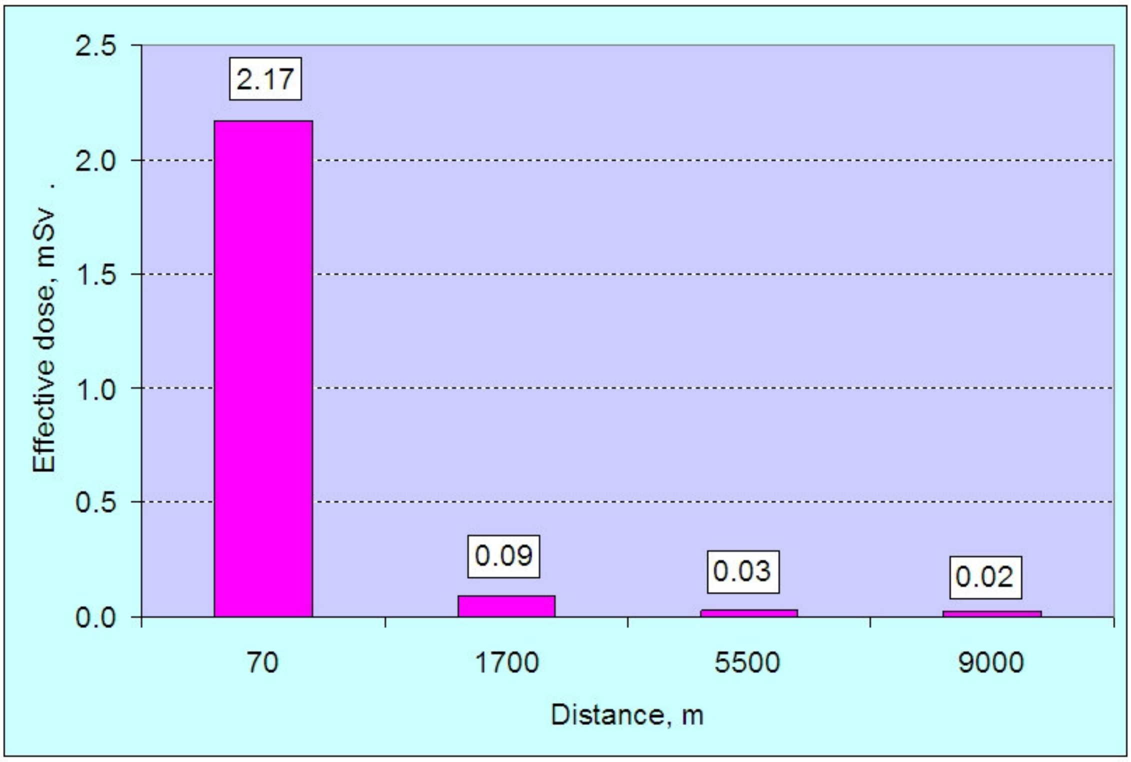


Figure 8.4 Dose to the member of population in case of airplane crash on LLW store's G3 waste section (beyond design basis accident)

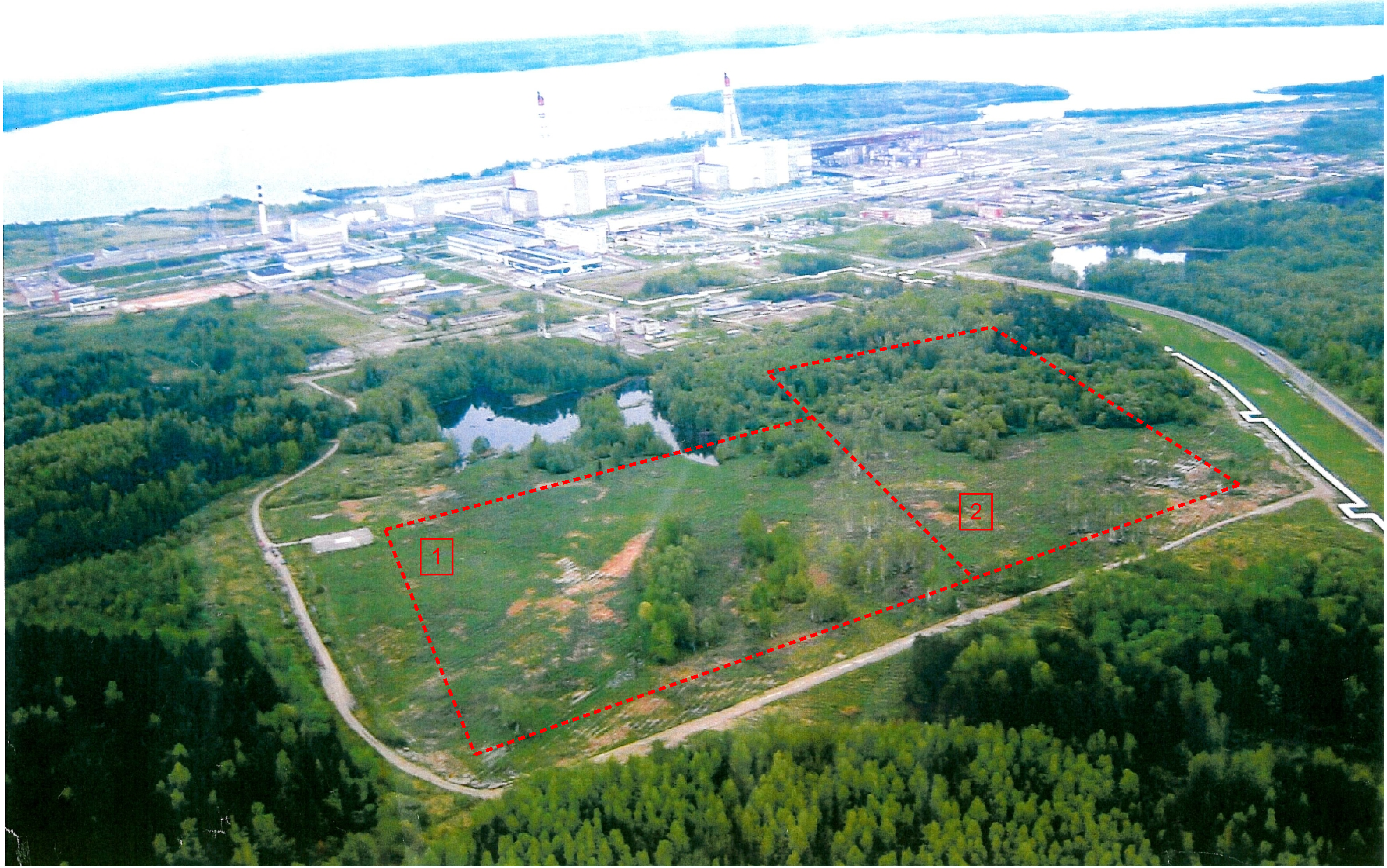
9 DESCRIPTION OF DIFFICULTIES

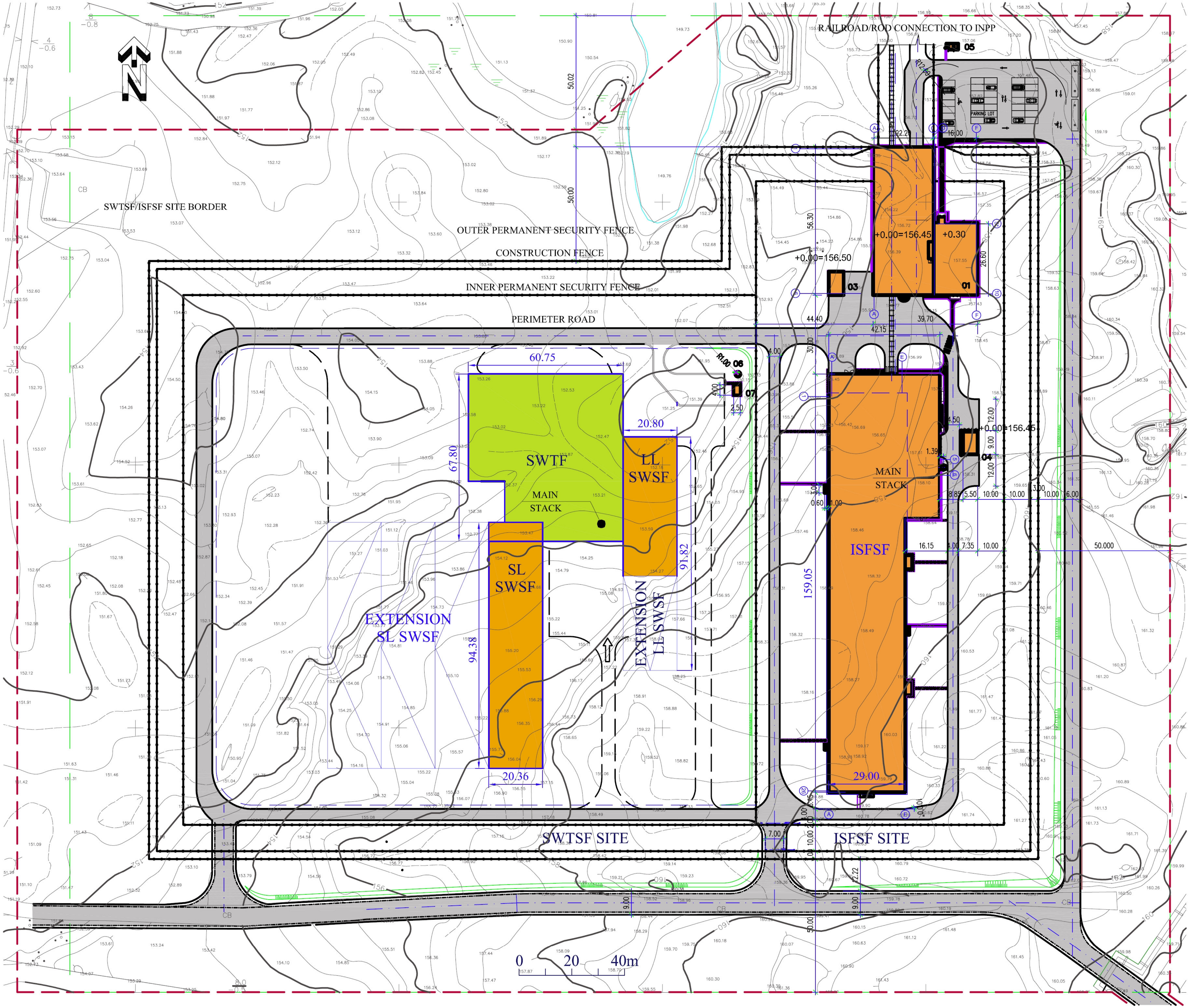
Description of difficulties (technical or practical) encountered by the developers while performing EIA and preparing the EIA Report will be presented. No difficulties are presently obvious.

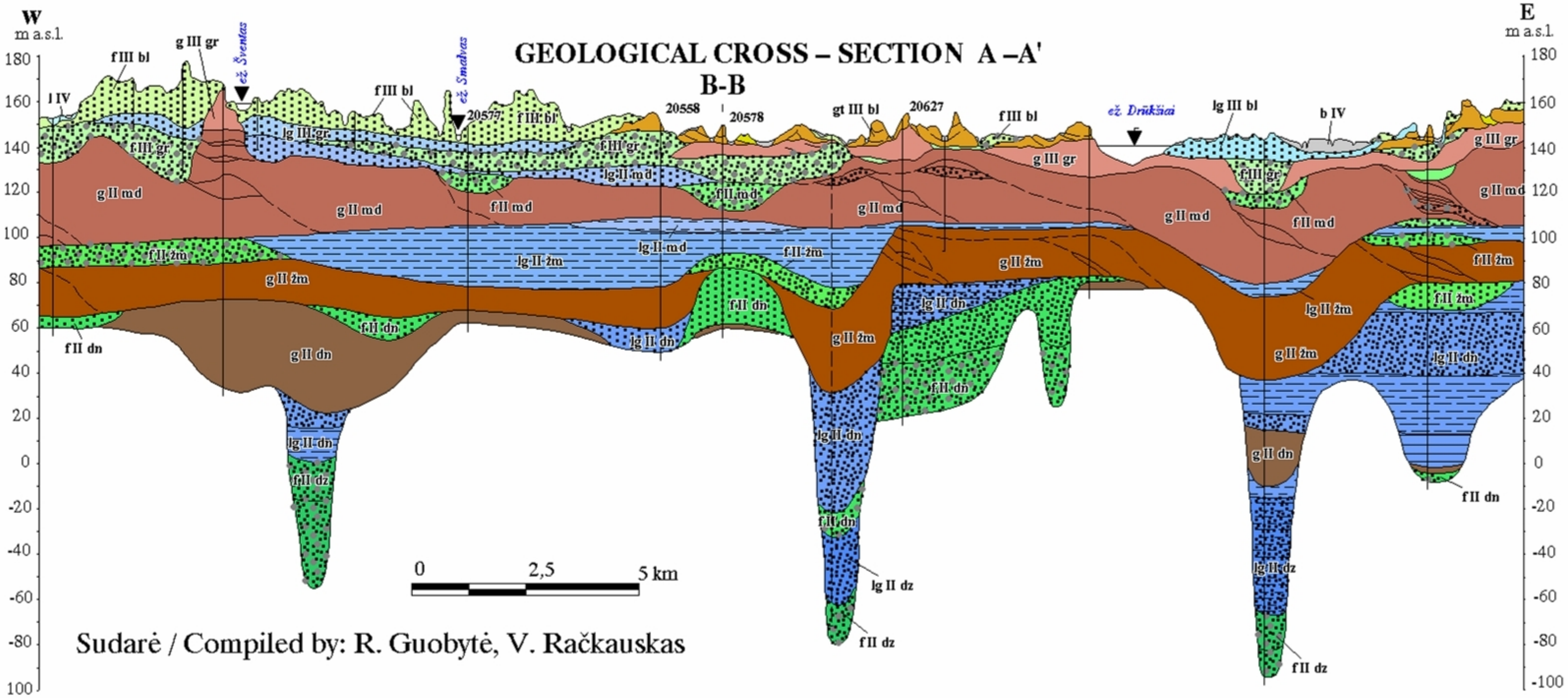
GRAPHIC MATERIALS

The following material is attached to this chapter of EIA Report:

- Panoramic photo of the proposed SWTSF and ISFSF sites, 1 page. Areas marked: 1 – proposed site for SWTSF, 2 – proposed site for ISFSF;
- Preliminary layout of SWTSF and ISFSF structures (buildings, internal roads, fences) at the SWTSF/ISFSF site;
- Quaternary geological cross-sections A-A’ and B-B’ of the INPP and SWMSF area. For location of cross-sections see chapter 4.4.9, Figure 4.16. Legend is presented in Figure 4.17.


1
2


RAILROAD/ROD CONNECTION TO INPP
SWTSF/ISFSF SITE BORDER
OUTER PERMANENT SECURITY FENCE
CONSTRUCTION FENCE
INNER PERMANENT SECURITY FENCE
PERIMETER ROAD
SWTF
MAIN STACK
LL SWSF
SL SWSF
EXTENSION SL SWSF
EXTENSION LL SWSF
ISFSF
MAIN STACK
+0.00=156.45
+0.30
+0.00=156.50
PARKING LOT
SWTSF SITE
ISFSF SITE
0 20 40m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B-B
W
E
m a.s.l.
ež. Šventas
ež. Smalvas
ež. Drūkšiai
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20558
20578
20627
l IV
f III bl
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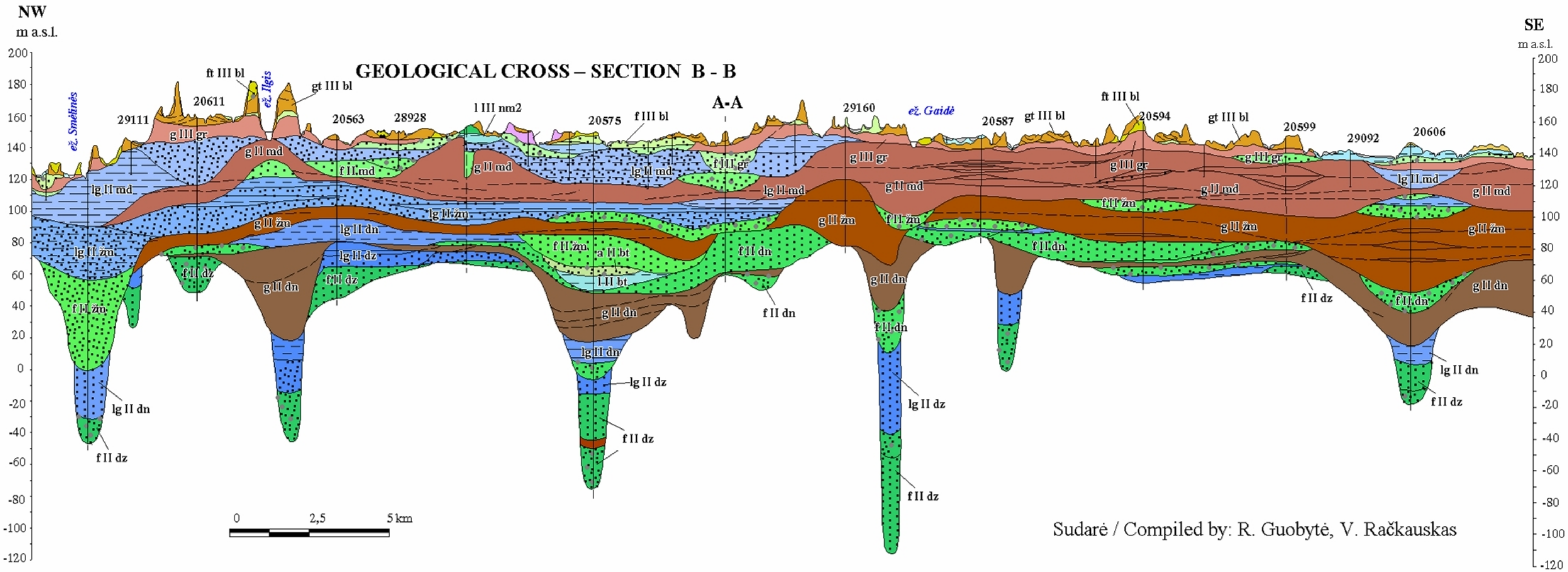
Sudarė / Compiled by: R. Guobytė, V. Račkauskas


GEOLOGICAL CROSS – SECTION B - B
A-A
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m a.s.l.
ež. Smėlinės
ež. Ilgis
ež. Gaidė
29111
20611
20563
28928
20575
29160
20587
20594
20599
29092
20606
ft III bl
gt III bl
f III bl
l III nm2
g III gr
f III gr
g II md
lg II md
f II md
lg II žu
g II žu
f II žu
a II bt
l II bt
f II dn
g II dn
lg II dn
lg II dz
f II dz
0
2,5
5 km
Sudarė / Compiled by: R. Guobytė, V. Račkauskas

CONCLUSIONS OF THE RELEVANT PARTIES

The prepared EIA report, issue date June 18, 2007, has been presented for the review to the subjects of EIA. The EIA report has been submitted to the following institutions of the Republic of Lithuania:

- Ministry of Health. The Ministry in the letter No. 10-4264 dated August 1, 2007, has presented 10 remarks;
- State Nuclear Power Safety Inspectorate (VATESI). The Inspectorate in the letter No. (12.5.17)-22.1-572 dated July 26, 2007, has presented 2 remarks;
- Department of Fire Protection and Rescue under the Ministry of Inner Affairs. No remarks to be considered have been received;
- Utena Regional Department of Cultural Heritage under the Ministry of Culture. No remarks to be considered have been received;
- Environment Protection Department of Utena Region. No remarks to be considered have been received;
- Visaginas Municipality Administration. No remarks to be considered have been received;
- Administration of the Utena District. No remarks to be considered have been received.

Answers to the remarks of the State Nuclear Power Safety Inspectorate (VATESI) are presented in the attachment 1.

Answers to the remarks of the Ministry of Health are presented in the attachment 2.

The EIA report has also been reviewed by the Technical Support Organizations (TSO) of the Radiation protection Center. The TSO have formulated 20 remarks to be considered. The Ministry of Health in the letter No. 10-6308 dated November 15, 2007, has provided TSO remarks and presented additional 3 remarks to be considered.

The answers to the remarks of the Technical Support Organizations are presented in the attachment 3.

The answers to the additional remarks of the Ministry of Health are presented in the attachment 4.

The presented answers have been evaluated by experts of VATESI, Radiation Protection Center, State Environment Health Center and Technical Support Organizations.

The VATESI in the letter No. (12.5.17)-22.1-896 dated November 23, 2007 stated that there are no additional remarks to the EIA report. It was recommended to correct expression used in the last paragraph of the chapter 1.8. The recommendation is accepted and the wording is updated.

The Ministry of Health in the letters No. 10-6875 dated December 11, 2007, and No. 10-7025 dated December 17, 2007, informed that there are no additional remarks to the EIA report. It is concluded that from radiation safety point of view the proposed economical activity is possible in the selected site.

The updated EIA report, issue date December 22, 2007, has been presented for review to the Ministry of Environment. The Ministry of Environment in the letter No. (1-15)-D8-5156 dated June 11, 2008 have presented 16 remarks to be considered.

Answers to the remarks of the Ministry of Environment is presented in the attachment 5.

The following documents are attached to this part of the English version of the EIA report:

- Attachment No. 1 for the chapter “Conclusions of the Relevant Parties”; Answers to the remarks of the Republic of Lithuania State Nuclear Power Safety Inspectorate (VATESI), 3 pages;
- Attachment No. 2 for the chapter “Conclusions of the Relevant Parties”; Answers to the remarks of the Republic of Lithuania Ministry of Health, 7 pages;
- Attachment No. 3 for the chapter “Conclusions of the Relevant Parties”; Answers to the Remarks of the Technical Support Organizations, 10 pages;
- Attachment No. 4 for the chapter “Conclusions of the Relevant Parties”; Answers to the remarks of the Republic of Lithuania Ministry of Health, 5 pages;
- Attachment No. 5 for the chapter “Conclusions of the Relevant Parties”; Answers to the remarks of the Republic of Lithuania Ministry of Environment, 15 pages.

NUKEM Technologies GmbH

Subcontractor
Lithuanian Energy Institute

Environmental Impact Assessment Report for New Solid Waste Management and Storage Facilities at Ignalina NPP

Attachment No. 1 for the chapter "Conclusions of the Relevant Parties"

Answers to the remarks of the Republic of Lithuania State Nuclear Power Safety Inspectorate (VATESI)

Prepared:	V. Ragaišis
Released:	P. Poškas
Issue date:	November 6, 2007
Number of pages	3

1 Introduction

This attachment to the EIA report includes answers to remarks and proposals for the EIA report "New Solid Waste Management and Storage Facilities at Ignalina NPP", as provided by the Republic of Lithuania State Nuclear Power Safety Inspectorate (VATESI) letter No. (12.5.17)-22.1-572 from July 26, 2007. Changes in the new revision (4) of EIA report are also indicated.

References to the EIA report used in this attachment (text location, literature) comply with the EIA report revision 3, issue date June 18, 2007.

2 Remarks and Answers

Remark 1

It is planned to install the New Solid Waste Management and Storage Facility in the Ignalina NPP sanitary protection zone. As we know, it is planned to install more nuclear objects in this zone – a repository for very low level radioactive waste, repository for low and intermediate level radioactive waste, new Interim Spent Nuclear Fuel Storage Facility, a possibility to construct a new nuclear power plant is also considered. Lithuanian Hygiene Standard HN 87:2002 "Radiation Protection in Nuclear Objects" (State News, 2003, No 15-624) determines the effective dose constraint to the population – 0.2 mSv during operation and decommissioning of nuclear power installations. The Regulation LAND 42-2001 "On the Restrictions on the Release of Radionuclides from Nuclear Installations and Procedure for the Authorization of Release of Radionuclides and Radiological Monitoring" (State News, 2001, No 13-415) establishes that in case when several nuclear installations from different subjects are close to each other, i.e. installations are located in the common sanitary protection zone, upon the agreement of the subjects, the dose constraints have to be distributed in-between subjects in such a way that the total sum of dose constraints would not exceed 0.2 mSv per year. The Ministry of Environment addressed the Ministry of Economy with the letter No (1-15)–D8-5401 from 2007-26-21 asking to obligate the Ignalina NPP to assess the above mentioned total annual effective dose following the recommendations as presented in the Ministry of Health letter No 10-2496 from 2007-05-09, and to present this assessment to the institutions involved. Both in this assessment and in the EIA Report for the New Solid Waste Management and Storage Facility at Ignalina NPP and also in other assessments for the new nuclear installations, it has to be clearly defined those existing and planned nuclear objects, the radiological impact of theirs to a specific critical group of the population has to be taken into consideration. The statement that the existing and planned nuclear power installations within the Ignalina NPP sanitary protection zone are considered in this Report is not justified, as in the assessment of the annual effective dose to a member of the critical group of the population at the site of the facility and in the planned sanitary protection zone, the only operation of the Interim Spent Nuclear Fuel Storage Facility and Cement Solidification Facility and operation, decommissioning of Ignalina NPP, unloading of fuel, and decontamination of RU1 and RU2 units are taken into consideration.

Answer

The EIA report chapter 4.9.2.2.4 "Summary of Radiological Impact and Compliance with Radiation Protection Requirements" is updated considering the remark.

The updated chapter is attached separately.

Remark 2

We also recommend avoiding such inaccuracies as nuclear power object, consisting of SWTSF and ISFSF sites (Chapter 1.8 "Connections to the existing infrastructure") and we suggest specifying the title of the new facility in this way: The New Solid Radioactive Waste Management and Storage Facility at Ignalina NPP.

<u>Answer</u>

Translation inaccuracy in Lithuanian version is corrected.

EIA report is updated as follows:

Text location	Chapter 1.8, last paragraph
Existing text	The joint SWTSF and ISFSF nuclear site will have site-common external infrastructure connection points.
Updated text	The SWTSF and ISFSF nuclear sites will have common external infrastructure connection points.

Concerning change of the title, it can be agreed that the title with additional keyword would better represent essence of the project. However it is proposed to keep up-till-now officially used title which also can be found in other project related documents like Technical Specification, EIA program etc.

NUKEM Technologies GmbH

Subcontractor
Lithuanian Energy Institute

Environmental Impact Assessment Report for New Solid Waste Management and Storage Facilities at Ignalina NPP

Attachment No. 2 for the chapter “Conclusions of the Relevant Parties”

Answers to the remarks of the Republic of Lithuania Ministry of Health

Prepared:	V. Ragaišis
Released:	P. Poškas
Issue date:	November 6, 2007
Number of pages	7

1 Introduction

This attachment to the EIA report includes answers to remarks and proposals for the EIA report "New Solid Waste Management and Storage Facilities at Ignalina NPP", as provided by the Republic of Lithuania Ministry of Health letter No. 10-4264 from August 1, 2007. Changes in the new revision (4) of EIA report are also indicated.

References to the EIA report used in this attachment (text location, literature) comply with the EIA report revision 3, issue date June 18, 2007.

2 Remarks and Answers

Remark 1

Subsection 3.3.2.3.5. It is not clear what does it mean „mažas lygis, kokį įmanoma ir yra tikslinga pasiekti ...

Answer

Translation mistake. Translation of chapter 3.3.2.3.5 into Lithuanian and Russian languages is revised and corrected.

Remark 2

Subsection 4.9.2.2. In the Environment Impact Assessment Program for Proposed economic activity "New Solid Waste Management and Storage Facilities for INPP" it was foreseen to investigate radiological impact on three critical groups of the population – farmers, fishermen and gardeners. However, the Report mostly discusses one critical group of the population, without clearly definition of it. Following the Lithuanian Hygiene Norm HN 73:2001, item 77.1, please explain more precisely how the critical groups of the population were identified, which members of the population were included, what kind of their activity was modified, doses to which members of the critical group are presented in the tables.

Answer

The EIA program, revision 3 indicates that radiation exposure of the critical group members of population in the environment of INPP resulting from the determined radioactive emissions into atmosphere will be calculated either using the dose conversion factors as recommended by the Lithuanian normative document LAND 42:2001 [63] or, if necessary, the recommendations of IAEA Safety Report Series No. 19 [64] will be applied. After performance of more detailed analysis of radioactive waste properties it was decided for EIA to use the radionuclides dispersion and environment impact assessment models as recommended by IAEA Safety report series No. 19. Therefore the final revision of EIA program has resigned to use LAND 42:2001 recommended conversion factors for assessment of dose to the critical groups - farmers, fishermen and gardeners resulting from release of radioactive material in the environment of INPP.

The LAND 42:2001 defines that the most negative impact due to airborne radioactive emissions in the environment of INPP is created to farmers. The most negative impact (from transuranic radionuclides) due to radioactive discharges into Lake Druksiai is created to fishermen and gardeners. In assessment of radiological impact due to radioactive emissions into atmosphere this EIA also considers "farmers" (i.e. inhabitants that live, produce and consume products in the environment of SWRF and SWTSF sites) as critical group of population. Additionally, dose calculations account for deposition of radioactivity into Lake Druksiai and human exposure due to consumption of local fish products. Effective doses are calculated for two age groups of critical group members – adults (age > 17 years) and infants (1-2 year). The description of the critical group - biosphere and lifestyle parameters used in calculations are summarized in Table 4.18.

It shall be noted that potential impact due to the airborne radioactive emissions is low and the direct irradiation is significant only close to the new nuclear facilities. These facilities will be constructed in the INPP existing sanitary protection zone where is no permanently living population. Therefore the impact is assessed considering hypothetical critical group (c.f. recommendations of the article 8 of LAND 42:2001) for which the impact in the environment of the SWRF and SWTSF sites would potentially be highest. The exposure doses are calculated for locations of the highest impact (i.e. where maximal near ground concentrations or maximal dose rates are expected) assuming maximal annual exposure duration (2000 h within the SPZ and 8760 outside the SAZ). The EIA approach in selection of critical group and estimation of potential impact shall be considered as conservative because the exposure of members of any realistic critical group will be lower.

EIA report is updated as follows:

Text location	A new paragraph is added before the last paragraph of chapter 4.9.2.2.1.1 "Method to assess radiological impact"
Existing text	
Updated text	These new SWRF and SWTSF will be constructed in the INPP existing sanitary protection zone where is no permanently living population. Therefore the impact to population is assessed considering hypothetical critical group (c.f. recommendations of the article 8 of LAND 42:2001 [63]) for which the impact in the surroundings of SWRF and SWTSF sites would potentially be highest. The exposure doses are calculated for the locations of the highest impact (i.e. where maximal near ground concentrations or maximal dose rates are expected) assuming maximal annual exposure duration (2000 h within the SPZ and 8760 outside the SAZ). The EIA approach in selection of critical group and estimation of potential impact shall be considered as conservative because exposure of members of any realistic critical group will be lower.

Remark 3

In the summary, and as well in Subsection 4.9.2.2, it is written, "the highest annual effective radiation dose to the critical member of the population is expected close to the SWTSF / ISFSF protective fence (eastwards) and is 0.190 mSv"; moreover, when transporting radioactive waste, population dose may exceed even 0.2 mSv. In this case, the issue becomes actual what is the expected error of the calculations assessing exposure of the population. In addition, in compliance with the Lithuanian Hygiene Standard HN 73:2001, Subsection 8.2, aiming at reducing the radiation of population due to direct exposure to as low as reasonably achievable (application of principle ALARA), but so that it would not exceed the limited dose, it is necessary to ensure the limited access to the hazardous locations by administrative and physical safety measures.

Answer

The calculations are performed basing on conservative approach and conservative parameters. Therefore the results of assessment shall be considered as conservative. The calculations using less conservative methodology and realistic parameters (also considering uncertainties of these parameters) would lead to lower exposure doses.

It shall be noted that the environment impact assessment of this EIA report does not have a goal to provide with calculations of actually expected doses. EIA is performed in advance to the Technical design and is based on conceptual solutions of the proposed economic activity. Therefore conservative assumptions are widely used to envelope uncertainties of parameters and design solutions. The EIA analyzes the concept of the proposed economical activity with the purpose to examine can the proposed economical activity by virtue of its nature and environmental impacts be carried out in the chosen site. Also the sources of potential impact on environment are identified and impact mitigation measures are also proposed where appropriate.

The calculation results show that the potential exposure due to radioactive airborne emissions is low. The conservatively calculated dose to the critical group member of population does not exceed 0.008 mSv (c.f. EIA report Tables 4.35 and 4.36). Calculated dose constitutes about 4% from the established dose constraint. Calculations with more precise parameters of potential impact sources and environment would refine the results of dose assessment, however due to low value of expected dose would not make any significant influence on the conclusions of the EIA.

The highest contribution to the impact will be stipulated by direct irradiation. As it is shown in the chapter 4.9.2.2.4.2 the highest annual dose to the population may be expected only in the close vicinity of the SWTSF / ISFSF permanent security fence. The dose to the member of population is governed by external exposure from the radioactive waste and spent nuclear fuel stored within the SWSF and ISFSF buildings. The dose is directly proportional to the exposure time. Calculations conservatively assume that the exposure duration of the member of population close to the security fence is not specially limited, and therefore the calculated annual effective dose due to the proposed economic activity equals to 0.18 mSv.

The EIA report also indicates that permanent activity of the population in the vicinity of the SWTSF / ISFSF permanent security fence is normally not expected. According to the requirements for physical protection of nuclear facilities, presence of the population in the vicinity of the SWTSF / ISFSF site must be controlled (and limited). Moreover, the calculations of the SWTSF and ISFSF radiation fields are based on conservative source terms and assume completely filled SWSF and ISFSF. Therefore, the actually expected population exposure will be lower than it is evaluated in this EIA Report.

Considering impact due to waste transfer, the EIA indicates that in the close vicinity to the planned waste transfer connection fence during the relatively short G3 waste retrieval and treatment phase the annual exposure of the member of the population may exceed the dose constraint. It is also indicated that these results are obtained assuming that the same member of the population will accompany all the waste transfers coming aside. While it cannot be reasonable expected that such situation might be relevant, the Technical design shall consider the results of the EIA and, if necessary, shall correct or supplement design solutions as to assure compliance of radiological impact with the requirements of radiation protection. The actual radiation protection means (administrative actions or / and technical solutions) shall be foreseen by the Technical design.

Remark 4

Subsection 4.9.2.2.4.1. Lithuanian regulations defines dose limits to the personnel and population, and dose constraint to the population, but do not define the average of annual doses to the members of critical group of population, as it may be understood reading the text, presented in this subsection. It is necessary to specify and correct the text of this subsection, and when establishing exposure of population, to follow the requirements of the regulations.

<u>Answer</u>

The indicated chapter presents requirements as they are formulated in article 9 of the LR normative document 42:2001 [63]. It can be agreed that the same requirements are better formulated in LR hygienic norms HN 73:2001 [107] and HN 87:2002 [75].

The EIA report chapter 4.9.2.2.4 “Summary of Radiological Impact and Compliance with Radiation Protection Requirements” is updated considering the remark.

The updated chapter is attached separately.

Remark 5

Subsection 4.9.3.2. The presented definitions of principle ALARA are not precise. We suggest using the definition as recommended by the first remark.

Answer

EIA report is updated as follows:

Text location	Chapter 4.9.3.2, next-to-last paragraph
Existing text	The application of the ALARA principle (dose constraint shall not be exceeded during normal operation and anticipated operational occurrences);
Updated text	The application of the ALARA principle;

Remark 6

Evaluating exposure of the population, we propose taking into consideration also the planned installation of the Near Surface Radioactive Waste Repository, as this repository is expected to be constructed in the Stabatiskes site, which is close to the planned Solid Waste Management and Storage Facility and will possibly belong to the INPP sanitary protection zone.

Answer

The EIA report chapter 4.9.2.2.4 “Summary of Radiological Impact and Compliance with Radiation Protection Requirements” is updated considering the remark.

The updated chapter is attached separately.

Remark 7

Chapter 8. Subchapter 8.2, p. 216, line 3 from the top. Dose limits to the population, determined in the Lithuanian Hygiene Standard HN 73:2001 (in Subsections B.2 and B.4 of the Appendix B) are not applicable for design basis accidents (Subsection 30.3 of the mentioned Hygiene Standard). For the design basis accidents, the probability of occurrence of which is from 10^{-2} to 10^{-4} per year, it is recommended (Safety Guide No NS–G-1.13, Radiation Protection Aspects of Design Nuclear Power Plants, 2005) to apply such dose limits, which would ensure that during design basis accidents there is no need for evacuation of the population (e.i. up to 50 mSv), and not 1 mSv, or 5 mSv, as it is written in the Report.

Answer

EIA report is updated as follows:

Text location	Chapter 8.2, end of second paragraph
Existing text	The dose limits for members of the public as defined in the Republic of Lithuania normative document [107], c.f. chapter 4.9.2.2.4.1, are used as the design criteria for limiting of exposure of the population under design basis accidents.
Updated text	The Lithuanian regulations in force do not define permissible dose limits for population in case of radiological accident. The Lithuanian hygienic norm HN 99:2000 [102] defines protective actions and levels of their applicability as to avert or reduce accident exposure. Sheltering as immediate protective action is applied when

	avertable dose is greater than 10 mSv. Evacuation as immediate protective action is applied when avertable dose is greater than 50 mSv. The temporary relocation of population is applied when avertable dose in 30 days is greater than 30 mSv. The relocation is terminated when avertable dose in 30 days becomes less than 10 mSv. Permanent resettlement of population is applied when avertable dose in lifetime is greater than 1000 mSv. The IAEA Safety Guide [103] specifies a design target for design basis accidents. It is required that there is only a minor radiological impact outside the site boundary or the exclusion area. Typically it corresponds to very restrictive dose levels so as to preclude the need for evacuation (corresponds to 50 mSv dose according to [102]). In this EIA the dose limits for the members of population as defined in the Lithuanian hygienic norm HN 73:2001 [107], c.f. chapter 4.9.2.2.4.1, are used as the design criteria for limiting of exposure of the population under design basis accidents. These dose limits normally are not applicable for accident exposure. Dose limits define levels of long-term and permanently acting irradiation, which does not cause negative health effects. Dose limits are significantly lower levels for application of protective actions [102] or internationally recommended radiation protection targets for design basis accidents. However, correspondence of accident dose to the dose limits demonstrates that accident exposure is low and will not cause negative health effects to the members of population.

Text location	The list of references is supplemented with new references
Existing text	
Updated text	102. Lithuanian Hygienic Norm HN 99:2000 "Protection of Population in Case of Nuclear Accident", State News, 2000, No 57-1691. 103. Radiation Protection Aspects of Design for Nuclear Power Plants. IAEA Safety Guide No. NS-G-1.13, IAEA, Vienna 2005.

Remark 8

Chapter 8. Most of the accidents presented in Table 8.1 (including radiologically hazardous accidents, that are likely to occur during transportation of the radioactive waste) are attributed to the class 3-4 of the accident probability classification (Pb), i.e. their probability is from 1 to 10^{-2} occurrences per year. According to recommendation of IAEA (SRS No 23, Accident Analysis for Nuclear Power Plants, 2002), these events are classified as expected operational occurrences and dose constrains, determined for normal operation conditions have to be applied to them (i.e. annual effective dose constraint to the population of 0.2 mSv, but not 1 mSv, as it is written in the Report).

Answer

When the risk of accident is high (i.e. accident probability (Pb) is high or serious accident consequences (Pr) are expected) the accident preventive measures are foreseen (c.f. column "Preventive measures" in Table 8.1) to reduce accident probability or expected consequences to the acceptable level. These measures shall be foreseen by Technical design and be considered by SAR. For example, during performance of G3 container transfer from RU3 down to the truck operation, an extreme weather conditions – strong wind can be expected. Strong wind can lead to swinging of container and collision against the wall accident. According to meteorological observations the probability of occurrence of such weather conditions in the region of INPP can be classified as very probable – occurrence is expected more than once per year (Pb = 5). Therefore preventive measures are foreseen to limit probability of accident – waste transfer operations shall not be performed under extreme weather conditions.

The probability of some of radiological accidents classified into class 3 cannot be essentially reduced without changing of design concept of this proposed economical activity. For example, the probability of G3 waste container drop from the crane is evaluated to be 0.31 for the whole G3 waste retrieval activity lifetime (c.f. Table 8.3). The probability corresponds to the accident frequency once per 16.1 years and is classified into class Pb = 3 (i.e., probable once in every 1 – 100 years). However the time to accident occurrence is beyond the operation time frame (5 years) and therefore the accident should not be classified as operational occurrence (expected during operation time frame) in accordance with indicated IAEA recommendation. As the accident probability is higher than 1% of operational time frame, the accident is classified as design basis accident.

Remark 9

We propose supplementing Table 8.1 (column "Consequences"), by indicating the possible impact to the population (presenting the values of potential exposure to the population) for every case of accident.

Answer

The table structure and the content of each column is defined the requirements of the normative document "Recommendations for the Assessment of the Potential Accident Risk of the Proposed Economic Activity R 41-02" [101]. Column "Consequences" shall qualitatively describe consequences of accident under consideration. The following three columns "Seriousness" quantitatively evaluate consequences to separate components of environment (i.e. consequences are classified according to significance of them).

The proposed information (for accidents which consequences are evaluated in chapter 8.2) might be provided in the column "Remarks". However presentation of information on accident expected doses without having regulatory approved accident dose limits and clear definition of meaning of them and may lead to misinterpretation of results. Therefore Table 8.1 includes only references to the appropriate chapters of EIA report where accident dose evaluation is presented and significance of impact on environment is discussed. Dose summary is also presented in Figures 8.2 and 8.3 for design and beyond design basis accidents correspondingly.

Remark 10

Subsection 4.9.2.2.4.3 "Summary radiological impact and conclusions" is written in a too formal manner, instead of summarized information, references to other chapters of the Report are presented. We recommend correcting this chapter, with the aim to make it more clear and accessible to readers and evaluators of the Report.

Answer

The EIA report chapter 4.9.2.2.4 "Summary of Radiological Impact and Compliance with Radiation Protection Requirements" is updated considering the remark.

The updated chapter is attached separately.

NUKEM Technologies GmbH

Subcontractor
Lithuanian Energy Institute

Environmental Impact Assessment Report for New Solid Waste Management and Storage Facilities at Ignalina NPP

Attachment No. 3 for the chapter "Conclusions of the Relevant Parties"

Answers to the Remarks of the Technical Support Organizations

Prepared:	V. Ragaišis
Released:	P. Poškas
Issue date:	November 22, 2007
Number of pages	10

1 Introduction

This attachment to the EIA report includes answers to remarks and proposals for the EIA report "New Solid Waste Management and Storage Facilities at Ignalina NPP", as provided by the Technical Support Organizations and presented in the Republic of Lithuania Ministry of Health letter No. 10-6308 from November 15, 2007. Changes in the new revision (4) of EIA report are also indicated.

References to the EIA report used in this attachment (text location, literature) comply with the EIA report revision 3, issue date June 18, 2007.

2 Remarks and Answers

Remark 1

3.1 Radiological safety Objectives: As already recommended in the review of the EIAP, it is suggested to report in the EIAP the design safety objectives of the facilities to be built (SWRF, SWTSF) in terms of radiological safety objectives. It means the clear indication of the established dose limits to workers and population in normal and accidents conditions. It is recommended to have these data clearly presented in a dedicated table. Some information are available but disseminated in the report. For instance at pag 129 (radiological impact) it is not indicated the dose constraint (public) for normal operation. At pag 195 (monitoring) it seems to be defined as 0,2 mSv/y.

<u>Answer</u>

The chapter 4.9.2.2.4 "Summary of Radiological Impact and Compliance with Radiation Protection Requirements" summarizes all assessed radiological impacts, considers their total effect and demonstrates the compliance of the radiological impact with the radiation protection requirements. Therefore the sub-chapter 4.9.2.2.4.1 "Radiation Protection Requirements" provides overview of radiological safety objectives. The chapter is revised and updated considering formulations as provided by LR hygienic norms HN 73:2001 and HN 87:2002.

EIA report is updated as follows:

Text location	Chapter 4.9.2.2.4.1 "Radiation Protection Requirements"
Existing text	The Republic of Lithuania normative document [107] defines dose limits for members of the public: • The limit of the effective dose – 1 mSv in a year; • In special circumstances the limit for the effective dose – 5 mSv in a year, provided that the average over five consecutive years does not exceed 1 mSv in a year; • The limit of the equivalent dose for the lens of the eye – 15 mSv in a year; • The limit of the equivalent dose for the skin – 50 mSv in a year. This limit has to be averaged over 1 cm^2 area of the skin subjected to maximal exposure. As members of the critical group can be irradiated by other controlled and non controlled (exempted) sources simultaneously, the Republic of Lithuania regulations [63], [75] require that the average annual effective dose to the critical group members due to the operation of the nuclear facility, including anticipated short-time operational increase, shall not exceed the dose constraint. The established dose constraint for nuclear facilities, both operating and planned, is 0.2 mSv/year. If

	several nuclear facilities are located in the same sanitary protection zone, the same dose constraint value shall envelope radiological impacts from all operating and planned nuclear facilities. During the calculation of the discharge limits it shall be taken into account the internal dose due to radionuclide intake by inhalation and ingestion as well as the external dose caused by airborne deposited radionuclides according to the methods presented in [63]. Different release routes (e.g. into the environment air and water) can lead to doses for the same or different critical group members. Therefore the dose constraint value used for each route should be one half of the actual dose constraint (i.e. 0.1 mSv per year).
Updated text	The Republic of Lithuania normative document [113] defines dose limits for members of the public: • The limit of the effective dose – 1 mSv in a year; • In special circumstances the limit for the effective dose – 5 mSv in a year, provided that the average over five consecutive years does not exceed 1 mSv in a year; • The limit of the equivalent dose for the lens of the eye – 15 mSv in a year; • The limit of the equivalent dose for the skin – 50 mSv in a year. This limit has to be averaged over 1 cm^2 area of the 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 [113]. The dose constraint for the members of the public due to operation and decommissioning of nuclear facilities is 0.2 mSv per year [76]. In the case when several nuclear facilities of different subjects are located in the same locality (they have common sanitary protection zone), under the agreement of the subjects the dose constraints shall be distributed among the subjects in such a way that their sum shall not exceed 0.2 mSv per year [64]. The Republic of Lithuania normative document [64] defines principle of radiation protection for other environment components: • Assessment of the impact to the environment should be based on the principle, according which protection measures ensuring an adequate safety for human are sufficient to protect both the environment and natural resources.

The occupational exposure is not addressed in this EIA report, c.f. discussion in the chapter 4.9.1 "General information". Therefore occupational radiological safety objectives are not provided in the EIA report.

The existing radiological safety requirements in case of accidents are described in the beginning of the chapter 8.2 "Assessment of Emergency Situations". The discussion on selection of radiological safety objectives is revised and updated.

EIA report is updated as follows:

Text location	Chapter 8.2 "Assessment of Emergency Situations", end of second paragraph
Existing text	The dose limits for members of the public as defined in the Republic of Lithuania normative document [107], c.f. chapter 4.9.2.2.4.1, are used as the design criteria for limiting of exposure of the population under design basis accidents.
Updated text	The Lithuanian regulations in force do not define permissible dose limits for population in case of radiological accident. The Lithuanian hygienic norm HN 99:2000 [102] defines protective actions and levels of their applicability as to avert or reduce accident exposure. Sheltering as immediate protective action is applied when

	avertable dose is greater than 10 mSv. Evacuation as immediate protective action is applied when avertable dose is greater than 50 mSv. The temporary relocation of population is applied when avertable dose in 30 days is greater than 30 mSv. The relocation is terminated when avertable dose in 30 days becomes less than 10 mSv. Permanent resettlement of population is applied when avertable dose in lifetime is greater than 1000 mSv. The IAEA Safety Guide [103] specifies a design target for design basis accidents. It is required that there is only a minor radiological impact outside the site boundary or the exclusion area. Typically it corresponds to very restrictive dose levels so as to preclude the need for evacuation (corresponds to 50 mSv dose according to [102]). In this EIA the dose limits for the members of population as defined in the Lithuanian hygienic norm HN 73:2001 [107], c.f. chapter 4.9.2.2.4.1, are used as the design criteria for limiting of exposure of the population under design basis accidents. These dose limits normally are not applicable for accident exposure. Dose limits define levels of long-term and permanently acting irradiation, which does not cause negative health effects. Dose limits are significantly lower levels for application of protective actions [102] or internationally recommended radiation protection targets for design basis accidents. However, correspondence of accident dose to the dose limits demonstrates that accident exposure is low and will not cause negative health effects to the members of population.

Remark 2

3.2 Dose calculation: The report contains data regarding results of doses calculation and reference, but does not give some relevant details (assumptions, applied formula, etc.) about the calculations. Maybe this will be part of the PSAR. It would be useful to have in an annex some information about.

<u>Answer</u>

The EIA report does not include detailed listings of calculations. The EIA report is a public document and the intentions are to have document of reasonable size. Also, a wide range of potential readers, which may not be only experts, has to be in mind. However the modeling approach and the main assumptions are described, parameters used in calculations are provided. The information is sufficient to reproduce the same or similar calculations. References to the detailed methodology descriptions or to the calculation reports are also provided.

Remark 3

3.3 Representative individual of the critical group of population: For dose calculation to the public the EIAR makes reference to the critical group members of population in a generic way, it is recommended to make reference to the representative individual of the critical group who, among the group, receives the higher dose. For instance in paragraph 4.9.2.2.1.1 (page 127) the calculated dose Hj should be referred to the most representative member of the critical group of population.

<u>Answer</u>

The EIA is based on the radionuclides dispersion and environment impact assessment models as recommended by IAEA Safety report series No. 19. Following recommendations the effective doses due to airborne releases are calculated for two age groups of critical group members, which receive the highest dose – adults (age > 17 years) and infants (1-2 year).

The impact resulting from direct irradiation is considered to be relevant to any member of population including any member of critical groups. Particular exposure conditions depend on situation and scenarios considered and are defined in appropriate chapters where dose calculation methodology is explained.

The new SWRF and SWTSF will be constructed in the INPP existing sanitary protection zone where is no permanently living population. Therefore the impact to population is assessed considering hypothetical critical group for which the impact in the surroundings of SWRF and SWTSF sites would potentially be highest. The impact calculation results are used for definition of the Sanitary Protection Zone for the SWMSF.

EIA report is updated as follows:

Text location	A new paragraph is added before the last paragraph of chapter 4.9.2.2.1.1 "Method to assess radiological impact"
Existing text	
Updated text	These new SWRF and SWTSF will be constructed in the INPP existing sanitary protection zone where is no permanently living population. Therefore the impact to population is assessed considering hypothetical critical group (c.f. recommendations of the article 8 of LAND 42:2001 [63]) for which the impact in the surroundings of SWRF and SWTSF sites would potentially be highest. The exposure doses are calculated for the locations of the highest impact (i.e. where maximal near ground concentrations or maximal dose rates are expected) assuming maximal annual exposure duration (2000 h within the SPZ and 8760 outside the SAZ). The EIA approach in selection of critical group and estimation of potential impact shall be considered as conservative because exposure of members of any realistic critical group will be lower.

Remark 4

3.4 Waste classification: Retrieved waste packages will be classified according the Lithuanian Waste classification into seven classes that including the exempt class, are ranked from "A" to "F" (see table 2.1 and table 2.2).

As this classification is based only on equivalent dose rate and surface contamination criteria, it is suitable for operational aspects. However this classification is not at all appropriate for disposal perspectives (see table 2.2) mainly because:

- Dose rate criterion is not at all representative for the radionuclide content in a waste package especially for the long-lived emitters (alpha or beta).

- A waste classification should include criterion on radionuclide concentration as indicated by IAEA (IAEA DS390 Classification of radioactive Waste).

References to radionuclide concentrations in a waste package exist but the associated values are quite high compared to the possible disposal options. Independently of the waste disposal option (very low-level waste or for low-level waste repository), it is stated that activity concentration of long-lived alpha emitting radionuclides should be less than 4000 Bq/g in individual waste package with condition on the overall average.

Lack of long-term safety criteria could lead in the future to conflict of waste classified according these rules with chosen waste disposal options. Such a conflict should be avoided.

It is strongly recommended classifying the waste package by defining long-term safety criteria complementary to the already adopted operational criteria.

Looking to very low-level disposal facility, EU TSO experts strongly recommended defining a much lower value than the 4000 Bq/g for the concentration activity of long-lived emitters.

Answer

The indicated Tables 2.1 and 2.2 are extractions from the regulatory documents. They are provided to illustrate the description of "old" and "new" waste classification systems as presented in the chapter 2.1.1 "Waste Classification and Segregation".

The requirements for the waste packages to be produced in the new SWTF are detailed in the Technical Specification for the SWMSF [8]. Contractor can state that the properties of the SWMSF produced waste packages will be in line with requirements of Technical Specification. Compliance shall be demonstrated in the Technical design.

The proposed economic activity produced radioactive releases are arising due to handling and treatment of waste that is sorted according to the "old" waste classification system. The impact from final packages is considered by shielding calculations. This EIA does not address impacts and safety of future repositories (landfill, near surface or deep geological repository etc.). Therefore requirements on long-term safety criteria or demonstration of compliance of these safety criteria with long-term safety objectives are not in the scope of this EIA.

Remark 5

3.5 High-level long-lived waste is not taken into account in the categorization of waste.

Some sentences could be added concerning the management of this type of waste (which probably is out of the scope of the described project).

Answer

The high level (i.e. generating significant quantities of heat) waste is not in the scope of the project. The spent nuclear fuel (including damaged fuel, fuel debris from the storage pools etc) is handled by another project of decommissioning of INPP.

Remark 6

3.6 §2.1.1 and Table 2.2 introduce a waste classification. This classification is specific to VATESI and is different from the IAEA classification of waste.

The upper level (0.5 mSv/h for surface dose rate) for very low level waste is rather high.

What are the upper limits for surface dose rate of waste in classes C and E?

Answer

The Tables 2.1 and 2.2 are extractions from the regulatory documents. They are provided to illustrate the description of "old" and "new" waste classification systems as presented in the chapter 2.1.1 "Waste Classification and Segregation".

There are no upper limits for surface dose rate of waste in classes C and E.

Remark 7

3.7 Scaling factors are given in table 2.7.

What are the uncertainties on the quoted values? Are uncertainties taken into account?

What are the results of the comparison between calculations and measurements?

Answer

The uncertainties of waste properties are discussed under chapter 2.1.4 "Waste Properties".

The EIA calculations are based on the best available waste data (directly measured where possible) and conservative release / exposure scenarios (assuming maximal design treatment capacity, maximally active waste group, no credits for radioactive decay, conservative exposure locations etc.).

Remark 8

3.8 Are all the waste packages containing class B or C short-lived waste put into waste containers?

The SL waste containers are individually shielded. What are the criteria for the surface dose rate of these containers containing class B or C waste?

Answer

The short lived low and intermediate waste (i.e. waste of the classes B and C) will be disposed of in the near surface repository. The SWTF will produce finally conditioned waste packages. LILW-SL containers may contain mixed waste of classes B and C. The waste tracking system will be used for optimization of efficient filling of LILW-SL containers.

The surface dose rate from the LILW-SL container shall not exceed 10 mSv/h.

Remark 9

3.9 What are the criteria for the shielding of the building designed for the storage of long-lived waste containers?

Answer

The overview of radiological safety objectives for population is provided under the chapter 4.9.2.2.4.1 "Radiation Protection Requirements", see answer to the remark 1. There are additional restrictions on dose rate fields inside the working premises and territory of nuclear object. These restrictions are necessary for assurance of occupational safety and shall be implemented by the SWMSF design. The occupational exposure is not addressed in this EIA report, c.f. discussion in the chapter 4.9.1 "General information". Therefore occupational radiological safety objectives are not provided in the EIA report.

Remark 10

3.10 The design of the buildings is out of the scope of the EIA report. It is supposed that protection of the workers against radiations and ALARA policy are treated in other documents. ?

Answer

Protection of the workers against radiations and ALARA policy is in the scope of the Technical design and Safety analysis report. These documents will also shall be reviewed and approved by competent authorities.

Remark 11

3.11 At page 67 are summarized the main aspects of the Radiological protection of the workers. It should give evidence also of the medical surveillance, which does not explicitly appears.

Answer

EIA report is updated as follows:

Text location	Chapter 3.3.2.3.5 "Radiation Protection", fourth bullet
Existing text	• Monitoring of individuals;
Updated text	• Monitoring of individuals and medical surveillance;

Remark 12

3.12 At page 80 is presented the code VARSA which uses the concept of Maximum Permissible Concentration (MPCs) which is quite old approach. Is there any reason why the approach based on 'limit on intake'' is not implemented?

Answer

The MPC approach is prescribed by LR hygienic norm HN 35:2002 "Limiting Values for Airborne Pollutants in the Living Environment". To demonstrate compliance with national regulation the potential ground level concentrations are calculated and compared against permissible values.

Remark 13

3.13 At pag 99 Table 4.16 The Licensed conditions do not envisage the emission in the into atmosphere of alfa emitting radionuclides or Iodio 129. But it is envisaged their monitoring at the stack.

Answer

The monitoring of SWMTF will be integrated into the INPP existing monitoring system. The INPP monitoring program and the existing licensed conditions shall be revised and updated.

Remark 14

3.14 In par 1.5 ''Production'' at pag.17 - RW production estimation is not according to the new classification system, it is recommended to show the processing rates also in accordance with the new classification system.

Answer

The Technical specification defines processing rates according to the INPP existing waste classification system. These processing rates shall be assured by design. The processing rates according to the new classification will depend on actual waste properties, which will be finally defined during operation of the SWMSF. See also answers to remarks 8 and 4.

Remark 15

3.15 Par.1.8 Connection to the existing structure - With reference to fig.1.4 pag.23 of [1] it is evident that RW and SF facilities will operate until 2066 that means for more than 30 y after the decommissioning of Unit 1 and 2 will be completed (2030), so it should be shown how the services provided to SWTSF are ensured from INPP infrastructure also after the end of decommissioning.

Answer

There will be more nuclear facilities in the INPP presently existing SPZ, which will operate after completion of decommissioning of power units 1 and 2. The overview is provided in the updated chapter 4.9.2.2.4.2 "Radiological Impact from other Existing and Planned Nuclear Facilities".

Provision of services, waste handling options in the period 2040–2070 and management of future arising SWSF / ISFSF decommissioning waste are not finally defined. Several options are possible. The SWMSF is a part of INPP decommissioning activities. The INPP final decommissioning plan is revised in each 5 years and shall be accordingly updated.

Remark 16

3.16 Par 2.1 Radioactive Waste - Table 2.5 List of radionuclide specific activities. According to the last international practice in RW disposal, the list seems not to be comprehensive: some radionuclide important for long term safety is missing (such as Cl-36). Since the RW will be transferred to a disposal facility, it is suggested that the list of radionuclides be complete (particularly for Long Lived Waste) by the time of storage or at least a program for the completion of the inventory should be provided.

Answer

The Table 2.5 provides waste inventory as it was registered by the existing INPP radioactive waste database. The list of radionuclides may not be comprehensive and some long-term safety radionuclides may be missing. The discussion on uncertainties in waste properties is presented in chapter 2.1.4 "Waste Properties". The proposed economic activity shall retrieve existing waste and sort, treat and condition according to its radiological content and physical properties. The comprehensive knowledge of radionuclide content in the waste is important and shall be assured by this proposed economical activity and by other projects of INPP decommissioning.

Remark 17

3.17 It is still not clear how a correct sorting and separation of the waste streams will be performed. In Par 2.1.5 it is mentioned a waste characterization system based on gamma emission (total or spectrometry?). How this complement the content of table 2.1 and 2.2 where it is shown that the criteria for classification is based only on dose rate. See also Comment above 3. 4.

Answer

The EIA provides just rough overview of planned waste characterization methods, which have to be developed and justified by Technical design. See also answer to remark 4.

EIA report is updated as follows:

Text location	Chapter 2.1.5 "Waste Assaying, Tracking and Activity Determination", fourth paragraph
Existing text	The waste characterization process will be made on the basis of gamma emission measurement.
Updated text	The waste characterization process will be made on the basis of gamma emission measurement (gamma spectrometry).

Remark 18

3.18 In Para 4.7 - Social and Economic Environment – the content does not give clear evidence of consideration of impact of RWTSF activity after the construction during the storage (50 y). It is *recommended to provide a description of the expected changes from end of construction during the commissioning and after up to the estimated life of 50 y.*

Answer

The EIA chapter 4.7 states that no impacts or evident changes of social and economical environment are foreseen which could be directly attributed to the implementation of proposed economic activity. Additional details on expected influence on social and economical factors can be found in Tables 4.50 and 4.51 of chapter 4.9.4 "Summary of Public Health".

From other hand the SWMSF is a part of the INPP decommissioning activities. The shut down and decommissioning of INPP will lead to changes in the existing social and economical environment of the region and the country. However consideration of integral impact is outside the scope of this report.

Remark 19

3.19 At pag.13 of the EIAR last sentences, it is affirmed that the operation of G3 transfer will last approximately 5 years and the annual exposure for the critical group close the fence could exceed the dose constraint. It would be appropriate to describe in this chapter 4 the impact of this operation and, eventually, the actions to be undertaken to mitigate that impact.

Answer

The indicated information is provided in chapter 4.9.2.2.2 "Radiological Impact due to Direct Irradiation Resulting from Radioactive Waste Transfer in-between INPP and SWTSF Sites". The actions to mitigate potential impact shall be specified by design. Examples of such actions might be:

- Use of additional shielding on transport platform;
- Reconsider design of G3 container shielding;
- Use administrative means to limit potential presence of population at the fence to less than 2000 hours per year;
- Establish temporary radiation protection fence;
- Etc.

Remark 20

3.20 Ch. 7 – Monitoring - Description of the monitoring seems to be fully described even if details on the environmental matrix used for the measurements beta and alfa emitters is not given.

Answer

The chapters 7.2 "INPP Current Environment Monitoring System" and 7.3 "Main Results of Radiation Monitoring in the INPP Region" are updated. A new Table 7.1 with description of radiological measurements performed according to the INPP current environment monitoring program is added.

Subcontractor
Lithuanian Energy Institute

Environmental Impact Assessment Report for New Solid Waste Management and Storage Facilities at Ignalina NPP

Attachment No. 4 for the chapter "Conclusions of the Relevant Parties"

Answers to the remarks of the Republic of Lithuania Ministry of Health

Prepared:	V. Ragaišis
Released:	P. Poškas
Issue date:	November 23, 2007
Number of pages	5

1 Introduction

This attachment to the EIA report includes answers to remarks and proposals for the EIA report "New Solid Waste Management and Storage Facilities at Ignalina NPP", as provided by the Republic of Lithuania Ministry of Health letter No. 10-6308 from November 15, 2007. Changes in the new revision (4) of EIA report are also indicated.

References to the EIA report used in this attachment (text location, literature) comply with the EIA report revision 3, issue date June 18, 2007.

2 Remarks and Answers

Remark 1

We would like to indicate that the Report considers requirements of the out of force (since July 1, 2007) Lithuanian Hygiene Standard HN 35:2002 "Limiting Values for Airborne Pollutants in the Living Environment" when forecasting the impact of the air pollution on the public health due to the proposed economic activity. We propose assessing values of pollutants in accordance with the Ordinance No. Dl-329/V-469 of the Minister of Environment of the Republic of Lithuania and the Minister of Health of the Republic of Lithuania "On Approval of the List of Pollutants, the Amounts of Which in Environment Air is Limited Pursuant to the Criteria of EU, and of the List of Pollutants, the Amounts of Which in Ambient Air is Limited According to the National Criteria, and of Limit Values of Environment Air Pollution" (State News 2007, No. 67-2627). When considering the impact of the air pollution we propose to distinguish separate pollution sources and pollutants.

Answer

The EIA report is prepared in accordance with regulations were in force at the time of report preparation. The considered revision 3 of the EIA report was issued on June 18, 2007.

Remark 2

The second paragraph of Section 4.9.2.1.2 "Noise" indicates that "the noise level … will be measured at locations in which such noise is perceived most clearly", however, forecasted noise levels are not provided. In the third paragraph it is indicated that "if an ambient noise at the SWTSF site reaches 85 dB (A) …, then the resulting noise at 2 km distance will be 20 dB (A)", but the methodology of estimation of noise decrease is not presented. In Table's 4.50 line 2.7 "Noise" in column "Possibilities to mitigate (eliminate) the negative impact" we propose to indicate additionally as follows: "the noise level will be measured; if the level is exceeded, the works will be stopped and means for noise reduction will be implemented". Sources of noise (e.g., high force compactor, equipment for waste sorting and size reduction) should be mentioned as well; they shall be indicated in column "Kind of activity or means, contamination sources" of Table 4.50.

Answer

The noise sources in the EIA are addressed in general way (i.e. SWMSF construction and operation). The indicated equipment (i.e. high force compactor, equipment for waste sorting and size reduction) will be installed in separate compartments (due to radiation protection reasons) and will be operated remotely. Operational practice (of INPP and Contractor) of similar radioactive waste treatment equipment shows that these installations are not exceptionally noisy. In addition, the equipment inside the SWTF will be shielded by the building structure.

EIA report is updated as follows:

Text location	Chapter 4.9.2.1.2 "Noise"
Existing text	The construction of the SWTSF will take approximately 2 years. Since construction machines operate intermittently and the types of machines in use at the construction site change with the phase of the project, the noise emitted during the construction will be highly variable. However, since the nearest residential properties are located at least 2 km away from the SWTSF site, it is estimated that construction noise will rarely exceed the existing levels. Consequently, the construction activities are expected to have minimal and temporary impacts on the noise environment in the communities south and west of the SWTSF site. Once operational the proposed SWTSF will produce no noise that will be perceptible at the nearest residential receptors. For example, if an ambient noise at the SWTSF site reaches 85 dB (A) (which is typical of an automobile passing at a few meters), then the resulting noise at 2 km distance will be 20 dB (A), which is a noise that cannot be distinguished from other ambient noises even in quiet places.
Updated text	The construction of the SWMSF will take approximately 2 years. Local noise increase might be expected during SWMSF construction works. Such impact, conventional for any construction activity, could be relevant only in close vicinity of SWTSF and SWRF sites where is no permanently living population. Since construction machines operate intermittently and the types of machines in use at the construction site change with the phase of the project, the noise emitted during the construction will be variable. However, since the nearest residential properties are located at least 2 km away from the SWTSF and SWRF sites, it is expected that construction noise will rarely exceed the existing levels. Account will be taken of the possibility of multiple noise sources emitting simultaneously. The noise level will be measured if such noise is perceived most clearly. If necessary, the works will be stopped and means for noise reduction will be implemented. Consequently, the construction activities will have minimal and temporary impacts on the noise environment at the locations of the nearest residential receptors. With termination of construction works the amount of potential noise impact sources will reduce. The construction machines will be removed from the sites, the transport of construction materials will be terminated. The radioactive waste management equipment will be installed in separate compartments (due to radiation protection reasons) and will be operated remotely. Premises of operators can be adequately isolated if necessary. Operational practice of similar radioactive waste treatment equipment shows that these installations are not exceptionally noisy. In addition, the equipment inside the SWMSF will be shielded by the building structure. Once operational the SWTSF will produce no noise that will be perceptible at the nearest residential receptors.

Text location	Table 4.50, line 2.7 "Noise", column "Possibilities to mitigate (eliminate) the negative impact
Existing text	The noisy activities will be carried out during daytime only.
Updated text	The noisy activities will be carried out during daytime only. The noise level will be measured; if the level is exceeded, the works will be stopped and means for noise reduction will be implemented.

Remark 3

According to Chapter IV of Regulations for Assessment of Impact on Public Health, approved by the Order No. V-491 of the Minister of Health of the Republic of Lithuania, dated July 1, 2004 (State News 2004, No. 106-3947), a compulsory part "Conclusions and Recommendations" is absent in the Report and according to Clause 16 information about the impact of the activity on the personnel's health is missing as well. The personnel's health is impacted not only by radiation, but by other factors as well; therefore a section "Analysis of the Plant's Personnel" should be included into the Report. This section should describe the planned number of personnel and working places, statistics on professional morbidity, forecasted factors of professional hazard: chemical, physical (noise, vibration, thermal environment, illumination, and industrial domestic conditions).

Answer

This EIA report is prepared in accordance with requirements of the Law on Assessment of the Impact on the Environment of the Planned Economical Activities and requirements of law supporting normative regulations. The structure and content of EIA report and its separate chapter 4.9 "Public Health" is prepared in accordance with requirements and recommendations of 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).

The approved EIA program indicates that assessment of impact on public health due to proposed economic activity will also consider requirements of Regulations for Assessment of Impact on Public Health. Therefore the EIA report includes separate chapter 4.9.4 "Summary of Public Health Assessment". This chapter summarizes information on factors and features influencing public health as it is foreseen by requirements of the Regulations for Assessment of Impact on Public Health.

According to the requirements of the Regulations for Assessment of Impact on Public Health the compulsory part "Conclusions and Recommendations" shall include information on information on alternatives planned, emissions control, monitoring, mitigation measures reducing impact on public health and substantiation of proposed measures, conclusions on public health assessment. All this information is included into the EIA report and is structured as defined by the approved EIA program. The analysis of alternatives is presented in chapter 6 "Analysis of Alternatives", the planned monitoring system is described in chapter 7 "Monitoring", public health impact mitigation measures are proposed in chapter 4.9.3 "Impact Mitigation Measures". The EIA report shows that impact on public health can be handled without violating of regulatory requirements in force and therefore the conclusion on possibility of proposed economical activity is made.

As it is indicated in the EIA program, the occupational exposure is not addressed in this EIA report. Practically proven and widely used radioactive waste management technologies will be implemented by the proposed economic activity. Operations, which presents direct hazard (like waste retrieval, sorting etc.) will be operated remotely. The personnel will stay in premises where radiological-safe working conditions are assured and therefore the limits for occupational exposure are not exceeded. Only exceptional cases (equipment failure, emergencies, maintenance etc.) will require human intervention. Such occupational exposure will depend on a variety of factors, which have to be adjusted during the Technical design (like equipment design and working place arrangements, organization of working activity, application of ALARA and implementation of mitigation measures, if necessary). In most of the cases applicable to this proposed economical activity the occupational exposure will depend on appropriate shielding design, exposure prevention and control measures. The existing INPP radioactive waste management practice (the same waste will be managed by the proposed economic activity) shows that the occupational exposure can be successfully handled within safe limits.

All these provisions are valid considering potential non-radiological impacts on personnel health. The Technical project design solutions shall implement requirements of regulations in force, which assure proper working conditions.

The actual working positions and requirements for the staff will be detailed during preparation of Technical and Detailed designs. It is planned that staff of the SWTSF will consist of about 60 persons and the staff SWRF will consist of about 30 persons.

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Environmental Impact Assessment Report for New Solid Waste Management and Storage Facilities at Ignalina NPP

Attachment No. 5 for the chapter "Conclusions of the Relevant Parties"

Answers to the remarks of the Republic of Lithuania Ministry of Environment

Prepared: V. Šimonis, J.E. Adomaitis, V. Ragaišis

Released: P. Poškas

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1 Introduction

This attachment to the EIA report includes answers to remarks and proposals for the EIA report “New Solid Waste Management and Storage Facilities at Ignalina NPP”, as provided by the Republic of Lithuania Ministry of Environment letter No. (1-15)-D8-5156 from June 11, 2008. Changes in the new revision (5) of EIA report are also indicated.

References to the EIA report used in this attachment (text location, literature) comply with the EIA report revision 4, issue date December 22, 2008.

2 Remarks and Answers

Remark 1

The terms used in the report subject to correction. Terms like „radioaktyviosios išlakos", „išmetos", „nuotekos", tričio nuotekos" according to LAND 42-2007, should be as follows: „radionuklidų išmetimai į aplinkos orą" ir „radionuklidų išmetimai į vandenį". Incorrect terms are used in Chapter 7 „radionuklidų savitasis aktyvumas ore", „radionuklidų savitasis aktyvumas krituliuose", „radionuklidų savitasis aktyvumas vandens terpėse", „radionuklidų savitasis aktyvumas stebėjimo gręžinių vandenyje" and etc. It should be noted that specific activity is a ratio of sample activity and its mass (unit Bq/kg), therefore, when discussing activity of radionuclide in a unit of volume, the term „turinis aktyvumas" should be used, or a more general term „koncentracija". The term „spinduliuotė" (pg. 211) should be substituted by the term „jonizuojanti spinduliuotė". The one of terms „mėginys" and „ėminys" should be selected used in the text (pg. 213).

Answer

The Lithuanian translation of the EIA report is reviewed, the indicated terms are corrected.

Remark 2

In the report Introduction (pg. 14), Chapter 4.2.3.1.2 “Non-radioactive Airborne Emissions from the Incineration Facility” (pg. 82), Chapter 5.2 “Potential Non-radiological Impact and Impact Mitigation Measures” (pg. 200), it is stated that after performing the assessment of dispersion of pollutants, released into the environment air during the proposed economic activity, concentrations of the pollutants will not exceed limits set by the Lithuanian Hygiene Norm HN 35:2002. Lithuanian Hygiene Norm HN 35:2007 “The highest permissible concentrations of chemical substances (pollutants) in the inhabited environment air” does not apply to the environment air. Standards of environment air contamination are regulated by the following regulations: Standards of environment air contamination, approved by the order No. 591/640 of the Minister of Environment of the Republic of Lithuania from December 11, 2001 (State News, 2001, No. 106-3827), by the order No. 471/582 of the Minister of Environment and Minister of Health Protection of the Republic of Lithuania from October 30, 2000 “On the list of pollutants, amount of which in the air is limited according to criteria of the European Union, and list of pollutants, amount of which in the air is limited according to the national criteria, and on approval of values of dose constraints for the environment air contamination” (State News, 2000, No. 100-3185; 2007, No. 67-2627), the order No. D-153/V-246 of the Minister of Environment and Minister of Health Protection of the Republic of Lithuania from April 3, 2006 “On approval of the reached valued of air contamination by arsenic, cadmium, nickel, and benzo(a)piren” (State News, 2006, No. 41-1486).

Answer

As indicated in the Republic of Lithuania Environment Impact Assessment Law (State News, 2005, No. 84-3105), EIA report is prepared according to the approved EIA program. The indicated Hygiene Norm HN 35:2002 was changed, and the indicated regulations came to force already after preparation of EIA report and having started the procedure of its coordination.

Remark 3

In chapter 2.4.3 “Incineration System” it is necessary to provide as much information as possible about the incineration facility: what kind of waste incineration technology will be employed, structure of the facility, characteristics (capacity and etc.) and other.

Answer

EIA report is updated as follows:

Text location	The description of the incineration facility is added at the end of the chapter 2.4.3. The figure 2.16 is also updated.
Existing text	The general concept of incineration system operation, required consumables and potential releases becomes evident from the block flow diagram given in Figure 2.16.
Updated text	The general concept of incineration system operation, required consumables and potential releases becomes evident from the block flow diagram given in Figure 2.16. The key points are described below. The solid waste for incineration is delivered to the reception box of incineration facility loaded into skeleton containers. The waste in the container is already pre-sorted, shredded and packed into plastic bags, each weighing approximately 5 kg. The bags are reloaded onto incinerator feeding conveyor of transfer box, transferred into the incinerator feed box and fall by gravity into the feed slide which will then be started, to automatically feed the incinerator. The feed slide is part of the safety lock between the incinerator atmosphere and the reception box atmosphere. Depending on the calorific value of the waste packages, the feeding into the incinerator has to be performed in time intervals of 2 to 4 minutes. The liquid combustible waste (spent oil etc.) can also be incinerated. The liquid waste for incineration is delivered into SWTF in 200 liter drums. The liquid waste at the SWTF is pumped into the receiving tank. Once the receiving tank is full, the radioactive liquid waste is transferred by the feed pump to the supporting burner of the incinerator where the waste is burned. The incineration of liquid waste occurs together with the incineration of solid waste. During this simultaneous incineration, the normal throughput of solid waste has to be reduced in the proportion with the heat throughput of the liquid waste. The average design capacity of incineration facility will be incineration of 100 kg/h of solid waste and 40 kg/h of liquid waste. The incinerator is of the shaft type, without any internals. Internal surface of the shaft is lined with multilayered refractory liner. The feeding of solid waste is performed from the top of the incinerator. The waste falls to the bottom. The bottom of the incinerator is equipped with a heat-resistant butterfly valve in order to discharge the ash. A fan supplies the incinerator with the necessary combustion air. The combustion air is filtered through a HEPA-filter (no shown in figure 2.16). This filter serves as a protection of the surroundings in case of a possible over-pressure condition in the incineration system. Incineration of the waste takes place in two zones; each supplied separately with combustion air. The solid waste is burned in the lower zone, just above the bottom of the incinerator and supported by a steam-air mixture. About one fourth of the total combustion air flow is used for the lower incineration zone. It is heated to 130°C in

	an electric heater and is mixed with steam before entering the incinerator. The steam flow is controlled in order to maintain an oxygen concentration of about 16 % in the steam-air mixture. An endothermic reaction between steam and carbon ensures an upper temperature limit of approximately 900°C in the burning material. As a consequence, the formation of slag is excluded and the settling of slag on the walls of the incinerator is avoided to a large extent. The rest of the combustion air flow is fed into the second zone directly above the burning zone of the solid waste. This air flow is calculated to provide an excess of oxygen to ensure complete combustion and is adjusted in order to reach an incineration temperature in the range of 1000°C and 1100°C. The flue-gas leaving the incinerator still contains combustible gaseous components and solid particles. These are combusted and destroyed in the upper section of the afterburner chamber (c.f. figure 2.16, post-combustion). The oxygen concentration in the upper section of the afterburner chamber is controlled and maintained to exceed 6 % by volume by additional compressed air as required. The fuel oil fired maintains the temperature in the afterburner chamber between 1100°C and 1150°C, This temperature range together with a residence time of the flue-gas in the afterburner zone of more than two seconds ensures the destruction of all of the organic compounds. The temperature of the flue-gas leaving the afterburner zone is lowered to 850°C by injection of process water into the lower section of the afterburner chamber. This treatment ensures that parts of the ash which might have been liquefied in the upper part of the chamber, will settle in the solid state on the bottom of the afterburner chamber. The NO_X reducing agent can be added to the process water if the NO_X concentration in the off-gas discharged into the stack reaches the upper permitted limit. The flue-gas contains hazardous constituents that have to be removed. Among them are HCl, HF, SO_2, NO_X, heavy metals and radionuclides. They will be eliminated in successive steps of flue-gas cleaning process. The hot flue-gas leaving the afterburner chamber is rapidly cooled down to 250°C in a static mixer. In this way the formation of dioxins and furans is excluded, as the temperature range between 250 to 450°C in which their formation occurs is passed rapidly. Further cooling is then performed in the reverse jet scrubbers I and II where cooled flue-gas is washed in two successive steps. In the scrubber I the flue-gas is washed to reduce the amount of hazardous constituents such as HCl and HF. The pH-value of the scrubbing solution is maintained between 0.5 and 1.5 by means of the addition of caustic soda. The flue-gas is then washed in the scrubber II to reduce the amount of hazardous constituents such as SO_2. The pH-value of the scrubbing solution is maintained between 7 and 9 by metering with caustic soda. This pH-range is selected as being the best for SO_2 absorption from the off-gas and simultaneously minimizing the absorption of CO_2. For both scrubbers, the scrubbing solutions are circulated in closed loops by means of special pumps. The spent scrubbing solution will be discharged in batches for further conditioning. The off-gas from the second reverse jet scrubber, already cleaned of most of the hazardous constituents, passes a particle-filter (HEPA-filter), where remaining small particles are retained. After the HEPA the off-gas has to pass the dioxin removal filter for the compliance of the emission limits for dioxins and furans. The dioxin removal filter is formed from an adsorptive material like activated charcoal. The negative pressure inside the incineration plant is maintained by two blowers. The main blower holds the negative pressure during normal operation. The smaller auxiliary blower is used during an interruption of the incineration process or in the stand-by mode at weekends when the gas flow rate in the system is low.

	The ash from the incinerator is removed once a day and the ash from the afterburner chamber once a week. The ash is discharged into 200 liter drums which afterwards are compacted by means of high force compactor, c.f. chapter 2.4.4. The monitoring of potentially hazardous chemical emissions is performed before discharging off the flue gas into the main stack. The radiological monitoring is performed in the main stack and considers radioactivity discharged from the whole SWTF.

Remark 4

Please explain, whether two collection subsystems of the liquid radioactive waste, generated in the controlled area, are described in the Chapter 2.4.7 "Liquid waste collection system" (p. 37). If so, it should be indicated, how the waste water from toilets in this area will be managed (in the report only shower waste water is addressed). The same is applicable to Chapter 3.2.2 "Radioactive Waste" (pg. 65) and Table 3.2 (pg. 70).

Answer

Yes, the chapter 2.4.7 "Liquid waste collection system" (pg. 37) describes two collection subsystems of the liquid radioactive waste, generated in the controlled area. It is not planned to equip toilets in this area. The toilets will be equipped in the supervised area, and management of the non-radioactive discharge is described in chapter 3.2.1.

Remark 5

In Chapter 3.1, when characterizing waste, generated during facility construction, and their planned management, it is necessary to follow the Construction waste management rules, approved by order No. Dl-637 of Minister of Environment from December 29, 2006 (State News, 2007, No. 10-403). This regulation should also be included in the list of regulations. It should be specified in detail which "necessary measures" are estimated to be taken in order to reduce the amount of waste generated during construction, what will contaminate soil during construction (Chapter 3.1, paragraph four), if it is known that during construction phase there will be contamination. Measurement units of the generated waste are not clearly indicated (Chapter 3.1 and 3.2.1). Amounts of generated waste should be measured in units of weight, not in number of containers.

Answer

EIA report is updated as follows:

Text location	Chapter 3.1, paragraph 3
Existing text	No toxic or chemically hazardous waste will be produced. The appropriate measures to minimize waste generation shall be implemented.
Updated text	No toxic or chemically hazardous waste will be produced. The following measures to minimize construction waste generation shall be implemented: materials that can be reused will be segregated and stored separately; biological waste will be collected into metal drums or cans; paper, cardboard, wood and similar waste may used for incineration in boiler-house, if it is determined as effective pricewise.

Text location	Chapter 3.1, paragraph 4
Existing text	The waste produced during construction of the SWMSF will be collected in on site holding tanks (for liquids) or containers (for solids) and will be transported off site for appropriate treatment and disposal. No direct discharge of untreated effluents will be allowed. The contractor is obliged to manage all waste material and contaminated

	ground generated during construction from the construction site and storage areas, and to provide any remediation work required to leave these areas in a neat and clean condition.
Updated text	The waste produced during construction of the SWMSF will be collected in on site holding tanks (for liquids) or containers (for solids) and will be transported off site for appropriate treatment and disposal, according to Construction Waste Management Regulations [24]. The contractor is obliged to manage all waste material from the construction site and storage areas, and to provide any remediation work required to leave these areas in a neat and clean condition.

Text location	New reference is added to the chapter "References"
Existing text	
Updated text	24. Construction Waste Management Regulations. Approved by Ordinance No. Dl-637 of Minister of Environment dated December 29, 2006. State News, 2007, No. 10-403.

Text location	Chapter 3.1, paragraph 5
Existing text	The estimated overall production quantity of solid construction waste during the construction phase of the SWMSF is as follows (waste classification according to the requirements of Regulation on Waste Management [24] is indicated in brackets): • Containers (20 m^3) with construction material (steel facades (non hazardous, code 17 04 02), insulation (non hazardous, code 17 06 02), brickwork (non hazardous, code 17 01 02), screed (non hazardous, code 17 02 01), sand (non hazardous, code 17 07 01), gravel (non hazardous, code 17 05 01) etc.): 60; • Containers (20 m^3) with packaging material (paper (non hazardous, code 20 01 01), wood (non hazardous, code 20 01 07), plastic foils (non hazardous, code 20 01 04) etc.): 30.
Updated text	The estimated overall production quantity of solid construction waste during the construction phase of the SWMSF is as follows (waste classification according to the requirements of Regulation on Waste Management [25] is indicated in brackets): • Construction waste: metal structures (non-hazardous, code 17 04 02) – 4000 kg, insulation (non-hazardous, code 17 01 02) – 1000 kg, brickwork (non-hazardous, code 17 01 02) – 2000 kg, screed (non-hazardous, code 17 02 01) – 2000 kg, sand (non-hazardous, code 17 07 01) – 1000 kg, gravel (non-hazardous, code 17 05 01) – 2000 kg and other construction waste, total about 15 tons; • Packaging material: paper and cardboard (non-hazardous, code 20 01 01) – 2000 kg, wood (non-hazardous, code 20 01 07) – 3000 kg, plastic foils (non-hazardous, code 20 01 04) – 500 kg and other packaging waste, total about 7 tons.

Text location	Chapter 3.2.1, paragraph 2
Existing text	• Containers (3 m^3) with mixed utility type waste (personnel protection means (non hazardous, code 15 02 01), paper and cardboard (non hazardous, code 15 01 01), textile (non hazardous, code 15 02 01), wood (non hazardous, code 15 01 03), plastic foils (non hazardous, code 15 01 02), tins (non hazardous, code 15 01 04) etc.): 60; • Containers (1 m^3) with organic kitchen-stuff for compost (non hazardous, code 20 02 01): 20.
Updated text	• Mixed utility type waste: personnel protection means (non hazardous, code 15 02 01) – 500 kg, paper and cardboard (non hazardous, code 15 01 01) – 2000 kg, textile (non hazardous, code 15 02 01) – 1000 kg, wood (non hazardous, code 15 01 03) –

	2000 kg, plastic foils (non hazardous, code 15 01 02) – 500 kg, tins (non hazardous, code 15 01 04) – 500 kg and other similar waste, in total about 7 tons; • Organic kitchen-stuff for compost (non hazardous, code 20 02 01) - about 10 tons.

Remark 6

The terms "buitinių nuotekų sistema", "sanitarinės-buitinės nuotekos" used in chapters 4.1.4 "Waste Water Management" (pg. 75), 4.1.5 "Potential Impact" (pg. 77), and 5.2 "Potential Non-radiological Impact and Impact Mitigation Measures" (pg. 199), should be corrected to be according to terms defined in the Waste Water Management Regulation, approved by the order No. D1-515 of Minister of Environment of the Republic of Lithuania from October 8, 2007 "On change of order No. D1-236 of Minister of Environment from May 17, 2006 "On Approval of Waste Water Management Regulation"." In chapter 7.3.4 "Radionuclides Discharges in the Aquatic Environment" (pg. 208) we suggest changing the term "silt of the purification facility" by "waste water silt," according to the requirements of the Waste Water Silt Usage for Fertilization and Re - cultivation Regulations LAND 20-2005 (State News, 2005, No. 142-5135).

Answer

The Lithuanian translation of the EIA report is reviewed, the indicated terms are corrected.

EIA report is updated as follows:

Text location	Chapter 4.1.4, paragraph 2
Existing text	The household waste water of the SWMSF will be discharged into the existing INPP sanitary-household waste water system from where it is pumped to the household waste water treatment plant outside the INPP territory.
Updated text	The household waste water of the SWMSF will be discharged into the INPP existing sanitary-household waste water system from where it is transferred into the State Enterprise "Visagino Energija" waste water treatment plant.

Text location	Chapter 4.1.5, paragraph 2
Existing text	The waste water will be released into the existing INPP waste water release system in a controlled manner and in accordance with the licensed conditions.
Updated text	The waste water will be released into the INPP existing waste water system in a controlled manner from where waste water is transferred into the centralized waste water system of State Enterprise "Visagino Energija".

Text location	Chapter 5.2, paragraph 4
Existing text	The household waste water of the SWMSF will be discharged into the existing INPP sanitary-household waste water system from where it is pumped to the household waste water treatment plant outside the INPP territory.
Updated text	The household waste water of the SWMSF will be discharged into the INPP existing sanitary-household waste water system from where it is transferred into the State Enterprise "Visagino Energija" waste water treatment plant.

Text location	Chapter 7.4.3, paragraph 1
Existing text	Alpha radionuclides are not found in the silt of the purification facility.
Updated text	Alpha radionuclides are not found in the silt of the waste water.

Text location	The reference [27] the chapter "References" is updated
Existing text	27. Regulation for Sewage Management. Approved by the Ordinance No. D1-236 of the Minister of Environment of the Republic of Lithuania dated May 17, 2006. State Journal, 2006, No. 59-2103.
Updated text	27. Regulation for Sewage Management. Approved by the Ordinance No. D1-515 of the Minister of Environment of the Republic of Lithuania dated October 8, 2007. State News, 2007, No. 110-4522.

Remark 7

Please note that references [27] and [28] are referring to no longer valid regulations – currently the Waste Water Management Regulation, approved by order No. Dl-515 of Minister of Environment of the Republic of Lithuania from October 8, 2007 "On changes of order No. D -236 of Minister of Environment of the Republic of Lithuania from May 17, 2006 "On Approval of Waste Water Managements Regulation" (State News, 2007, No. 42-1594) and Surface Waste Water Management Regulation, approved by order No. Dl-193 of Minister of Environment of the Republic of Lithuania from April 2, 2007 "On Approval of Surface Waste Water Management Regulation" (State News, 2007, No. 42-1594) are valid. Therefore, it is necessary to specify the information presented in Chapters 4.1.4, 5.2, 7.1.3, where there is a reference to the specific mentioned regulation paragraphs and List of References (pg. 290).

Answer

EIA report is updated as follows:

Text location	Chapter 4.1.4, paragraph 3
Existing text	According to clause 6 of [27], the discharge of sewage water into the environment may be performed only through a perfect discharger (e.g. accredited as perfect for use by order established in regulations, having the permission for sewerage water discharge etc.) and only then when the conditions for the sewerage water discharge are approved by competent authorities. The household waste water from the INPP is transferred to SE "Visagino energija" under the agreement.
Updated text	According to clause 6 of [27], the discharge of sewage water into the environment may be performed only through a discharger for installation of which a permission for construction is issued or a construction works project is coordinated by the order established in regulations, and only then when the order is established, the conditions for the sewerage water discharge are approved (the condition are established in the approved construction works project (according to which the permission for construction is issued) or in the permission for sewage water discharge).

Text location	Chapter 4.1.4, paragraph 4
Existing text	Surface drainage water will consist of the storm water collected from the non-controlled areas of the SWTSF site, ground run-off, the drainage from the building roofs, and other sources with no radioactive contamination. The storm water will be derived with external down pipes at the outer perimeter of the site, collected with underground sewers and connected to the new storm water drainage system. Radionuclides concentration in the storm drain water and in the groundwater of each new observation borehole, which will be installed around the sites of SWTSF and ISFSF (see chapter 7.4.5 "Groundwater Monitoring"), as well as the chemical content of storm drain water and groundwater will be monitored. After obtaining Permission on Integrated Prevention and Control of Pollution, issued for SWMSF,

	the INPP environmental monitoring program will be updated.
Updated text	Surface water will consist of the precipitation and irrigation water collected from supervised areas of SWTSF, water from drainage systems of building roofs and other sources, not contaminated by radionuclides. New SWTSF surface water drainage system will be connected to the INPP existing underground storm drain and sewage water system. Radionuclides concentration in the storm drain water and in the groundwater of new observation boreholes, which will be installed around the SWTSF and ISFSF sites (see chapter 7.4.5 "Groundwater Monitoring"), as well as the chemical content of storm drain water and groundwater will be monitored. The INPP environmental monitoring program will be updated before obtaining Permission on Integrated Prevention and Control of Pollution for the SWMSF.

Text location	Chapter 5.2, paragraph 3
Existing text	According to clause 6 of [27], the discharge of the sewage water into the environment may be performed only through the perfect discharger (e.g. accredited as perfect for use by the order established in the regulations, having the permission for sewerage water discharge etc.) and only then when the conditions for the sewerage water discharge are approved by competent authorities. The household waste water from the INPP is transferred to the state enterprise "Visagino energija" under the agreement.
Updated text	According to clause 6 of [27], the discharge of sewage water into the environment may be performed only through a discharger for installation of which a permission for construction is issued or a construction works project is coordinated by the order established in regulations, and only then when the order is established, the conditions for the sewerage water discharge are approved (the condition are established in the approved construction works project (according to which the permission for construction is issued) or in the permission for sewage water discharge).

Text location	Chapter 5.2, paragraph 5
Existing text	The surface drainage water will consist of the storm water collected from the non-controlled areas of the SWTSF site, ground run-off, drainage from building roofs, and other sources with no radioactive contamination. The storm water will be collected with underground sewers and connected to the new storm water drainage system. Radionuclides concentration in the storm drain water and in the groundwater of each new observation borehole, which will be installed around the sites of SWTSF and ISFSF (see Chapter 7.4.5 "Groundwater Monitoring"), as well as the chemical content of storm drain water and groundwater will be monitored. After obtaining Permission on Integrated Prevention and Control of Pollution, issued for SWMSF, the INPP environmental monitoring program will be updated.
Updated text	Surface water will consist of the precipitation and irrigation water collected from supervised areas of SWTSF, water from drainage systems of building roofs and other sources, not contaminated by radionuclides. New SWTSF surface water drainage system will be connected to the INPP existing underground storm drain and sewage water system. Radionuclides concentration in the storm drain water and in the groundwater of new observation boreholes, which will be installed around the SWTSF and ISFSF sites (see chapter 7.4.5 "Groundwater Monitoring"), as well as the chemical content of storm drain water and groundwater will be monitored. The INPP environmental monitoring program will be updated before obtaining Permission on Integrated Prevention and Control of Pollution for the SWMSF.

Text location	The reference [28] the chapter "References" is updated.

Existing text	28. Environmental Requirements for Management of Surface Drain Water. Approved by Ordinance No. 6871 of the Minister of Environment of the Republic of Lithuania dated December 24, 2003. State Journal, 2004, No. 10-289; 2005, No. 123-4400.
Updated text	28. Requirements for Management of Surface Drain Water. Approved by the Ordinance No. D1-193 of the Minister of Environment of the Republic of Lithuania dated April 2, 2007. State News, 2007, No. 42-1594.

Regulation [27] is updated under answer to remark 6.

Remark 8

The chapter 4.2.3.1 "Non-radioactive Airborne Emissions" (pg. 80.) indicates that dispersion of airborne pollutants is modeled according to average half hour values of the released pollutants. In Appendix 5 of the Waste Incineration Environment Protection Requirements (further – Incineration requirements), approved by order No. 699 of Minister of Environment of the Republic of Lithuania from December 31, 2002 (State Journal, 2003, No. 31-1290) also other average values of the released pollutant are established (e.g. average day values). In is not explained in the report, why dispersion of pollutants is modeled based only on the average half hour values of the released pollutants.

Table 4.4 of the report "Assumed peak amounts of discharged air pollutants calculated basing on emission limit values" (pg. 90) should be corrected presenting references, which s limited values of released pollutants are used for each type of released pollutants. The unit of volume of released gases is cubic meter under normal condition and is indicated as Nm^3.

Answer

Dispersion is modeled using the code VARSA, which is based on methodology according to the OND-86. This methodology evaluates point concentrations for averaging range of 20-30 minutes. Therefore, reliable results are received particularly for this averaging range.

Table 4.4 of the report is corrected and updated following the remark.

EIA report is updated as follows:

Text location	Chapter 4.2.3.1.2, paragraph 5
Existing text	The following effects are included into the model: initial plume / jet rise, complex terrain, building downwash, sedimentation of heavy particles.
Updated text	The following effects are included into the model: initial plume / jet rise, complex terrain, building downwash, sedimentation of heavy particles. The OND-86 methodology evaluates point concentrations for averaging range of 20-30 minutes. Therefore, in order to obtain reliable results, a 30 minutes averaging periods have been selected for the assessment.

Remark 9

In chapter 4.2.3.2.5 "Summary of Radioactive Annual Airborne Emissions" (pg. 86), it is incorrect to compare the estimated radioactive releases from SWMSF with limited activities defined in the INPP permission to release radionuclides into the environment. Many of radionuclides presently not defined by the valid permission will be released into the environment while implementing the proposed economic activity., Before issuing license for operation (for this and other proposed economic activities), the existing permission will have to be reviewed and updated, and in case of new radionuclides, the existing values of limited activities will have to be updated.

Answer

The comparison is presented only for illustrative purposes to assist the ordinary reader to understand the significance of the calculated releases. Such comparison does not excludes necessity for updating of current permission for release of radionuclides from INPP into the environment.

EIA report is updated as follows:

Text location	A new paragraph is added at the end of chapter 4.2.3.2.5
Existing text	
Updated text	Together it should be noted that implementation of the proposed economic activity foresee release of radionuclides which are not covered by conditions of the actual Permission [57]. Therefore, the Permission for the Releases of Radioactive Material into the Environment will have to be reviewed and updated before issuing operation license for the SWMSF.

Remark 10

In chapter 4.2.5 Table 4.16 presented limited activity of C-14 "2.77E+11 Bq/year" is incorrect, in the Appendix of the "Permission for Discharge of radioactive Material in to the Environment" issued on December 16, 200, limited activity of C-14 is – 2.27E+11 Bq/year. On the pg. 209, first paragraph, it is stated that "in 2004, $9.2x10^{11}$ Bq of tritium is released via channel into the Lake Druksiai." According to the information presented to us by INPP in 2004, releases of tritium into the Lake Druksiai were $7.5x10^{11}$ Bq.

<u>Answer</u>

The noticed inaccuracies in the EIA Report have been corrected.

Remark 11

In Chapter 4.3 "Soil," comparing with Environment Impact Assessment Program, there is practically no additional information about the potential impact on soil and impact mitigating measures. Paragraph five of this Chapter is not understandable – it is not clear, what sediments in the surface waste water from the construction site are addressed in this chapter. It is doubtful that "hay packages" or silt barriers are the best suitable technology for protection of erosion, and it is absolutely not clear how these measures will reduce "concentration of sediments in the surface waste water."

<u>Answer</u>

EIA report is updated as follows:

Text location	Chapter 4.3, paragraph 2
Existing text	The surface of the SWTSF site has been artificially changed in the past (during the construction of INPP) and later re-cultivated [40], [41].
Updated text	The surface of the SWTSF site has been artificially changed in the past (during the construction of INPP) and later re-cultivated. Construction site is thoroughly covered by mound soil: dusty sand, clay deposits of the low plasticity with organic admixture and locally encountered construction scrap. The thickness of mound is 0.3–3.2 m. Swamp sedimentation – well decomposed peat, clay deposits of the low plasticity with organic admixture, organogenic dust – are stratified on the shore-line of the swamp. The thickness of the layer is 0.8–5.9 m [40], [41].

Text location	Chapter 4.3, paragraph 5
Existing text	Site grading and materials stockpiling will be performed using techniques designed

	to minimize the potential erosion of the topsoil. If necessary, hay bales and/or silt fencing will be installed to minimize sediment loading in storm water runoff.
Updated text	Site grading and materials stockpiling will be performed using techniques designed to minimize the potential erosion of the topsoil.

Remark 12

Analysis of the alternative sites (Chapter 6.3) should be updated presenting information about other alternative sites analyzed and information how this particular site has been selected. It is not clear how special objects in the vicinity, such as Visaginas city waterworks etc., have been considered (chapter 6.3, last paragraph).

Answer

EIA report is updated as follows:

Text location	Chapter 6.3, two last paragraphs
Existing text	The site shall conform to geological suitability criteria. The SWTSF shall not be constructed above the identified tectonic faults zones. Due to geological consideration the present SWTSF site was selected to be more distant to the south of INPP in comparison with another alternative location closer to the INPP industrial area [30]. The selection of the SWTSF site nearby the existing spent fuel storage facility site was not possible due to geological considerations and area limitations. The presence of specific objects like Visaginas city waterworks nearby also has been considered [50].
Updated text	The selection of SWTSF and ISFSF sites was carried out in two stages. Initial screening of potential sites and their suitability evaluation were performed at first. The data of existing geological, hydrogeological and seismic investigations, accumulated in archives of INPP and Lithuanian Geological Service, were used. The purpose of investigations was to detail and evaluate characteristics of geological structure, hydrogeological conditions and geological processes relevant to the potential sites, to define categories of seismic stability of the soil layers and their parts at the territory of the sites, to clarify location of known tectonic fractures and distribution of the fractured zones. During the first stage of investigation, several potential sites have been analyzed in detail, c.f. Figure 6.1. The selection of the SWTSF site nearby the existing spent fuel storage facility site was not possible due to geological considerations and area limitations. The alternative site No.2, located close to the fence of the industrial INPP site was found to be located on the active linear neotectonic zone of sub-longitudinal orientation (c.f. chapter 4.4.5 “Neotectonics” and Figure 4.18) and also did not meet criteria for geological suitability. Therefore, taking into consideration conclusions of the geological analysis, a slightly to the south from the INPP located alternative site No.1 was selected for construction of the SWTSF. The selected site conforms to geological suitability criteria. The SWTSF will not be constructed above the identified tectonic faults zones. At the second stage, by methods of direct boring, geological sampling, underground water sampling and laboratory analysis, the suitability of selected site for the construction of seismically resistant nuclear object was confirmed [39], [40], [41]. The nearby presence of specific objects like Visaginas town waterworks also has been considered. For this purpose the study [50] was prepared by request of INPP, aiming to identify the compatibility of the sanitary protection zone of the waterworks of Visaginas town with the ISFSF and the SWTSF. The results of detailed investigations and modeling [50] have shown that the ISFSF and the SWTSF sites are outside the SPZ of the waterworks of Visaginas town (c.f. chapter 4.1.5).

Text location	A new Figure 6.1 is added to the chapter 6.
Existing text	
Updated text	Figure 6.1 Location of alternative sites for the SWTSF 1 –SWTSF alternative site No. 1 (selected for the construction of the SWTSF); 2 - SWTSF alternative site No. 2; A – Existing INPP SNF storage facility; B1 and B2 – alternative sites for the newly planned NPP; C – selected site for the planned short lived low and intermediate level radioactive waste near-surface disposal facility (Stabatiskes site); D - one of the proposed sites (southern) for the very low-level radioactive waste disposal facility (Landfill)

Text location	A new paragraph is added at the end of chapter 4.4.5.
Existing text	
Updated text	Tectonic scheme of the Ignalina NPP area is shown in the Figure 4.18.

Text location	A new Figure 4.18 is added to the chapter 4.4.9.
Existing text	
Updated text	Figure 4.18. Tectonic scheme of the Ignalina NPP area 1– Tectonic faults; 2– Neotectonic zones by morphometric analysis; 3– Neotectonic zones by morphostructural analysis [34]

Remark 13

It should be noted that in chapter 7 "Monitoring" (pg. 204) there is a reference to LAND 42-2001. The indicated documents is out of force (order No. D1-699 of the Minister of Environment from December 22, 2007), therefore, the chapter should be updated. It is proposed to update chapter 7.3 "Main Results of Radiation Monitoring in the INPP Region" with year 2007 data. That is important, because increase of airborne releases of certain radionuclides into the atmosphere was observed in this year. Average volumetric activity of tritium also increased in the monitoring boreholes; in 2007 it reached 6400 Bq/l, till 2006 it was 4100 Bq/1 (pg. 209). Moreover, in some places the results from observations in years 2004 and 2006 are provided, however results of year 2005 are missing (chapter 7.3.1, chapter 7.3.4, chapter 7.3.7, and chapter 7.3.8).

Answer

The EIA report is revised and updated considering changes in the new LAND 42-2007 and including newly available results of radiological monitoring in the INPP region for year 2007.

Remark 14

In Chapter 7.4.2 "Off-Gas Monitoring at the SWTSF" (pg. 212) for permanently monitored pollutants in off-gas content, the monitoring of the general organic coal is not indicated, it is not explained how the measurements of HF will be performed. In chapter 9 of the "Incineration Requirements", requirements for measurements of working parameters, heavy metals, dioxins and furans for incineration process are established. It is not specified in the report how these requirements will be fulfilled. We think that it is necessary that chapter 7.4,2 "Off-Gas Monitoring at the SWTSF" be updated according to requirements of "Incinerations Requirements".

Answer

EIA report is updated as follows:

Text location	Chapter 7.4.2.1, paragraph 1
Existing text	The emission of the contaminants CO, NO, SO_2 and HCl are monitored by means of sampling and analysis. The measurement locations for the determination of the contaminant concentration are the installation points of the sampling probes in the off-gas line. Sampling to determine the levels of chemical emissions and the reference parameter O_2 is done in a straight, horizontal section of the off-gas line close to the setup location of the analytical equipment in Room 24R014.
Updated text	Automatic measuring devices will be installed in the incineration facility and measurement methods will be selected in order to ensure monitoring of parameters, conditions and concentrations, expressed in units of mass, that are relevant for specific or general conditions of incineration process and that are necessary for control and performance of environmental monitoring. Monitoring of the incineration operational parameters, CO, NO_X, SO_2, general organic coal, HCl, HF and of general dust content will be performed on permanent basis by sampling and analysis as foreseen by waste incineration requirements [20]. Similarly, at least two measurements per year will be performed for heavy metals, dioxins and furans. During the first 12 months of the operation, these measures will be carried out at least once in three months. Measuring points, at which the concentration of pollutant is determined, are installation locations of sampling probes in the off-gas flow. Sampling to determine the levels of chemical emissions and the reference parameter O_2 is done in a straight, horizontal section of the off-gas line close to the setup location of the analytical equipment room.

Remark 15

It is proposed to change some places in the text: in chapter 7.4.2 (pg. 212) it is stated that “to show that gaseous releases to the environment are within permitted limits...,“ limited activity or permitted releases do not limit gaseous releases, but define limited activities of radionuclides in releases. It is not clear what does it mean “to control the quantity and radioactivity of radionuclides,” maybe it should be “to control content and activities of radionuclides.” To correct: 7.4.1.5 – by changing “activities of aerosols” by “activities of radionuclide in aerosols,” and “measuring the activity accumulated on a Filter” by “measuring the activity of radionuclides accumulated on a Filter;” 7.4.2 – in stead of “concentration of alpha- and beta-active aerosols, iodine and tritium” use “volumetric activities of alpha- and beta-active aerosols, iodine and tritium;” 7.4.2.4 – changing “alpha- and beta-aerosols” by “alpha- and beta- radiation in aerosols.”

<u>Answer</u>

EIA report is updated as follows:

Text location	Chapter 7.4.2, paragraph 1
Existing text	Off-gas monitoring is designed to measure and control the quantity and radioactivity of radionuclides in the exhaust air (including off-gas from the Incineration Process) during normal and abnormal operation and to show that gaseous releases to the environment are within permitted limits.
Updated text	Off-gas monitoring is designed to measure and control content and amounts of radionuclides and potentially hazardous chemical compounds in the exhaust air (including off-gas from the incineration process) during normal operation and abnormal conditions and to show that gaseous and aerosol releases to the environment are within permitted limits.

Text location	Chapter 7.4.1.5, paragraph 1
Existing text	Aerosol Monitors, both stationary and mobile, will be used to measure the radioactivity on the air bonded on aerosols. The Monitor will also enable the monitoring of average volume activities in the air by measuring the activity accumulated on a Filter.
Updated text	Aerosol monitors, both stationary and mobile, will be used to measure activities of radionuclides in the air bonded aerosols. The monitors will also enable the monitoring of average volumetric activity in the air by measuring activity of the radionuclides accumulated in a filter.

Text location	Chapter 7.4.2, last paragraph
Existing text	Determination of the concentration of alpha- and beta-active aerosols, iodine and tritium will be carried out continuously using tested and reliable detector arrays.
Updated text	Determination of volumetric activities of alpha- and beta-active aerosols, iodine and tritium will be carried out continuously using tested and reliable detector arrays.

Text location	Chapter 7.4.2.4
Existing text	This system uses an aerosol monitor for continuous monitoring of the off-gas for the detection of alpha- and beta-aerosols.
Updated text	This system uses an aerosol monitor for continuous monitoring of the off-gas for the detection of alpha and beta emitters in aerosols.

Remark 16

In chapter 7.6, in the last column of line 5 in Table 7.4 instead of words “chemical parameters” there should be “radiological parameters.”

Answer

EIA report is updated as follows:

Text location	Chapter 7.6, Table 7.4, column “Comments”
Existing text	It is taking into consideration that monitoring of chemical parameters (harmful substances) of the lake Druksiai, monitoring of the water quality of the lake Druksiai and monitoring of drainage to the lake Druksiai are already realized by INPP.
Updated text	It is taking into consideration that monitoring of radiological parameters of the lake Druksiai, monitoring of the water quality of the lake Druksiai and monitoring of discharges to the lake Druksiai are already realized by INPP.

PUBLIC INFORMING DOCUMENTS

The EIA report, issue date April 13, 2007, has been presented for the public consideration in accordance with requirements of the Law on the Environmental Impact Assessment of Planned Economic Activity [5] and of the Order on Informing the Public and the Public Participation in the Process of Environment Impact Assessment [120].

The public was informed about the issued EIA report and planned meeting with the public more than 10 working days before the meeting date. The announcements were placed in the national newspaper "Lietuvos rytas" (2007-05-16), Ignalina region newspaper "Nauja vaga" (2007-05-19), Zarasai region newspaper "Zarasų kraštas" (2007-05-22), Visaginas town newspaper "Sugardas" (2007-05-17). The announcement has been placed in the advertisement board of the municipality of the Visaginas town. Information on meeting location and scheduled time was placed in the official municipality web site (http://www.visaginal.lt). Hard copies of the EIA report for public review were available at the municipality of the Visaginas town and at the Ignalina NPP information center. The electronic version of the EIA report for free download was available on the Ignalina NPP internet web site (http://www.iae.lt). Public presentation and consideration of the EIA report took place in the premises of Visaginas town municipality on June 1, 2007, convenient for the public and during non working time. During the meeting the proposed economical activity was defined, the EIA report was described, EIA results and conclusions were announced, and answers to the questions of participants were provided.

The minutes of the meeting have been prepared and signed on June 4, 2007. No public comments or objections concerning the minutes of the meeting have been received.

Up to now no motivated proposals from the public for the proposed economic activity have been received.

The copies of published announcements and minutes of the public meeting are attached to the Lithuanian version of the EIA report.

Following the requirements of the ESPOO Convention [121], the Republic of Lithuania Ministry of Environment has informed respective institutions of the Republics Latvia and Belarus about the proposed economic activity and has presented the EIA report for their review.

On the request of the neighboring countries the meetings with the public of these countries have been organized. The public meeting in Republic of Latvia was held on March 13, 2008 in Daugavpils. The public meeting in Republic of Belarus was held on May 14, 2008 in Braslav. During the meetings the proposed economic activity was presented, the participants were introduced to the EIA report on the proposed economic activity, the raised question were answered.

Following to the public meetings, comments for the EIA report from the neighbouring countries have been received. The Republic of Latvia comments are included into the Republic of Lithuania Ministry of Environment letter No. (1-15)-D8-4154 from May 13, 2008. The Republic of Belarus comments are included into the Republic of Lithuania Ministry of Environment letter No. (1-15)-D8-4701 from May 28, 2008.

The answers to the comments of the Republic of Latvia for the EIA report are presented in the attachment 1. The answers to the comments of the Republic of Belarus for the EIA report are presented in the attachment 2.

The following documents are attached to this chapter of the English version of the EIA report:

- Attachment No. 1 for the chapter "Public informing documents". Answers to the Questions and Motivated Proposals of the Ministry of the Environment of the Republic of Latvia, 6 pages;

- Attachment No. 2 for the chapter “Public informing documents”. Answers to the Questions and Motivated Proposals of the Ministry of Natural Resources and Environment Protection of the Republic of Belarus, 7 pages.

NUKEM Technologies GmbH

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Environmental Impact Assessment Report for New Solid Waste Management and Storage Facilities at Ignalina NPP

Attachment No. 1 for the chapter "Public Informing Documents"

Answers to the Questions and Motivated Proposals of the Ministry of the Environment of the Republic of Latvia

Prepared:	V. Ragaišis
Released:	P. Poškas
Issue date:	May 16, 2008
Number of pages	6

1 Introduction

This attachment to the EIA report provides answers to the questions and motivated proposals for the EIA report "New Solid Waste Management and Storage Facilities at Ignalina NPP", as submitted by the Ministry of the Environment of the Republic of Latvia and provided in the Ministry of the Environment of the Republic of Lithuania letter No. (1-15)-D8-4154 from May 13, 2008. Changes in the new revision (5) of EIA report are also indicated.

The document presented by the Ministry of the Environment of the Republic of Latvia "Opinion about Results of an Environmental Impact Assessment Report of the New Solid Waste Management and Storage Facility at Ignalina NPP", No. 2.1-03/1810 from April 11, 2008, summarizes broad range of aspects raised by the Latvian institutions and the public during review of the EIA report. Beside the questions related to the EIA of the proposed economic activity, issues concerning implementation of this project and overall INPP decommissioning, improvement of organization in information exchange etc. are raised as well.

Some of issues raised extend outside the borders of the EIA procedure and the scope of this proposed economic activity and have to be managed on institutional or national levels. Therefore an attempt is made to select and respond to the questions that might be directly relevant to this EIA report.

References to the EIA report used in this attachment (text location, literature) comply with the EIA report revision 4, issue date December 22, 2007.

2 Remarks and Answers

Remark 1

It should be noted that the project authors shall check the technical information included in the report regarding to consumption of the planned resources (see page 19, table 1.2) otherwise one might arise a necessity to make an extra assessment on the use of the given amount of the hot water and its impact on the situation in this object.

<u>Answer</u>

Hot water will be used as a heat supply source for the SWTSF systems of building heating, ventilation, chilled water preparation etc. Hot water is supplied from a district hot water supply system and after use is returned back - the water at SWTF circulates through a closed heat exchanges where heat is taken from the hot water. The water is not discharged out of the district heat supply system.

Remark will be added to the Table 1.2, column "Source, remark" indicating that hot water will be used for heat supply.

Remark 2

During safety assessment for the New Solid Waste Management and Storage Facility, the seismic risks are not evaluated. The following additional questions must be discussed:

- *The seismic parameter of platform;*
- *Influence of seismic factors on the security of interim storages and radioactive wastes management objects (can be included as a separate scenario).*

Answer

The tectonic structure of the region and conditions of potential earthquakes are briefly described in chapters 4.4.4 – 4.4.6 of the EIA report. The risks arising from earthquakes are discussed in chapter 8.1 (c.f. Table 8.1) where conclusion is drawn that destruction of structures and lose of radioactivity confinement (in case of earthquake) may lead to serious or very serious consequences for life, environment and property. Therefore occurrence of such a situation shall be prevented by appropriate (respect to potential risks) design solutions which have to be in line with regulatory requirements on seismic-resistant nuclear installations. The EIAR does not further assume complete destruction of SWTSF and does not investigate potential consequences.

Two types of earthquake conditions will be considered by the design of the SWMSF – the so named "design basis earthquake" (DBE) and "ultimate design basis earthquake" (UDBE).

The DBE is defined as earthquake of maximal expected intensity with recurrence once in 100 years. The UDBE is defined as earthquake of maximal expected intensity with recurrence once in 10 000 years. The UDBE is more severe than DBE.

The terms DBE and UDBE originate from the nuclear safety standards of former Soviet Union and were used for designing of Ignalina NPP seismic-resistant structures, systems and components (SSC). The concept of DBE and UDBE is used in the updated nuclear safety standards of Russian Federation.

The parameters of DBE and UDBE for the INPP area are established on basis of extensive geological, geophysical, seismological and geotechnical investigations performed in the region for more than several decades. The INPP region local specific, regional aspects as well as historical context are also taken into account. The parameters for DBE and UDBE were revised by the Lithuanian Geological Survey and are included into Technical Specification [8] which defines the design requirements for the SWMSF. As indicated in chapter 4.4.6 of EIA report, the DBE for Ignalina NPP area is defined as grade 6 (according MSK-64 scale) earthquake with maximal ground acceleration of 0.05 g. The UDBE for Ignalina NPP area is defined as grade 7 (according MSK-64 scale) earthquake with maximal ground acceleration of 0.1 g.

To consider local specific of the SWTSF site a special geotechnical investigations (using boreholes etc.) have been performed in the course of development of the basic design. Basing on these investigations a soil improvement measures by introducing vibration-piling system is proposed. The vibration-piling system will adapt to the different soil conditions by varying the pile-length. The gravel layer between the pile-head and the floor-slab reduces horizontal shear loads in case of seismic events to a minimum. The envisaged foundation system evidences a high resistance towards liquefaction effects in case of earthquakes. The assembly of these basic measures assures a high dynamic rigidity of the building structures.

Recently, a new regulation on analysis of seismic impact for nuclear objects has been introduced in the Lithuania. The new regulation is based on IAEA recommendations and defines two design levels for potential earthquakes – the seismic level 1 (SL-1) and seismic level 2 (SL-2). In the new regulation the DBE corresponds to the SL-1 and UDBA corresponds to SL-2.

According to requirements of nuclear safety, the structures, systems and components of SWMSF will be classified on the basis of their safety significance and will be designed, manufactured and installed to a level quality commensurate with that classification. Consideration of the seismic risk is prescribed by safety standards. The safety classification will be developed during preparation of basic design and will be justified in the safety analysis report (SAR).

It can be expected that at least the following systems of normal operation will be classified as important to safety:

- Power supply system;

- Fire protection system;
- Nuclear ventilation system;
- Radiological monitoring system;
- Waste handling (internal transportation) system.

The safety SSC will be designed to retain their serviceability after seismic load of DBE. The building structure of SWTSF will be designed with sufficient strength margin for seismic load of UDBE. Seismic stability and safety of radiation protection barriers will be assured to be in line with requirements of nuclear safety regulations in force and internationally recognized recommendations of IAEA.

Application of the seismic requirements for the facility structures, systems and components shall be demonstrated in the basic design documentation. The seismic risk in more details will be addressed in the SAR which evaluates and justifies safety of basic design solutions.

The text in chapter 4.4.6 of EIA report with description of DBE and UDBE parameters will be updated.

Remark 3

The description of the proposed interim storage radiation monitoring system is too general, which hinders to evaluate the efficiency of the system. The answers on following questions are necessary:

- *How the control of emissions in environment will be organized?*
- *In which way and how quickly the Latvian side will be informed on emission in environment?*

These two questions are essential for the Latvian side for adequate reaction in case of pollution of the environment with radionuclides.

<u>Answer</u>

The EIA report describes concept of radiation monitoring system which has to be developed during preparation of the basic design. Therefore analysis of efficiency of actual design solutions is not possible at the stage of development of the EIA report.

The organization of monitoring and control of emissions is in the responsibility of operator. The emission of radionuclides into environment is permitted only after obtaining of permission for radioactive emissions. The permission is issued by Ministry of Environment.

The subjects who are willing to obtain such permission shall have to submit the Ministry of Environment an application for permit, the plan of radioactive emissions and the program of radiological monitoring. The program of radiological monitoring shall be coordinated with Agency of Environment protection, Lithuanian Hydrometeorological Service and Radiation Protection Center.

Among others, the program of radiological monitoring shall include information on the frequency of the sampling and analyses, list of procedures and methods for activity measurements, indication of detection limits, procedures for calibration and quality assurance, procedures for data collection and storage, models to be used for dose assessment, order of monitoring report presentation etc.

The actual regulatory requirements on radiological monitoring are presented in Lithuanian normative document LAND 42-2007 [64] and other relevant normative documents. The design of SWMSF shall be in line with Lithuanian statutory requirements.

The performance of radiological monitoring is controlled by Agency of Environment protection and other state institutions in accordance with subject of their competence.

Organization of information exchange with neighboring countries shall be discussed and organized on governmental level.

In case of emergency, the VATESI is collecting information about situation in the NPP. VATESI ensures a 24 hours connection with emergency preparedness institutions of Republic of Lithuania and international organizations. VATESI specialists are ready to receive and provide information about nuclear and radiological accidents or incidents in Lithuania and other countries 24 hours per day. After receiving notification concerning nuclear accident VATESI emergency response centre begins its operation, but not later than after 1 hour. Among others, VATESI responsibilities in a case of nuclear or radiological emergencies are fallowing:

- Analyzing and forecasting the development of the situation and predicting possible emissions and pathways of radioactive materials;
- Providing information and advice to the Government, Fire and Rescue Department, Ministry of Environment and Radiation Protection Centre;
- Providing information and consulting Emergency commission;
- Providing information to the mass-media and public about the situation in the NPP;
- Notifying European commission, IAEA, neighboring countries in accordance with the Convention on early notification and bilateral agreements.

Remark 4

The radiation risks minimization program based on ALARA principles is not included in the report. This question is very important for Latvia side, taking into account the large number of infrastructure objects at the territory of Ignalina NPP and plans for construction of new NPP.

Answer

The EIA report includes proposals on impact mitigation measures (c.f. chapters 4.2.4.2, 4.9.3.2) and application of ALARA principle while concrete design solutions could be implemented are not discussed. Therefore a special attention shall be paid to the application of ALARA principles during the design phase. In this approach the designer shall evaluate and provide for the SWMSF project the best industry practices and its own experience.

At the present stage of design development the following measures for ALARA implementation are considered by design:

- Source reduction (e.g. by decontamination, material selection, air filtration, purification, respective controls, etc.);
- Improvement of shielding - increase of distance between worker and source (i.e. remote handling);
- Reduction of occupancy time in radiation fields by:
  - specifying high standards of equipment to ensure very low failure rates;
  - ensuring ease of maintenance or removal of equipment;
  - introducing simplifications in operational procedures (i.e. built-in auxiliary equipment (e.g. redundant drives));
  - ensuring ease of access and good lighting.

The planned measures will also reduce impact on environment outside the boundaries of SWMSF structures.

Respect to radiological impact on neighboring countries, the EIA report (c.f. chapter 5.1) assessment results demonstrate that starting from a distance of 500 m and more from the permanent security fence of the SWTSF site the radiological impact can be considered as insignificant. The state border of the Republic of Latvia is considerably further. Waste retrieval activities at the SWRF site will not change the existing impact resulting from the present day operation of INPP. Finally it leads to a reduction of the radiation level due to the continuous reduction of the waste volume and the activity stored in the existing waste storage facilities. Therefore no relevant radiological impact can be expected to members of the population of the neighboring country.

Also see answer to the next remark.

Remark 5

Other project related to the decommissioning of the Ignalina NPP and the construction of the new NPP have to be identified and evaluated to ensure precise evaluation of total possible impacts and risks, excluding "salami slicing".

Answer

The identification of other existing and planned nuclear activities in the INPP region and evaluation or discussion of their impacts on environment is presented in chapter 4.9.2.2.4.2 of the EIA report. Evaluated total impact due to the proposed economic activity also considers impacts (as known per today) from other existing and planned nuclear facilities, c.f. chapter 4.9.2.2.4.3.

However not all impacts from the certain future planned nuclear facilities are known for today. The construction of SWMSF is one of separate Ignalina NPP decommissioning projects. According to the INPP Final Decommissioning Plan [77] the 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 [78] provides to develop EIA reports separately for each DP. Every EIA report of a subsequent DP shall take into account results of previous reports. The planned design solutions shall be adjusted correspondingly. 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.

Environmental impact assessment for the new nuclear power plant has not been performed yet and the results of environmental impact assessment are not available at present. The design and environmental impact assessment of the newly planned NPP shall consider the potential environmental impacts from the INPP decommissioning activities and to adjust planned design solutions correspondingly.

According to the radiation protection requirements in force, the design, operation and decommissioning of nuclear objects 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 (which is set to 0.2 mSv per year). If several nuclear facilities contribute to radiological impact, the same dose constraint value shall not be exceeded. Therefore consideration and limitation of overall radiological impact from all potentially relevant nuclear facilities are foreseen by the radiation protection requirements in force and have to be taken into account.

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Environmental Impact Assessment Report for New Solid Waste Management and Storage Facilities at Ignalina NPP

Attachment No. 2 for the chapter "Public Informing Documents"

Answers to the Questions and Motivated Proposals of the Ministry of Natural Resources and Environment Protection of the Republic of Belarus

Prepared:	V. Ragaišis
Released:	P. Poškas
Issue date:	June 2, 2008
Number of pages	7

1 Introduction

This attachment to the EIA report provides answers to the questions and motivated proposals for the EIA report "New Solid Waste Management and Storage Facilities at Ignalina NPP", as submitted by the Ministry of Natural Resources and Environment Protection of the Republic of Belarus and provided in the Ministry of the Environment of the Republic of Lithuania letter No. (1-15)-D8-4701 from May 28, 2008. Changes in the new revision (5) of EIA report are also indicated.

References to the EIA report used in this attachment (text location, literature) comply with the EIA report revision 4, issue date December 22, 2007.

2 Remarks and Answers

Remark 1

The storage of class A (very low level) waste is foreseen in a Landfill type disposal facility. The quantity of this waste is not specified in the report, practically there are no data regarding the disposal facility: its design, physical condition, ability for reception of such waste, and also the material of high-capacity containers for class A waste storage is not specified.

Answer

A separate EIA study will be prepared for the short-lived very low level waste near-surface disposal facility. Documents (the EIA program and report) will be provided for consideration to the Belarus party in accordance with the requirements of the Convention on Environmental Impact Assessment in a Transboundary Context.

Currently the EIA Program has already been prepared. The document is being under consideration by appropriate Lithuanian institutions. The EIA Program, updated according to the results of the consideration, will be further submitted to the Ministry of Environment, which is responsible for the fulfillment of requirements of the Convention on Environmental Impact Assessment in a Transboundary Context.

Regarding to the technical characteristics, it might be preliminary specified, that the Landfill facility will consist of three disposal modules with a capacity of each of 20 000 m^3. Disposal facility modules will be above-ground structures where waste will be placed in three types of packages: in metal 20 foot half-height standard ISO containers, in 1 m^3 bales and in 1 m^3 plastic containers. In total the disposal modules of the Landfill facility should accommodate approximately 60 000 m^3 of treated and packaged waste. Packages will be placed in levels on the supporting concrete foundation and isolated from the environment by several layers of engineering barriers, based on natural and artificial materials.

Remark 2

During decommissioning of the Ignalina nuclear power plant it is planned to construct and operate following radiation- and nuclear-hazardous objects in the 3 km radius sanitary protection zone of plant:

2.1 Solid Waste Management and Storage Facility (SWMSF);

2.2 New Intermediate Spent Fuel Storage Facility (ISFSF);

2.3 Landfill repository for very low level radioactive waste;

2.4 Near-surface repository for low and intermediate level radioactive waste (RW);

2.5 Bituminized RW storage facility, which is planned to be transformed into a repository;

2.6 Liquid RW solidification unit;

2.7 Spent nuclear fuel dry type storage facility;

2.8 Two old units of Ignalina NPP that are being decommissioned;

2.9 A construction of a new NPP with total electric power 3400 MW is also planned.

The considered SWMSF EIA report notices, that for objects 2.3, 2.5 - 2.9 environmental impact assessment (further - EIA) has not been performed yet. Hence, safety of the whole complex of the objects can be justified only basing on a separate research.

In our opinion the Environmental Impact Assessment Report should consider all the objects that exist and are planned to be constructed at the Ignalina NPP. With this purpose it is necessary to carry out a complex environmental impact assessment of these objects.

<u>Answer</u>

At the moment not all environmental impacts from the future planned nuclear facilities have been estimated in detail. According to the INPP Final Decommissioning Plan [77] the 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.

The construction of SWMSF is one of separate Ignalina NPP decommissioning projects.

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 [78] provides to develop EIA reports separately for each DP. Every EIA report of a subsequent DP shall take into account results of previous reports. The planned design solutions shall be adjusted correspondingly. 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.

Environmental impact assessment for the new nuclear power plant has not been performed yet and the results of environmental impact assessment are not available at present. The design and environmental impact assessment of the newly planned NPP shall consider the potential environmental impacts from the INPP decommissioning activities and shall adjust planned design solutions correspondingly.

According to the radiation protection requirements in force, the design, operation and decommissioning of nuclear objects shall be such as to assure that the annual dose to the critical group members due to operation and decommissioning of a nuclear facility including short time anticipated operational transients shall not exceed the dose constraint (which is set to 0.2 mSv per year). If several nuclear facilities contribute to radiological impact, the same dose constraint value shall not be exceeded. Thus, the estimation and limiting of the total radiological impact from all potentially possible nuclear facilities is prescribed by the requirements of radiation safety and will be considered.

Remark 3

From our point of view it is expediently to append the EIA report with an estimation of annual effective doses for the population of Byelorussia residing in the immediate vicinity from the existing and planned objects of Ignalina NPP (e. g., Druksiai and others, located in the monitoring zone of *the plant), taking into account all complex of the objects, including the operating unit of Ignalina NPP.*

Answer

The assessment results of potential exposure of the critical group members of population demonstrate that starting from a distance of 500 m and more from the permanent security fence of the SWTSF site the radiological impact due to the SWTSF can be considered as insignificant (see section 4.9.2.2, the results also summarized in subsection 4.9.2.2.4.3). The estimated annual effective dose for the critical group member of population is less than 0.018 mSv, and more than by half is stipulated by radioactive releases from the existing and planned activities at the INPP. The state border of the Republic of Belarus is considerably further, in a distance of about 5 km to the East and South-East from the power units of the INPP and the SWTSF site. Waste retrieval activities at the SWRF site will not change the existing impact resulting from the present day operation of the INPP. Finally implementation of the planned activity will lead to a reduction of the radiation level due to the continuous reduction of the waste volume and the activity stored in the existing waste storage facilities. Therefore no relevant radiological impact from the planned economic activity can be expected to the population of Belarus.

Also see the answer to the previous remark.

Remark 4

It is planned, that SWMSF and ISFSF will be located in one site. SWMSF includes liquid and solid long-lived, as well as short-lived RW treatment and storage facilities (SWTF, SL SWSF, LL SWSF). As it is noted in the report, accidents at these facilities can have the most serious consequences. Unfortunately, the estimation of accidents impact on the adjacent facilities, including ISFSF and vice-versa, has not been carried out. It is possible that results of such estimations will not demonstrate safety of such neighborhood.

Answer

In general, the SWMSF and ISFSF (storage facilities in particular) are not the potentially dangerous objects with respect to each other. An accident situation at one of facilities should not affect safety of operation of other facilities. If required, such conditions shall be assured by design solutions. Certainly, accidents at one of facilities can worsen radiation conditions on the site. Some beyond design accidents can lead to the population exposure exceeding the dose limits established for normal operation. Therefore, measures for accidents management and mitigation of their consequences shall be foreseen in advance.

Possible interactions (as well as other potential external impacts) in more detail will be considered in the Safety Analysis Report. If necessary, the design solutions can be updated accordingly.

Remark 5

The assessment of beyond design accidents includes analysis of environmental impacts in case of an airplane crash on many considered objects, except the most dangerous one – the ISFSF. Apparently, such estimation is necessary from the point of view for both the impact on environment and the influence on the neighboring radiation-hazardous objects.

Answer

This EIA report considers the INPP new Solid Waste Management and Storage Facility.

The risk analysis for the ISFSF is presented in the separate EIA report "Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2". The indicated report was provided for consideration to the Belarus party.

Remark 6

For timely detection of violation of operational conditions and occurrence of emergency state at the objects it is expedient to organize regular and operative exchange with monitoring data as established by the international requirements not in case of extreme situations, but also in normal operating mode of the radiological-hazardous objects which are in immediate vicinity to the state border.

<u>Answer</u>

Organization of exchange with monitoring data in between neighboring countries shall be discussed and organized on institutional or state levels.

Remark 7

In the report the attention practically has not been paid to an estimation of the total impact from the considered objects on such natural object, as the basin of the lake Druksiai. At operational and emergency regimes the contamination will be discharged into the lake both by the air pathway and with surface as well as underground run-off. This water body will accumulate contamination not only in the water, but also in vegetation, fish and mostly in bottom sediment, which in a consequence can become a source for secondary environmental contamination. As this natural object belongs both for Lithuania and Belarus, the estimation of contamination dynamics of the lake system is necessary for the purpose of implementation of preventive actions for reduction of anthropogenic load on the lake.

<u>Answer</u>

The radiation exposure of the critical group members of the population in the environment of INPP resulting from determined releases of radioactive materials into the atmosphere is calculated using appropriate models as recommended by the IAEA publication Safety Report Series No. 19 [65]. The models selected include and consider all basic impact pathways as relevant for the environment of the SWMSF sites, including calculation of the radioactivity deposition on to the water body - Lake Druksiai with account for activity sedimentation and transfer into the water body from the lake catchment area. Calculation of annual effective dose to the human includes calculations of radioactivity concentration in the water, accumulation of radioactivity in the fish and estimation of internal human exposure due to consumption of the fish products. The methodology for assessment of radiological impact due to radioactive releases into the atmosphere is described in section 4.9.2.2.1.1.

An accident during transportation of liquid waste is considered in section 8.2.2.3. One of the scenarios considers potential consequences due to direct discharge of radionuclides into the Lake Druksiai (through the rain water drainage system of the SWTSF site or the connecting road).

Remark 8

Due to increase of amount of radiological-hazardous objects the modernization of existing instrumentation system for performance of radiation monitoring at the Belarus side will be required in order to maintain appropriate technical level of the monitoring system. It is one of important aspects of the EIA for the activity planned by the Republic of Lithuania.

Answer

The question on supporting of the monitoring system at the Belarus side shall be discussed and considered on institutional or state levels.

Remark 9

At the public hearings which took place in Braslav on May, 14th, 2008, the public participants raised questions and delivered offers, which are described in the appended Record No. 3. The population of Braslav region proposed these offers to be submitted to the Government of the Lithuanian Republic, as well as they would like to receive detailed explanations on the first two questions of the hearings as applicable to the population and territory of Byelorussia:

1. What security measures are provided for the case of possible terroristic act?

2. How the population informing about the conditions of radiation safety is organized?

Answer

1. The question raised exceeds the scope of the EIA procedure. It can be indicated that the physical security system is defined as the complex of the organizational, legal, and technical measures aimed at protecting equipment as well as radioactive material from their illegal possession or seizure. The main objectives of the site security system are as follows:

- Minimization of number of the persons having access to radioactive waste;
- Prevention of non-authorized access to the facilities territory;
- Timely and authentic detection of attempts of non-authorized access to the limited access areas;
- Intrusion prevention;
- Preclusion of non-authorized actions;
- Identification of persons undertaking actions connected with preparation for nuclear terrorism or non-authorized radioactive waste displacement;
- Record information on personnel access/exit to SWTF and SWSF.

Physical security system will be developed during technical designing. The certain information, concerning the Site Physical Protection System s, will be classified as the state or official secret.

2. According to the requirements of the Republic of Lithuania Law on Environment Monitoring [96], monitoring is carried out at the state, municipal and local levels where data about a condition of components of the environment and their changes are collected and analyzed.

Local level - the INPP monitoring system and its planned updating due to operation of the SWMSF, is described in chapter 7 of the EIA report. According to the requirements of the normative document LAND 42:2007 [64], monitoring data shall annually be summarized in a report, which shall be submitted to the state institutions (the Ministry of Environment, Environmental Protection Agency, Radiation Protection Center, State Nuclear Power Safety Inspectorate) and also to local municipalities.

Coordination of the monitoring on the state level is carried out by the Ministry of Environment and its authorized institutions. Radiation Protection Center and Environmental Protection Agency are the main institutions that collect, summarize and provide the information. State Nuclear Power Safety Inspectorate (VATESI) provides the information on safety conditions at nuclear facilities.

The websites of the mentioned institutions provide the simplest way of acquaintance with the latest information, reports, publications etc.:

- Radiation Protection Center - http://www.rsc.lt;

- Environmental Protection Agency - http://aaa.am.lt;
- State Nuclear Power Safety Inspectorate - http://www.vatesi.lt;

Through the website of Environmental Protection Agency it is possible to get the latest information from the state gamma radiation monitoring system RADIS. INPP also have a webpage and provides information (http://www.iae.lt).

In case of emergency, the VATESI is collecting information about situation in the NPP. VATESI ensures a 24 hours connection with emergency preparedness institutions of Republic of Lithuania and international organizations. VATESI specialists are ready to receive and provide information about nuclear and radiological accidents or incidents in Lithuania and other countries 24 hours per day. After receiving notification concerning nuclear accident VATESI emergency response centre begins its operation, but not later than after 1 hour. Among others, VATESI responsibilities in a case of nuclear or radiological emergencies are fallowing:

- Analyzing and forecasting the development of the situation and predicting possible emissions and pathways of radioactive materials;
- Providing information and advice to the Government, Fire and Rescue Department, Ministry of Environment and Radiation Protection Centre;
- Providing information and consulting Emergency commission;
- Providing information to the mass-media and public about the situation in the NPP;
- Notifying European commission, IAEA, neighboring countries in accordance with the Convention on early notification and bilateral agreements.

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