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GNS - NUKEM

Subcontractor
Lithuanian Energy Institute

Environmental Impact Assessment Report

Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2

The organiser of the Proposed Economical Activity:	**State Enterprise Ignalina Nuclear Power Plant**
The developer of the EIA Report:	**Consortium GNS - NUKEM (Germany)** **Lithuanian Energy Institute, Nuclear Engineering Laboratory**

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Table of Revisions

Revision	Issue date	Description
0	30 November 2005	Original version as presented to the Consortium by LEI
1	22 December 2005	Integration of received comments. Version as presented to the organizer of proposed economic activity for review
2, Issue 1	10 August 2006	Integration of received comments. Version as presented to the organizer of proposed economic activity for approval
2, Issue 2	02 October 2006	Integration of received additional comments. Version as presented to the organizer of proposed economic activity for approval
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3, Issue 1	21 June 2007	Integration of the public review results. Integration of relevant parties' comments and conclusions. Version as presented for competent authority review and approval.
4	24 October 2007	Integration of comments from technical support organizations and competent authority. Version as presented for approval by competent authority.

Introduction

The proposed economic activity is implemented in support to the Ignalina Nuclear Power Plant (INPP) pre-decommissioning and decommissioning activities. The decommissioning of main systems can only start when spent nuclear fuel is fully removed from Reactor Units. Taking into account the fact that a deep geological repository is not available in Lithuania and likely will not be available at least until the middle of this century, the long-term storage is the only option for the management of spent nuclear fuel. The Government of the Republic of Lithuania by its resolution [1] has decided to start the design of the spent nuclear fuel storage facility at INPP.

The proposed economic activity, to which the present Environmental Impact Assessment (EIA) Report is associated, concerns the design, erection, installation, setting-to-work, commissioning, operation and decommissioning of the new Interim Spent Fuel Storage Facility (ISFSF) at INPP. The ISFSF is equipped with a Hot Cell to provide the possibility of spent nuclear fuel repackaging during the storage period.

In addition to the ISFSF, the proposed economic activity includes all necessary spent nuclear fuel retrieval, packaging, sealing operations at Reactor Units, transfer between Reactor Units and ISFSF, and other equipment appropriate to the chosen design solution and required for the safe removal of the existing spent nuclear fuel from storage pools and insertion into the new ISFSF.

RWE NUKEM GmbH and GNS mbH consortium named as “Consortium GNS – RWE NUKEM GmbH” (“contractor”) is contracted to fulfil the design, construction and licensing for operation of proposed economic activity. RWE NUKEM GmbH has the consortium lead. The overall activity organisation will include Lithuanian as well as western sub-contractors. For fulfilment of the individual proposed economic activity tasks such as quality assurance, engineering, planning and cost control, contracting, procurement, construction and installation, safety and licensing and testing and commissioning, the consortium will nominate well-experienced and well-educated personnel.

The EIA Report is prepared in accordance with the Law on the Environment Impact Assessment of Planned Economic Activity [2] and the EIA Programme, approved by the Ministry of Environment [3], and complies with EU Directive [4], Conventions [5, 6] and EBRD polices [7–9].

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Abbreviations

ALARA	As Low As Reasonably Achievable
DFHS	Damaged Fuel Handling System
DP	Decommissioning Project
DPMU	Decommissioning Project Management Unit
EBRD	European Bank of Reconstruction and Development
EIA	Environmental Impact Assessment
EIAP	Environmental Impact Assessment Programme
EIAR	Environmental Impact Assessment Report
EU	European Union
FA	Fuel Assembly
FBHE	Fuel Bundle Handling Equipment
FIHC	Fuel Inspection Hot Cell
FR	Fuel Rod
IAEA	International Atomic Energy Agency
IIDSF	Ignalina International Decommissioning Support Fund
INPP	Ignalina Nuclear Power Plant
ISFSF	Interim Spent Fuel Storage Facility
LEI	Lithuanian Energy Institute
MW(e)	Electrical Mega Watt (Power Production)
MW(th)	Thermal Mega Watt (Thermal Production)
RBMK	Water-cooled, graphite-moderated, pressure-tube-type boiling-water power reactor
SAR	Safety Analysis Report
SFA	Spent Fuel Assembly
SNF	Spent Nuclear Fuel
TS	Technical Specification
VATESI	The State Nuclear Power Safety Inspectorate
WAC	Waste Acceptance Criteria

Part I. Environment Impact Assessment Report

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1. GENERAL INFORMATION

1.1. Information about the Organiser of the Proposed Economical Activity

The organiser of the proposed economical activity:

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1.2. Information about the Developers of the EIA Report

The Developers of the EIA Report:

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1.3. Name and Concept of the Proposed Activity

The proposed economic activity is named as the “Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2”.

By this proposed economic activity about 36000 spent RBMK-1500 nuclear fuel bundles (from about 18000 of nuclear fuel assemblies) will be loaded into storage casks of CONSTOR® RBMK1500/M2 type at Reactor Units. The casks will be transferred into newly constructed Interim Spent Fuel Storage Facility (ISFSF) for long-term (at least for 50 years) interim storage.

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

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

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

The ISFSF will be designed to comply with functional requirements defined in the Technical Specification [1]. Main requirement is safe and secure storage of the spent fuel from INPP in full compliance with statutory requirements, for a period at least of 50 years. Cask storage concepts are approved and licensed in different countries and cask storage using the proposed cask concept has already been licensed in Lithuania. Long-term storage is ensured by use of cask materials resistant to aging, by excluding of corrosion damage to fuel rods and casks and by limiting the cladding temperature below the threshold of relevant creeping.

ISFSF storage capacity is planned for 201 storage casks.

It will be possible at any time during the storage period to inspect the cask. The casks can be easily removed from their storage place and can be inspected at the Cask Service Station.

It will be possible at any time during the storage period to repack the spent fuel if a cask is found to be defective. The ISFSF will have Fuel Inspection Hot Cell (FIHC) where nuclear fuel could be inspected and reloaded into new cask after dismantling of storage pools at INPP.

It will be possible to transport the spent fuel away from the ISFSF site after interim storage without repackaging the fuel. The CONSTOR® RBMK1500/M2 type casks will be designed to meet requirements for B(U) packages according to IAEA Regulations for the Safe Transport of Radioactive Material [2] and therefore will be suitable for the off-site transport. For the off-site transport casks are equipped with a transport over-pack and lid-side and bottom-side shock absorbers forming together with the cask the transport package according to above mentioned regulation. These components guarantee that transport requirements are fully met. Justification of this will be given in Safety Analysis Report (SAR). For the off-site transport a transport license will be necessary, which is not included in the license of the ISFSF.

1.4. Location of Proposed Economic Activity

The proposed economic activity will be held in two closely located places:

- At the determined premises of INPP Reactor Units, where spent nuclear fuel will be appropriately processed and loaded into storage casks and;
- At the newly constructed ISFSF site, where casks with spent fuel will be prepared for interim storage and stored as minimum 50 years.

An appropriate connection will be established in between two sites to assure safe and secure cask transfer.

It is proposed to build the ISFSF on a land owned by Ignalina NPP. Location alternatives are analysed in Chapter 7 “Analysis of Alternatives”. The selected ISFSF site is approximately 550 m to the south of the current INPP security fence. The approximate site dimensions are 300×100 m.

The regional level map with marked ISFSF location is presented on Figure 1.4-1. The legend of the map is presented in Figure 1.4-2. ISFSF construction site is now recultivated (planted with pine seedlings) former soil buffer dump. Approximately 50 % of the territory is represented by highland marshes and other 50 % – by lowland bogs (Figure 1.4-3).

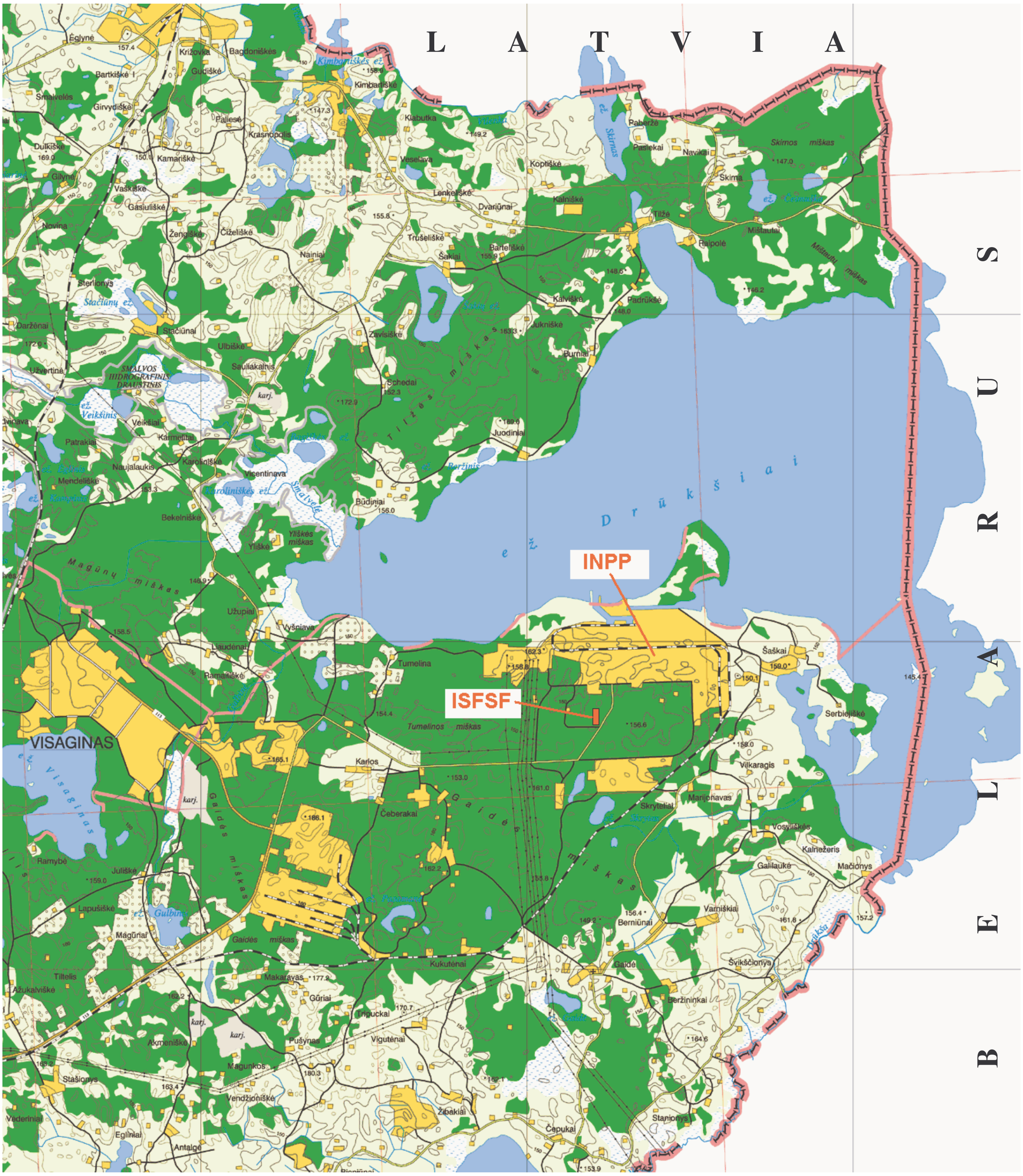


Figure 1.4-1. The regional level map with marked ISFSF location (the legend of the map is given in Figure 1.4-2)

Miestai		Towns
sostinė; daugiau nei 500000 gyventojų	VILNIUS	capital; population over 500000
nuo 100000 iki 500000 gyventojų	KAUNAS	population from 100000 to 500000
nuo 50000 iki 100000 gyventojų	ALYTUS	population from 50000 to 100000
nuo 20000 iki 50000 gyventojų	KĖDAINIAI	population from 20000 to 50000
nuo 10000 iki 20000 gyventojų	PALANGA	population from 10000 to 20000
nuo 3000 iki 10000 gyventojų	BIRŠTONAS	population from 3000 to 10000
mažiau kaip 3000 gyventojų	DŪKŠTAS	population less than 3000
Kaimo gyvenvietės		**Settlements**
miesteliai	Žasliai	small towns
kaimai	Dalinonys	villages
Sienos ir ribos		**Boundaries**
valstybės siena		international boundary
savivaldybės riba		boundary of municipality
valstybinių parkų, rezervatų draustinių ribos		boundaries of national parks and reservations
Keliai ir kelių numeriai		**Roads and road numbers**
magistraliniai	A5	main roads
krašto	165	state significance roads
apskričių		regional roads
vietinės reikšmės		local roads
Geležinkeliai		**Railroads**
dviejų kelių		double track
vieno kelio		single track
geležinkelio stotys		railway stations
Hidrografija		**Hydrography**
upės ir kanalai siauresni nei 10 m		rivers and canals less then 10 m wide
upės ir kanalai nuo 10 iki 30 m		rivers and canals from 10 to 30 m wide
upės ir kanalai platesni nei 30 m		rivers and canals over 30 m wide
ežerai ir tvenkiniai		lakes and ponds
Reljefas		**Relief**
horizontalės kas 10 m		contour lines 10 m
horizontalės 50 m		contour lines 50 m
skardžiai		cliffs
griovos		ravines
altitudės metrais	• 18.2	height points in meters
Kiti ženklai		**Other signs**
užstatytos teritorijos		built-up areas
sodai		orchards
kapinės		cemeteries
miškai		forests
pelkės		wetlands
smėlynai	smėl.	sands
durpynai	durp.	peat-bogs
karjerai	karj.	quarries
sąvartynai	sąv.	dumps
dirbama žemė		agricultural areas
330 kV elektros tiekimo linijos		330 kV power lines
koordinuotos bažnyčios	+	coordinated churches
oro uostai		airports

Figure 1.4-2. The legend of the ISFSF region map presented in Fig. 1.4-1

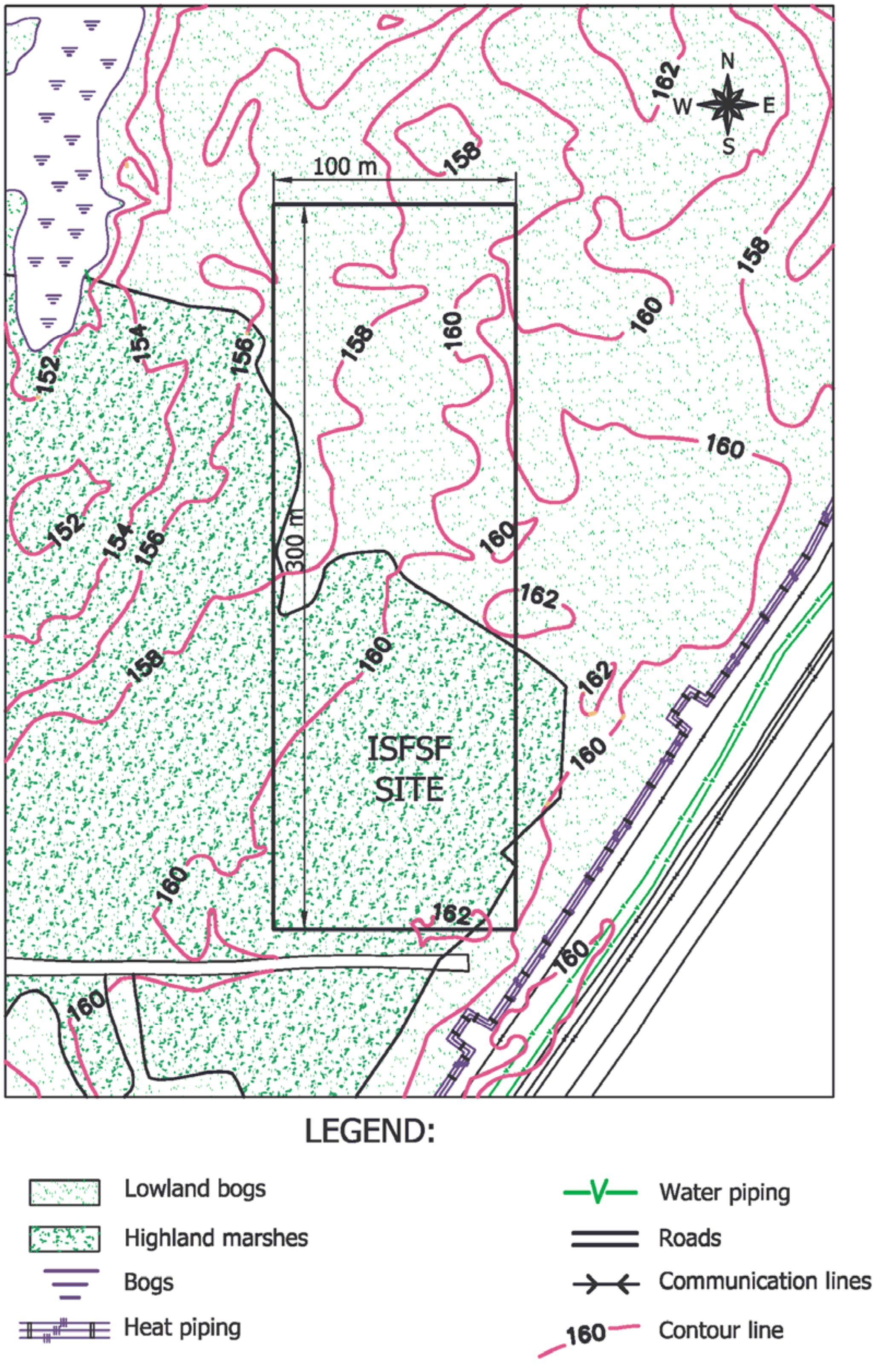


Figure 1.4-3. Biotopes, contour lines and existing infrastructure of the new ISFSF site (the site was previously used as soil buffer dump)

From a geomorphological point of view the ISFSF site is located in a distal part of Baltic upland, 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 of the site has an incline (156–162 m altitude) towards southwest (Figure 1.4-3).

The detailed description of the components of the environment of the region and the ISFSF site is given in Chapter 4. Geotechnical characteristics of the site [3] are compatible with the project and suitable for construction of the ISFSF.

1.5. Stages of Activity

The main stages of proposed economic activity and their duration are indicated in Figure 1.5-1. More detailed description of the main proposed economic activity stages is provided in Subchapters below.

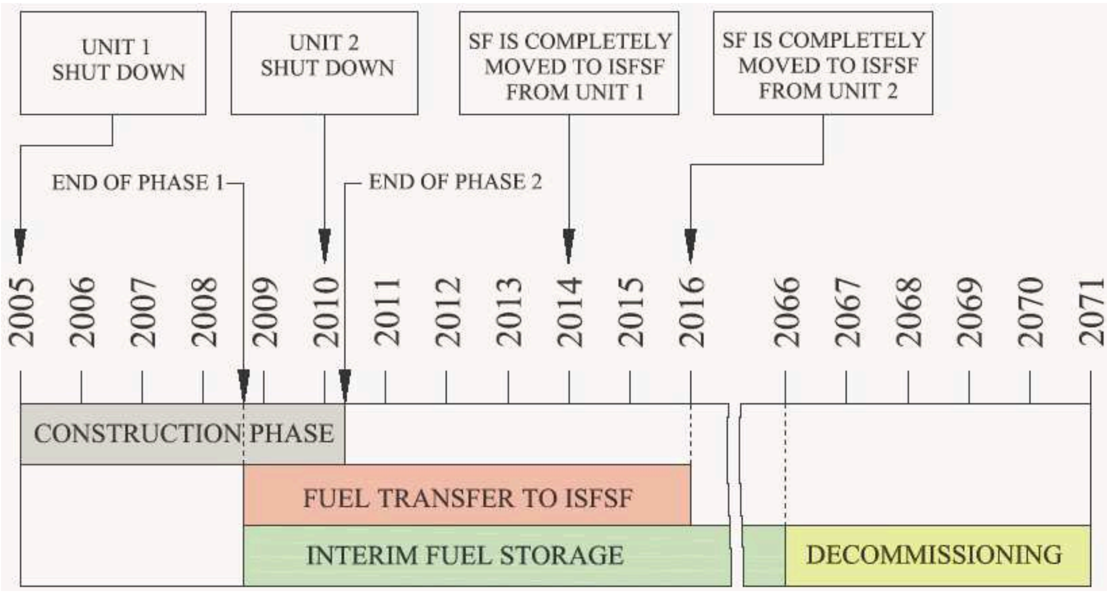


Figure 1.5-1. The main activity stages of the proposed economic activity

1.5.1. Construction and Licensing for Operation

The design, construction and licensing for operation of proposed economic activity is divided in two phases. The Phase 1 shall be completed in 2008, Phase 2 – in 2010.

Phase 1 provides the following scope:

- Provision of equipment for nuclear fuel retrieval, packaging, loading and transfer from INPP Reactor Units;
- Provision of a fully operational and licensed ISFSF for storage of 201 CONSTOR® RBMK1500/M2 containers loaded with spent nuclear fuel;
- Delivery of 39 CONSTOR® RBMK1500/M2 containers.

Phase 2 provides the following scope:

- Provision of equipment for leaking, damaged, experimental nuclear fuel and fuel debris retrieval, packaging, loading and transfer from INPP Reactor Units;

- Delivery of 163 CONSTOR® RBMK1500/M2 containers (201 casks are foreseen for spent nuclear fuel storage and the 202nd cask is a spare one);
- Completion of the Fuel Inspection Hot Cell;
- Transportation of contractor generated construction debris from the site;
- Completion of the infrastructure finishing and site clean-up of contractor's equipment.

1.5.2. Operation

Spent fuel packaging, loading and transfer from INPP Reactor Units to the ISFSF will start with completion of construction Phase 1. By the end of the year 2015 all spent fuel from INPP will be retrieved from existing spent fuel pools and will be stored at ISFSF. The duration of the ISFSF operational phase is foreseen to last until the end of 2065. Duration of ISFSF operation until 2065 is defined in the INPP Final Decommissioning Plan. INPP will manage, along the decommissioning, to provide the various utilities taking into account the changes that will occur in the systems; this is to be tackled in the Decommissioning Projects.

1.5.3. Decommissioning Options

Existing, modified and additional equipment will be used for handling of new type CONSTOR® RBMK1500/M2 casks at the INPP Reactor Units. The new equipment can be decommissioned as usual radioactive or conventional waste in course of dismantling and decommissioning of the INPP.

The equipment for processing and handling of mechanically damaged spent fuel assemblies will be designed with the consideration for decontamination, modular dismantling and handling. The most of equipment and components will be decontaminable to low level waste. Only minor parts (e.g. abrasive discs and filtration media) could be necessary to treat as intermediate level waste.

The decommissioning of ISFSF will not cause any technological and environmental impact problems. After completion of spent fuel storage a cask can be reused for further spent fuel storage or for another application (e. g. storage of radioactive waste) or it has to be decommissioned.

In case that cask has to be decommissioned, three aspects of cask radioactivity have to be assessed:

- Material activation by neutron flux;
- Contamination of cask cavity, basket and primary lid caused by particles possibly loosened from the surface of fuel rods and fuel assembly structures, by solid residues of pool water from vacuum drying and by deposits of fission products possibly released from leaking fuel rods;
- Possibly remaining contamination of the outer cask surface resulting from under-water cask loading.

Justification of the long term integrity of the SNF during handling and storage will be performed in the Safety Analysis Report (SAR) and Technical Design.

Mainly due to the high cobalt impurity content in the applied steels, the expected neutron activation of the most cask and basket components will be to such an extend that additional measures will be necessary for the decommissioning of those materials. More detailed substantiation of the neutron activation will be provided in Safety Analysis Report.

The design of the cask body, lids and trunnions allows easy surface decontamination and subsequent conventional cutting and packaging of the material for recycling respectively the conventional disposal of the concrete filling. Baskets require a more intensive global decontamination due to existing gaps and additional local decontamination in the course of dismantling.

No specific technologies and measures will be required for decommissioning of ISFSF compared to decommissioning of other nuclear facilities and installations of INPP. ISFSF will be decommissioned as an ordinary nuclear installation. Experience gained during decommissioning of INPP will be used also.

More detailed analysis of the decommissioning concept will be performed during preparation of Technical Design and SAR. Decommissioning of the ISFSF will be performed in accordance with requirements of Lithuanian legislation and regulations.

1.6. Demand for Resources and Materials

1.6.1. Demand for Energy Resources

1.6.1.1. Electrical power

Existing installations are sufficient to provide necessary electrical power for proposed economic activity.

Electrical power for the ISFSF will be supplied from the power grid. Electrical power will be used for ISFSF equipment, lighting, ventilation, air conditioning, security fence etc. The estimated electrical power demand is to be about 700 kW.

The back up power shall be assured for safety important installations (such as ventilation systems etc.). The backup power will be provided by an emergency diesel-generator (approx. 80 kW) and will be limited to 24 hours.

1.6.1.2. Thermal energy

Existing installations are sufficient to provide necessary thermal energy for proposed economic activity.

Hot water for the ISFSF will be supplied from the steam boiler plant. Hot water is necessary for ISFSF room heating system, ventilation and sanitary purposes. The total heat supply is estimated to be about 1600 MWh per year (approx. heating needs –150 MWh/y, ventilation – 1300 MWh/y and hot water – 150 MWh/y).

The total demand for energy resources is summarised in Table 1.6.1-1.

Table 1.6.1-1. Demand for ISFSF energy resources

Resources	Capacity or annual amount	Remark
Electrical energy, kW	700	From the power grid
Thermal energy, MWh/y	1600	From the steam boiler plant
Diesel fuel, litres/y	300	External supply

1.6.2. Demand for Water

Existing installations are sufficient to provide necessary cold water supply for proposed economic activity. The potable water will be supplied by “Visagino Energija”. No new boreholes are foreseen.

The potable water supply to the ISFSF will be necessary for hand washing, showers and toilets as well as for fire fighting system (hydrants). The potable water is processed at local purification plant. Its quality is constantly monitored. It is used for some other everyday purposes (showers, toilets) as well. The total potable water consumption during ISFSF operation is estimated to be about 4200 m^3 per year (approx. process needs – 1000 m^3/y, household needs of operators – 2900 m^3/y and watering needs of the lawns and paved areas – 300 m^3/y).

1.6.3. Other Materials

Expected amounts of main raw materials needed for construction of the ISFSF are presented in Table 1.6.3-1.

Table 1.6.3-1. Information about construction of the ISFSF and rough amounts of main materials

Construction extent and materials*	**Dimension**	**Amount**
Construction area (ground area for the main and auxiliary structures of the ISFSF)	m^2	6 200
Constructed volume (main and auxiliary structures of the ISFSF)	m^3	90 000
Excavation	m^3	8 500
Soils improvement	m^3	6 200
Re-fillment	m^3	2 400
Piles (vibrated concrete columns Ø0.6 × 10 m)	pieces	1 366
In-situ concrete	m^3	8 100
Pre-fabricated girders RC	pieces	32
Reinforcement	tons	2 200
Steel	tons	350
Walls in brickwork	m^2	1 200
Roof and facade panels	m^2	13 000
Roads	m^2	6 900

* - No hazardous chemical substances and preparations according to [4] will be used.

1.7. Potential Environment Impact Sources

Potential environment impact sources that may arise from the proposed economic activity are presented in Table 1.7-1.

Table 1.7-1. Potential environment impact sources that may arise from the proposed economic activity

Pollution type	Hypothetical possibility of pollution	Comments
Ionizing radiation	Possible additional ionizing radiation due to: - the nuclear fuel retrieval, packaging, loading at Reactor Units; - the transfer of spent nuclear fuel from Reactor Units to the ISFSF; - the handling, preparation and interim storage of spent nuclear fuel in the ISFSF; - the decommissioning of the ISFSF.	Maximum allowable impact to the population (still harmless to the environment and humans): - dose limit – 1 mSv per year; - dose constraint – 0.2 mSv per year (impacts from all nuclear facilities located within the same INPP sanitary protection zone shall be included).
Nonionizing radiation	This type significant pollution of environment components is not foreseen by this proposed economic activity.	
Noise	Possible local impact to environment during construction of the ISFSF.	
Biological pollution (microorganisms, viruses)	Not foreseen	Possible controlled slight pollution due to utilities type sewage release to environment.
Other pollution of environment	Possible pollutant emissions due to emergency diesel (80 kW). Other significant pollution of environment components is not foreseen by this proposed economic activity.	Insignificant atmospheric emissions of sulphur, nitrogen and carbon oxides and solid particles. Possible slight pollution of environment due to mobile sources and accidental spills of combustive-lubricating materials from mobile sources and during storage of building materials.

2. MAIN EQUIPMENT AND TECHNOLOGICAL PROCESSES

By this proposed economic activity about 36000 spent RBMK-1500 nuclear fuel bundles (from about 18000 of spent fuel assemblies) have to be loaded into storage casks of CONSTOR® RBMK1500/M2 type. Then the casks have to be transferred into newly constructed ISFSF for preparation for storage and for long-term interim storage. The ISFSF will have Fuel Inspection Hot Cell (FIHC) where stored fuel could be inspected and reloaded into new cask after dismantling of INPP SNF storage pools.

The bulk of SFA are leak tight and without mechanical defects. They will be processed in the existing INPP Hot Cell. The Hot Cell is licensed for such activity and has been in successful operation for years. However a small proportion of the SFA has suffered (or is expected to suffer) damage. Special equipment will be designed and installed in the Storage Pools Hall for processing of mechanically damaged SFA. The fuel debris collection equipment is also provided for removing of resident fuel pellets from the storage pools and for collecting and removing of fuel pellets accidentally lost during damaged fuel handling. A certain number of SFA can have cladding leakage. These, mechanically not damaged SFA will be processed by existing INPP Hot Cell.

The description of main equipment and technological processes presented in this EIA Report is mainly based on two documents, the Ignalina NPP issued Technical Specification [1] and Consortium GNS–RWE NUKEM GmbH developed Technical Proposal [2].

2.1. Spent Nuclear Fuel

2.1.1. RBMK-1500 Fuel Assembly

A full-size RBMK-1500 fuel assembly, Fig. 2.1.1-1, consists of lower and upper fuel rod bundles mounted on the central rod (fuel assembly type 50) or central tube (fuel assembly type 49) with an extension rod. Lower and upper caps, fasteners and retainers guarantee rigid connection of bundles and correct positioning of fuel rods in the assembly. Each of the bundles contains 18 fuel rods.

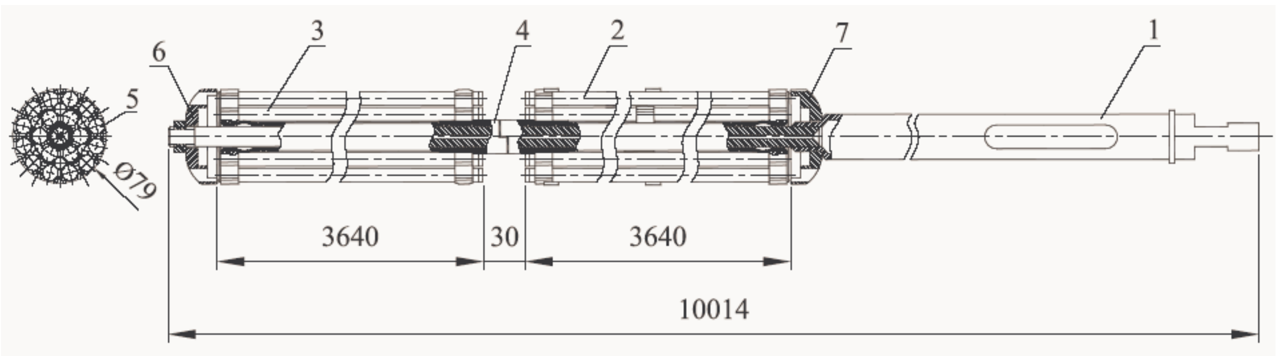


Figure 2.1.1-1. Typical RBMK-1500 fuel assembly: 1 – extension rod, 2 – upper fuel rod bundle, 3 – lower fuel rod bundle, 4 – central rod/tube, 5 – fuel rod, 6 – lower cap, 7 – upper cap

The fuel rod itself is a stack of caked UO_2 pellets enclosed in a leak-tight tube (cladding). The pellet length is 15 mm and diameter is about 11.5 mm. The mass of pellet is about 15 g. Most of the fuel pellets have an axial hole to decrease the inside temperature gradient. The cavity of fuel rod is filled with helium.

Several types of nuclear fuel have been used at INPP which mainly differs by initial enrichment of U-235 and presence of Erbium absorber. Fuel assemblies with different fuel pellets have the same overall dimensions and strength properties but can have a different level of burn up. Main technical characteristics of RBMK-1500 SFA are presented in Table 2.1.1-1.

Table 2.1.1-1. Technical characteristics of RBMK-1500 fuel assemblies [1]

Characteristic	Fuel type (initial fuel enrichment)				
	2.0 %	**2.1 %**	**2.4 %**	**2.6 %**	**2.8 %**
Nominal mass fraction of U-235 in uranium, % from Uranium mass	2.0	2.1	2.4	2.6	2.8
Mean mass fraction of burnt erbium absorber (E_2O_3), % from Uranium mass	No	No	0.41	0.5	0.6
Uranium mass (isotope composition), kg	111.20±1.60			111.08±1.60	
Uranium dioxide (UO_2) mass, kg	~126				
Expected average burn up, MW×day/FA	1900	1700	2500	2700	3000
Maximum burn up, MW×day/FA	2600	2100	3000	3050	3200
Expected amount of FA to be stored at ISFSF *)	~ 8500	~ 400	~ 3500	~ 2000	~ 2400

*) The exact amount of fuel which has to be stored at ISFSF after the closure of the power plant depends upon the INPP operating regime

For storage in the casks the SFA have to be processed by cutting the fuel assembly in two pieces thus separating upper and lower fuel rod bundles. The extension rod, central rod/tube, lower and upper caps, see Fig. 2.1.1-1, are separated and are treated as solid radioactive waste using existing and licensed INPP technologies.

2.1.2. Damaged and Experimental Spent Nuclear Fuel

A small amount of spent fuel has been (or is expected will be) damaged. It is estimated [1] that the amount of existing and anticipated future damaged SFA will be below 3 % from the total amount of SFA. The damage of SFA may be minor – slight mechanical damage without loss of integrity of the cladding – or it may be major and result in rupture of the cladding and, in some cases, loss of fuel pellets from the cladding. Lost fuel pellets form fuel debris located inside storage pools. Most of damaged SFA have cladding leakage. The damaged fuel including lost fuel debris will also be retrieved from the storage pools, loaded into the casks, transferred and stored in the ISFSF.

Leak tight SFA with minor mechanical defects can be processed by existing INPP Hot Cell and placed into 32M baskets and ring basket as typical SF bundles.

SFA with cladding leakage and minor mechanical defects with only a few exceptions from technical point of view can be processed and handled by existing INPP Hot Cell. These SNF bundles can also be placed into 32M baskets and ring basket as typical SF bundles. However the existing INPP Hot Cell and SFA handling route are not licensed for use of SFA with cladding leakage. The existing INPP Hot Cell and handling methods shall be qualified additionally for such kind of operation.

SFA with major mechanical defects or SFA which is likely to be damaged in cutting process cannot be processed by the existing INPP Hot Cell. Due to conditions and variations in the physical dimensions these SF bundles cannot be positioned in 32M type and ring basket as typical SF bundles. These SFA shall be processed using a new technology introduced by the proposed economic activity. SF bundles with major mechanical defects will be over packed into cartridges. Up to 105 SFA with major mechanical damages are anticipated after the INPP final shutdown.

There is also a small number (33) of experimental SFA. The functions of the experimental SFA are as follows:

- Cladding temperature measurement during operational period on reactor core using some thermocouples;·
- Temperature measurement of the fuel rods extension during operational period on reactor core using some thermocouples;·
- Pressure measurement during operational period on reactor using pressure sensors;
- Measurement of some reactor core parameters during loading-unloading of the FA in reactor core.

There are several designs of experimental SFA. To some extent experimental SFA are similar to typical SFA. Experimental SFA contain two or one fuel bundles. The length of experimental fuel bundles and the number of fuel rods are the same or smaller as of typical fuel bundle. In general experimental SFA are of 2 % initial enrichment of U-235. However, some experimental SFA contain 4 separate fuel rods of 4.4 % initial enrichment of U-235. These rods are ~7 m in length and each contains 5 kg of uranium (isotope composition). Experimental SFA can not be processed using existing INPP equipment and installations. These SFA will be processed using a new technology introduced by the proposed economic activity. It should be noted that during normal processing of experimental SFA and cutting it into two fuel bundles the fuel rods with 4.4 % enrichment will be cut through. Therefore, releases from the 4 fuel rods with 4.4 % enrichment during normal processing of experimental SFA must be evaluated.

2.1.3. Activity Inventory

The inventory activity of RBMK-1500 SFA after 5 years cooling time and with different enrichments is presented in Table 2.1.3-1. This table includes the activities of relevant light element isotopes (structural materials of the FA skeleton), the activities of dominant fission products, which in total represent more than 90 % of the total fission product activity and the activities of the dominant actinide isotopes for the two reference fuel assemblies, i. e. 2.0 % and 2.8 % [3]. Activity values for experimental fuel assemblies were calculated using SAS2/ORIGEN-S code from the SCALE computer codes system [4, 5]. This verified and validated code [6-8] is widely used for the estimation of SNF radiological characteristics. Applicability of the SAS2/ORIGEN-S code for the evaluation of the RBMK fuel characteristics is demonstrated in [9-11] where calculation results are compared with available experimental results for RBMK fuel. Also ORIGEN-S code was used for the estimation of nuclide content of the irradiated RBMK-1500 nuclear fuel in the safety analysis of the existing CASTOR RBMK-1500 and CONSTOR RBMK-1500 storage casks.

The main amount of SFA to be stored at ISFSF will be of lower enrichment, cf. Table 2.1.1-1. SFA with 2.8 % U-235 enrichment in comparison to other SFA with lower enrichment and experimental SFA has a highest level of burn up and therefore contains higher nuclide activities and decay heat power. The most active SFA potentially can result in a higher impact on environment. Therefore, the SFAs with 2.8 % U-235 enrichment are selected as the conservative case in assessing the maximal expected impact on environment. It must be noted that activities of the Ce-144, Pr-144 and Pm-147 for experimental SFA are slightly higher in comparison with 2.8 % fuel. However, exposure caused by these nuclides is negligible (cf. Chapter 5), so 2.8 % fuel results the highest impact on environment.

Table 2.1.3-1. Activities of main radionuclides and total activity (Bq/FA) of RBMK-1500 SFA with different enrichments

Nuclide	Fuel type (initial fuel enrichment) and burn up in MW×day/FA			
	2.0% [1)] **2504**	**2.8%** [1)] **3268**	**Experimental FA 2632**	
			4.4% [2), 3)]	**2.0%+4.4%** [4)]
^{14}C	5.84E+09	5.89E+09	Activation elements of the spacing grids which are not cut through during normal processing	5.84E+09
^{54}Mn	2.14E+10	2.25E+10		2.14E+10
^{55}Fe	5.76E+12	5.52E+12		5.76E+12
^{60}Co	2.40E+12	2.40E+12		2.40E+12
^{59}Ni	3.71E+09	3.72E+09		3.71E+09
^{63}Ni	4.85E+11	4.86E+11		4.85E+11
^{93}Zr	5.12E+08	5.49E+08	5.69E+07	5.12E+08
^{93m}Nb	9.41E+07	1.01E+08	1.05E+07	9.41E+07
^{94}Nb	2.21E+10	2.49E+10	2.46E+09	2.21E+10
^{3}H	9.94E+11	1.25E+12	2.49E+11	1.13E+12
^{85}Kr	2.24E+13	2.93E+13	5.59E+12	2.55E+13
^{90}Sr	1.84E+14	2.47E+14	5.32E+13	2.17E+14
^{90}Y	1.85E+14	2.47E+14	5.32E+13	2.18E+14
^{106}Ru	4.94E+13	5.09E+13	5.94E+12	4.99E+13
^{106}Rh	4.94E+13	5.09E+13	5.94E+12	4.99E+13
^{125}Sb	6.52E+12	7.43E+12	1.15E+12	6.94E+12
^{129}I	1.12E+08	1.45E+08	1.36E+07	1.13E+08
^{134}Cs	5.77E+13	7.95E+13	8.20E+12	5.95E+13
^{137}Cs	2.67E+14	3.44E+14	6.03E+13	2.98E+14
^{137m}Ba	2.67E+14	3.44E+14	5.69E+13	2.94E+14
^{144}Ce	3.34E+13	3.55E+13	1.04E+13	4.01E+13
^{144}Pr	3.34E+13	3.55E+13	1.04E+13	4.01E+13
^{147}Pm	1.42E+14	1.63E+14	4.34E+13	1.70E+14
^{154}Eu	6.95E+12	9.64E+12	7.80E+11	6.96E+12
^{155}Eu	3.20E+12	4.11E+12	3.07E+11	3.15E+12
^{237}Np	4.34E+08	6.90E+08	6.75E+07	4.53E+08
^{238}Pu	3.04E+12	5.09E+12	2.79E+11	2.98E+12
^{239}Pu	6.37E+11	6.82E+11	9.92E+10	6.65E+11
^{240}Pu	1.82E+12	1.96E+12	2.00E+11	1.82E+12
^{241}Pu	2.16E+14	2.48E+14	2.33E+13	2.15E+14
^{241}Am	2.23E+12	2.62E+12	2.33E+11	2.22E+12
^{242m}Am	8.89E+09	1.29E+10	1.06E+09	8.96E+09
^{243}Am	4.26E+10	6.03E+10	1.16E+09	3.90E+10
^{242}Cm	5.15E+10	6.94E+10	3.07E+09	4.89E+10
^{243}Cm	2.11E+10	3.15E+10	6.96E+08	1.95E+10
^{244}Cm	2.87E+12	4.82E+12	3.50E+10	2.59E+12
Total	**1.54E+15**	**1.92E+15**	**3.40E+14**	**1.71E+15**

1) – Nuclide activity values according to [3];
2) – Activities calculated using ORIGEN-S code;
3) – Activity per 4 fuel rods with 4.4% enrichment (these rods will be cut through during normal processing);
4) – Experimental FA consists of 4 fuel rods with 4.4% enrichment and 32 fuel rods with 2.0% enrichment.

The total activity that is going to be stored at ISFSF can be estimated as follows:

$$A = \sum_i n_i \cdot a_i \ ,$$

where:

n_i – amount of specific type of SFA to be stored at ISFSF, cf. Table 2.1.1-1;

a_i – total activity of specific type of SFA, cf. Table 2.1.3-1. For fuel of 2.6 % initial enrichment the activity data of fuel of 2.8 % initial enrichment were used.

The total activity that is going to be stored at ISFSF is estimated to be of order of 10^{19} Bq. The more exact activity estimation will be provided in the Safety Analysis Report.

2.1.4. Decay Heat Power

The radionuclides present in spent fuel produce heat when matter absorbs their decay gamma rays and particles. The main contribution of the thermal power originates from fission products. Activation products and actinides contribute only a minor fraction of the total decay power. The decay heat power of RBMK-1500 SFA is presented in Table 2.1.4-1.

Table 2.1.4-1. Decay heat power of RBMK-1500 SFA [1]

Characteristic	**Fuel type (initial fuel enrichment)**				
	2.0 %	**2.1 %**	**2.4 %**	**2.6 %**	**2.8 %**
Burn up, MW×day/FA	1900	1700	2400	2800	3200
Cooling time, years	5	3.3	5	5	5
Decay heat power, W/FA	119.6	143.1	120	140	154.1

The maximal expected heat power dissipated from ISFSF can be estimated as follows:

$$Q = \sum_i n_i \cdot q_i \ ,$$

where:

n_i – amount of specific type of SFA to be stored at ISFSF, cf. Table 2.1.1-1;

q_i – decay heat power of specific type of SFA, cf. Table 2.1.4-1.

The ISFSF dissipated heat power rate is calculated to be about 2.4 MW. The calculated value shall be considered as conservative estimation, because it is based on minimal cooling time requirements (cooling time is not greater than 5 years), maximum number of SFA and assumes that storage capacity of ISFSF is reached at the end of cooling time. In reality, it is planned that ISFSF will be completely loaded by 2016, while Unit 1 was shut down by the end of 2004 and Unit 2 has to be shut down by the end of 2009, see Figure 1.5-1. For most of SFA, the cooling time will be greater than 5 years (or even 10 years) and decay heat power will be lower. It is calculated [3] that with increasing of cooling time from 5 to 10 years the decay heat power reduces by factor 1.5–1.6. So, it is expected that the ISFSF dissipated heat power rate could be in the range of 1–2 MW. The ISFSF is a stand alone building within its sanitary protected zone and the released heat will be dispersed into atmosphere.

2.2. Storage Cask System CONSTOR® RBMK1500/M2

For long-term interim storage the SNF bundles will be loaded into a storage cask. For positioning of SNF bundles within the cask body special fuel baskets are inserted into the cask. The cask itself is designed as multi-barrier system which shall assure confinement and long-term storage of SNF without any need for scheduled intervention during the whole storage period. Design of the cask will meet requirements defined by [1]. Detailed analysis of the cask safety issues will be presented in the Safety Analysis Report.

2.2.1. Cask Body and Cask Lid System

CONSTOR® RBMK1500/M2 casks are designed for the long-term (at least for 50 years) storage of RBMK1500 SNF bundles.

The CONSTOR® RBMK1500/M2 cask uses steel for the containment of the cask, heavy concrete as additional shielding, and a triple closure system with one bolted lid and two welded lids. Design of CONSTOR® RBMK1500/M2 casks is based on the technology of cask body and lid system, as well as of the lid welding procedure of the CONSTOR® RBMK1500 casks, which are successfully in use at INPP.

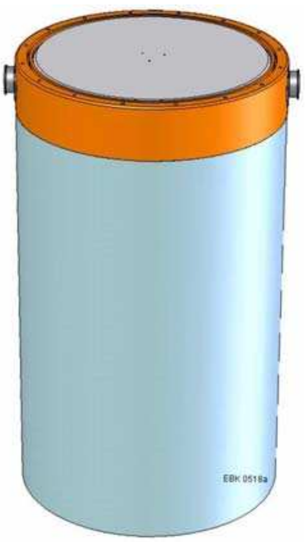


Figure 2.2.1-1. CONSTOR® RBMK1500/M2 cask

The sandwich design of the cask body consists of two thick-walled liners made from fine grain construction steel and heavy concrete (with granulated steel filling) in the inter space. The steel / heavy concrete / steel system provides both gamma and neutron shielding, and mechanical strength. The CONSTOR® RBMK1500/M2 type casks are dual purpose casks meeting the requirements for long-term storage and for transport.

The CONSTOR® RBMK1500/M2 type casks will be designed to meet requirements for B(U) packages [2] and therefore will be suitable for the off-site transport after interim storage is finished. For off-site transport cask shall be equipped with shock absorbers and a transport overpack.

The cask cavity is coated with a corrosion protection layer (on zinc silicate basis), which provides appropriate compatibility with the pool water during cask loading. After loading with SNF, the cask cavity is vacuum-dried and filled with inert gas (helium). In this way corrosion is inhibited and heat transfer in the cask cavity is improved.

The outer cask surface is protected by multi-layer epoxy resin, or comparable coating with proven corrosion protective and decontamination properties. The multi-layer epoxy resin is qualified against the cask dose rates (no deterioration, pealing, etc.).

The special feature of cask system is a triple lid closure system. The lid system consists of:

- The primary lid, sealed by an elastomer O-ring, which forms a shielded and gas-tight barrier of cask for handling, transfer to ISFSF and preparation for storage until welding of the seal plate;
- The welded seal plate which acts as the first leak-tight barrier for long-term storage;
- The welded secondary lid, which constitutes the second leak-tight barrier for long-term storage.

The combination of welded seal plate and welded secondary lid provides a full metal double containment system. The double-barrier welded lid system, together with the double-barrier design of the cask body, will ensure tightness of activity during long-term storage. The complete welded lid system enables CONSTOR® RBMK1500/M2 cask storing without need for active continuous monitoring of the leak-tightness of the cask lid system.

The preliminary cask dimensions are: cask body outer diameter is about 2.6 m, cask height is about 4.5 m; the wall is composed of the 4 cm thick inner steel liner, the 25 cm thick special concrete layer and the 4 cm thick outer steel liner; the lid system consists of the bolted, 27.5 cm thick primary lid, the welded 4 cm thick seal plate and the welded 4 cm thick secondary lid.

2.2.2. Fuel Baskets

For positioning of SNF bundles within the cask body a special baskets (i.e. fuel baskets) are inserted into the CONSTOR® RBMK1500/M2 cask. Three types of fuel baskets will be used for positioning of typical (i.e. leak-tight and with cladding leakage) or over packed (i.e. with mechanical damages) SNF bundles:

- 32M type basket for positioning of 102 typical SNF bundles;
- Ring basket for positioning of 80 typical SNF bundles;
- Special ring basket for positioning of 30 over packed SNF bundles.

32M type basket is presently used at INPP for storage of spent fuel in CONSTOR® RBMK1500 and CASTOR® RBMK1500 casks. Ring or special ring basket will be used together with 32M type basket to increase the total cask capacity for typical SNF bundles and to allow contemporaneously storage of typical and over packed SNF bundles.

The CONSTOR® RBMK1500/M2 casks capacity is 182 typical SNF bundles or 102 typical SNF bundles and 30 over packed SNF bundles.

The maximal spent nuclear fuel load is achieved in case of storing typical SNF bundles only. Depending on loaded SNF type, such a cask can contain higher activity content and potentially can result in a higher impact on environment. Activity and radiation sources of the reference fuel bundle in 32M basket may consist of the spent 2.0% and 2.1% fuel. Activity and radiation sources for the ring basket may consist of experimental, 2.4%, 2.6% and 2.8% fuel (see Chapter 2.1.3). Therefore the cask loaded with 102 SNF bundles of the maximal values from the spent 2.0% and 2.1% fuel in 32M basket and 80 SNF bundles of the 2.8% fuel (most conservative option from experimental, 2.4%, 2.6% and 2.8% fuel) in ring basket is selected as to be representative in assessing of maximum expected impact on environment. An erroneous loading of 32M basket with 2.8% fuel is limited to handling operations during cask loading. It will be detected by checking the 32M basket labels. An erroneous loading of the 32M basket with 2.8% fuel and radiological impact to personnel caused by this event, as well as technical measures for detection of this error and its elimination, will be analyzed in Safety Analysis Report.

2.2.3. Over Pack Cartridges

The over pack cartridges perform several functions:

- Ensure safe handling of the damaged (or other not typical) SNF bundle;
- Prevent spreading of fuel particles on storage pools equipment and into cask cavity;
- Ensure proper positioning of the SNF bundle inside the cask;
- Ensure de-watering and vacuum drying of the over pack cartridges during the cask de-watering and drying processes.

The SNF with mechanical damage will be processed (cutting, preparation to fit into the cartridges) and loaded into the cartridges under the water. Empty over pack cartridges will be pre-loaded into the transfer basket, which is positioned in the transfer canal adjacent to pool. Damaged fuel bundles will be removed from the submerged worktable (after separation of the fuel bundle from the fuel assembly) and will be transferred into the empty over pack cartridge. The over pack cartridge will be lidded remotely under water.

Design of cartridges will be specified during developing of Technical Design. Several types of over pack cartridges can be used depending on defective fuel damage nature.

2.2.4. Other Cask System Elements

At INPP Reactor Units the cask loaded with SNF will be closed with bolted primary lid only. For transfer to the ISFSF an additional protective plate will be mounted on the top of cask. The protective plate:

- Protects cask lid cavity against impact from atmosphere;
- Forms additional neutron and gamma shielding;
- Acts as additional cask structure support element.

At the ISFSF the protective plate will be dismounted and a seal plate and secondary lids will be welded into the cask body thus forming a full metal double containment fuel storage system. Then protective plate will be mounted again and cask will be transferred to its storage position. At the storage position cask system forms a structure capable to withstand severe external impacts such as airplane crash.

In the storage configuration the cask is provided with a protection plate and a concrete plate arranged above.

The function of the protection plate is twofold:

- During storage: Providing additional resistance for the cask lid system against external load from severe accidents (missile from aircraft crash);
- During transport and warehousing of empty casks and during transfer of loaded casks from the reactor units to the ISFSF: Protection of the cask lid area from dust, humidity and effects of the weather.

The concrete plate provides additional neutron shielding with respect to the dose rate external to the ISFSF.

For fuel inspection in FIHC, the cask protective plate, welded secondary lid and the welded seal plate shall be removed at the Cask Service Station. Then the cask can be transferred to FIHC. Due to long time storage, the tightness of the elastomer seal of primary lid could be insufficient. To prevent possible activity spread out during cask transfer from Cask Service Station to FIHC, a gas tight plate (so called “alpha seal”) will be mounted above primary lid.

2.3. Main Equipment and Technological Processes at Reactor Units

By this proposed economic activity at the Reactor Units the SNF bundles will be loaded into storage casks of CONSTOR® RBMK1500/M2 type and the cask will be prepared for transfer to newly constructed ISFSF.

2.3.1. Cask Reception, Loading with Spent Fuel and Preparation for Transfer

The reception of empty cask, loading with SNF and preparation for transfer to ISFSF will be held at Storage Pools Hall. Existing Cask Service Station is located in the same Storage Pools Hall. The Storage Pools Hall crane is used for cask transfer. A cask transporter parking room is below Storage Pools Hall and cask loading onto transporter is performed through hatch at Storage Pools Hall.

An empty CONSTOR® RBMK1500/M2 cask will be transported to the existing Cask Service Station for reception and preparation for loading. Existing Cask Service Station is presently used for handling of CONSTOR® RBMK1500 casks and is equipped with appropriate cask handling, radiation monitoring and other necessary installations. Most of existing installations will be used for handling of new type CONSTOR® RBMK1500/M2 casks. Only minor modifications of existing Cask Service Station will be necessary. Within proposed economic activity it is planned to install additional mechanical equipment necessary for handling of new type cask.

Cask reception and preparation for loading operations include removing of cask protective plate, checking of the ring geometry and mounting of cask contamination protection skirt. Then the cask will be lowered into the pool and the cask cavity will be filled with water.

The pool filled with water will assure appropriate radiation shielding during SNF loading operation. Existing, modified and additional equipment will be used for cask transfer operations.

The SNF bundles (loaded into 32M fuel baskets) are located in neighbouring pools at the same Storage Pools Hall. The existing and licensed fuel handling equipment will be used to transfer 32M fuel basket into fuel loading pool. The same equipment will be used for handling of special transfer basket with canned fuel.

The 32M fuel basket will be loaded into the cask using existing INPP equipment. For fuel bundles or canned fuel loading into ring baskets of the cask, a new Fuel Bundles Handling Equipment (FBHE) will be installed by this proposed economic activity.

The functional requirements for the FBHE are as follows:

- Removing a fuel bundle from a 32M basket located in the centre of the CONSTOR® RBMK1500/M2 cask and subsequently inserting the fuel bundle into the ring basket of the CONSTOR® RBMK1500/M2 cask;
- Removing an overpack cartridge from a transfer basket located in the centre of the cask and subsequently inserting overpack cartridge containing damaged / experimental fuel bundle or fuel debris container into the special ring basket of the CONSTOR® RBMK1500/M2 cask.

All fuel bundle transfers (both intact and damaged fuel loaded into overpacks) will be performed in the pool under the cover of water in a safe and controlled manner in full compliance with Lithuanian legislation and regulations.

The loaded with fuel cask will be closed by a primary lid. Then the loading pool will be isolated, drained and the primary lid will be bolted. Prior transfer back to Cask Service Station the cask will be de-watered, the contamination protection shirt will be sprayed with water and radiation dose rate measurements will be performed. The existing shock absorbers installed at appropriate levels of loading pool will be upgraded with respect to the increased weight of the new cask.

At the Cask Service Station loaded cask will be prepared for transfer to ISFSF. The accessible surfaces of the cask will be checked for contamination and will be decontaminated as far as required. Contamination protection skirt will be dismounted. The cask cavity will be vacuum-dried and filled with helium. The leak tightness of the primary lid will be tested and cask protective plate will be mounted on the top. Existing and additional equipment will be used for final cask preparation.

Then the cask will be loaded on the rail transport and tied down for transfer to ISFSF. After the cask has been lifted contamination monitoring and dose rate measurements will be performed at the cask bottom area. The existing shock absorber in the floor of transporter parking room will be upgraded with respect to the increased weight of the new cask.

2.3.2. Processing of Mechanically Damaged and Experimental Fuel

In order to retrieve and package the mechanically damaged and experimental fuel and fuel debris a Damaged Fuel Handling System (DFHS) will be designed to perform the following main functions:

- The safe removal of mechanically damaged and experimental SFA from the storage pools, processing of the mechanically damaged and experimental SFA, and insertion of the individual SNF bundles into cartridge overpacks for subsequent loading into the CONSTOR® RBMK1500/M2 casks;
- The safe removal of spent fuel pellets and fuel pellet debris from the floor of the storage pools; visual inspection and insertion of fuel pellets and debris into suitable cartridge overpacks for subsequent loading into the special ring basket of a CONSTOR® RBMK1500/M2 cask.

Up to 105 damaged SFA which require to be processed using the DFHS are anticipated after the INPP shutdown. In addition to the mechanically damaged fuel up to 33 experimental SFA (they are approximately ~10 m, ~16.3 m and ~17 m in length) require also to be processed using the DFHS.

By this proposed economic activity special equipment will be installed into emptied pool for processing of damaged and experimental fuel and fuel debris. The main components are Worktable Assembly and Fuel Debris Collection Equipment.

Damaged and experimental SFA will be collected from the storage position within storage pools and will be transferred using adapted INPP handling equipment to Worktable Assembly. The Worktable Assembly will be a steel fabricated assembly capable of being submerged in the existing storage pools. It will be installed after the undamaged fuel has been processed and the pool has been cleared.

The Worktable Assembly will be designed with the capabilities to first cut off the extension rod and then to cut the lower and upper fuel bundles from the SFA. The equipment for collection of metallic swarf which is probable during the cutting of non fuel components of SFA will be foreseen. The Worktable Assembly will be also capable of attempting to correct the geometry of distorted SFA with a bent central rod. Once cut from the SFA the damaged fuel bundles will be transferred to an overpack cartridge located in a transfer basket using the building crane for onward movement to the Fuel Bundle Handling Equipment and transfer to a CONSTOR® RBMK1500/M2 cask. Underwater equipment will be designed with the consideration for decontamination, modular dismantling and handling.

The experimental SFA will also be handled by the Worktable Assembly and will be cut into standard fuel bundle lengths following a detailed assessment of the engineering drawings as to the best place to cut. However because of the length of the experimental SFA some size reduction of the assembly may be required before the fuel bundles can be cut away. It is intended that the cut lengths of experimental fuel will be loaded into standard baskets prior to loading the basket into the CONSTOR® RBMK1500/M2 cask.

Pellet and fuel debris retrieval will take place after the ponds have been cleared of all types of stored fuel, (either in baskets, or in assemblies – including undamaged, damaged and experimental fuel), and sludges removed. The Fuel Debris Collection Equipment will be designed for removing of resident fuel pellets from the storage pools or for collecting and removing of fuel pallets accidentally lost during damaged fuel handling. Any fuel pellet debris collected from the pool floor will be placed into the overpack, which is designed to ensure that the quantity of fuel debris that can be held is significantly below any level at which a criticality incident may occur. Collection of pellets will be conducted from working platforms above the surface of the ponds in which they reside. Collection and repackaging will be a predominantly manual operation using extended collection and repackaging tools purpose designed to aid and assist in this process. Underwater equipment will be designed with the consideration for decontamination, modular dismantling and handling.

2.4. Transfer of Spent Nuclear Fuel and Other Transport from INPP to the ISFSF Site

The transfer of casks from INPP Reactor Units to ISFSF main storage building will take place by rail transport. A new railway line up to 1000 m length from INPP to ISFSF site will be constructed and connected to the existing railway system at INPP as shown in Figure 2.4-1. The part of railway line which connects INPP and ISFSF sites (up to 600 m length) will be protected with a fencing system.

The casks from INPP to ISFSF will be transferred loaded on a rail transporter in vertical position. The adaptations to the rail transporter for the CONSTOR® RBMK1500/M2 cask require a change in the main load-carrying frame, as the diameter of the cask is larger than the CONSTOR® RBMK1500 cask already used at INPP. The rail transporter will be drawn / pushed by the existing INPP locomotive.

For transportation of other materials (i.e. waste transport etc.) and safety needs (i.e. fire fighting transport from INPP etc.) several new roads will be constructed and connected to the existing road system of INPP area, Fig. 2.4-1. The internal ISFSF site roads will also be constructed. They are foreseen for controlling and maintenance activities as well as for assuring fire fighting needs.

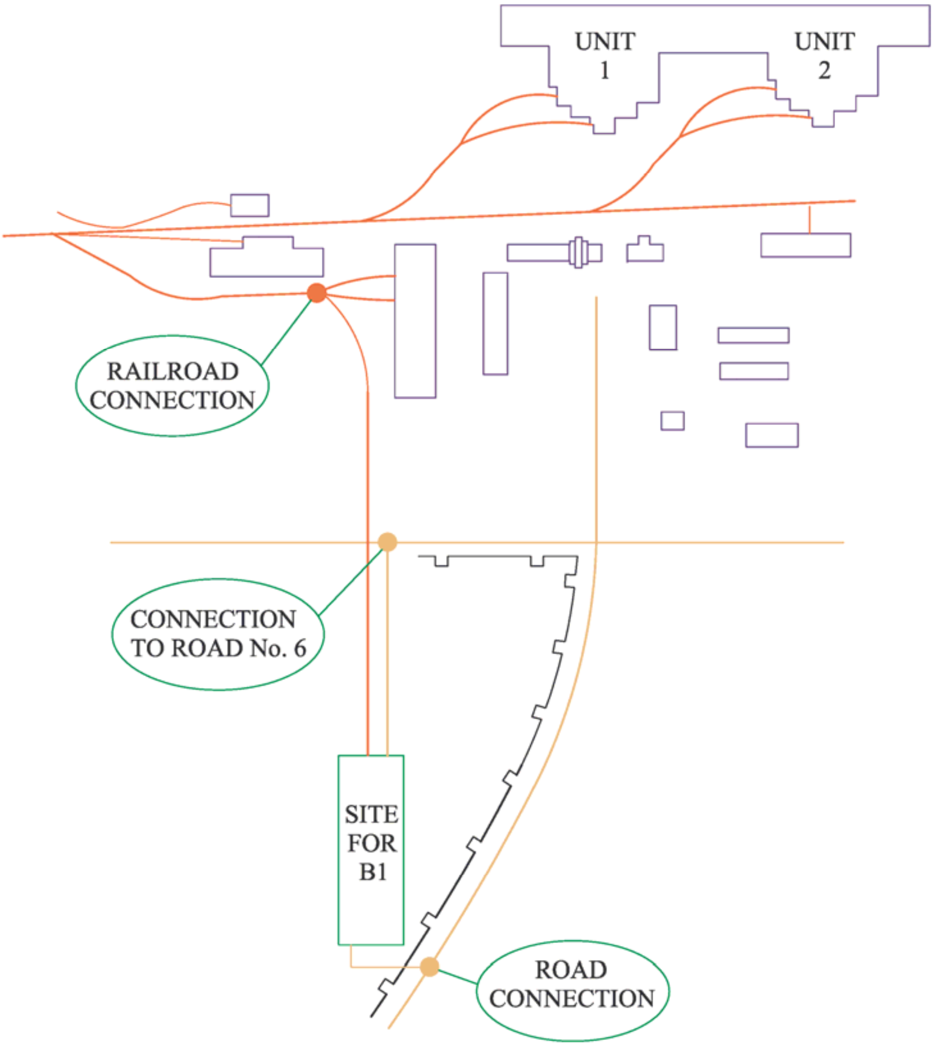


Figure 2.4-1. Scheme of the railroad and roads connection with the existing system

2.5. Main Equipment and Technological Processes at the ISFSF Site

By this proposed economic activity at the ISFSF site the main storage building will be constructed for preparation for storage and for interim storage of 201 casks with SNF transferred from INPP. The necessary auxiliary structures (for casks reception control, site physical protection, site and personnel service etc) also will be constructed. The ISFSF will have Fuel Inspection Hot Cell (FIHC) where stored fuel could be inspected and reloaded into new cask after dismantling of INPP SNF storage pools.

2.5.1. Buildings and Structures within the ISFSF Site

Main Storage Building

From the architectural point of view, the main storage building will have a clean functional design that will blend in well with the surroundings.

The main storage building is divided into two basic operating areas: reception (Reception

Hall) and storage (Storage Hall). The FIHC structure is also integrated into the main building construction. The main preliminary dimensions in plane of main storage building are indicated in Fig. 2.5.1-1. Preliminary height of the main storage building is 19.3 m. Final dimensions will be fixed during the design of the facilities.

Reception Hall

The Reception Hall includes:

- Controlled transport corridor with an impact limiter (i.e. shock absorber to protect the cask in the event of a dropped load after being unloaded from the transporter);
- Cask Service Station;
- Control room;
- Room for the instruments measuring aerosol and gaseous activity in the exhaust air;
- Dosimeter room, workshop, store rooms;
- Waste water tank room;
- Low and high voltage rooms;
- IAEA inspection room;
- Personnel entrance and exit;
- Staff facilities including toilets and washbasins, and a change-room with health physics control and showers;

The Cask Service Station will be designed for 2 working positions: one open for the controlled welding under normal conditions; the second one may be transformed into a closed room, where the introduced ventilation air after filtration is led into the exhaustion system of the FIHC.

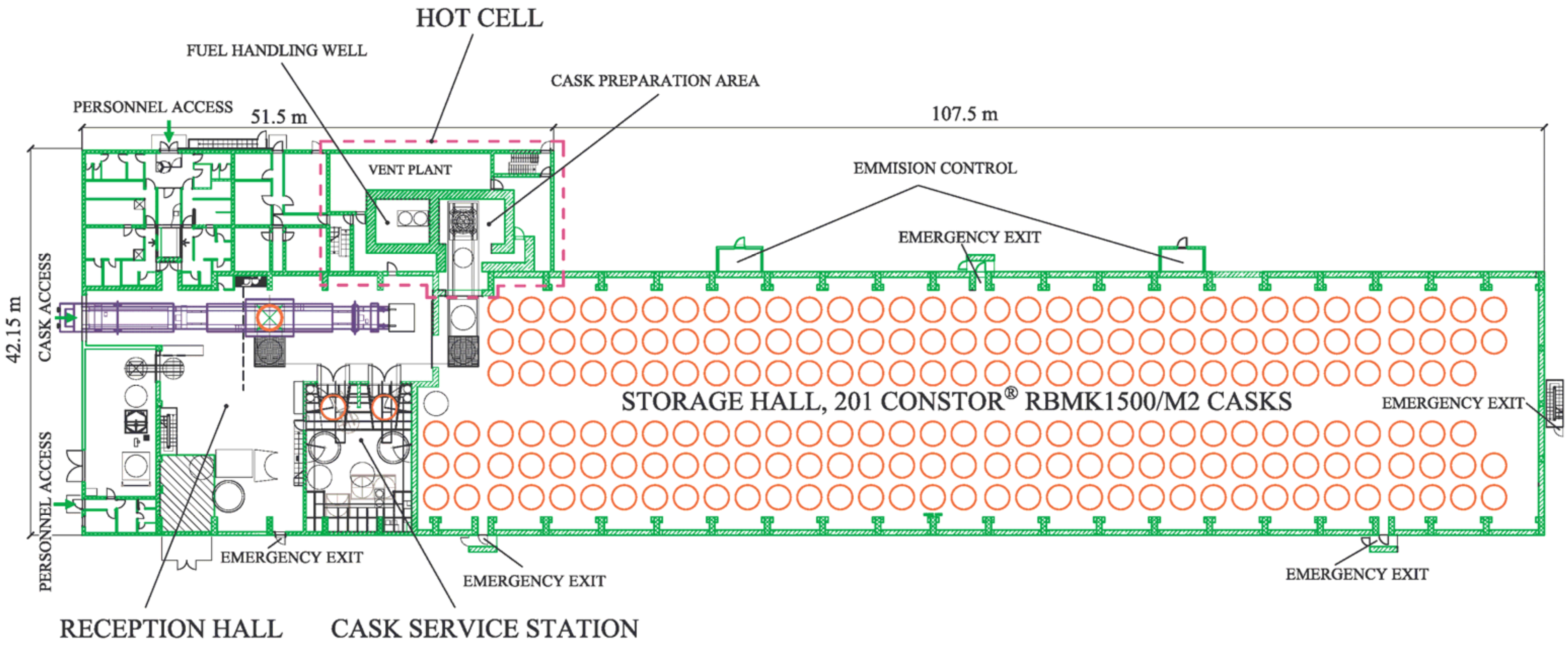


Figure 2.5.1-1. Conceptual layout of the main storage building

Storage Hall

The Storage Hall serves for storing of the casks. The Storage Hall, integrated into the main building construction, has the same wall and floor slab conditions as the Reception Hall. The Storage Hall is separated from the Reception Hall by a shield wall with a sliding shield door for moving the casks in and out.

Inside the main storage building (Reception and Storage Halls) the cask transfer operations will be performed by an overhead crane with a suitable vertical traverse. The crane will be remote-controlled using operator view, cameras and a cask position locating support system. The system allows a remote handling of the casks in the storage area.

The Storage Hall will be provided with natural ventilation, transporting by demand the eventually generated heat of the casks. The air inlets and air outlets will be programmed in the position “closed”. If the temperature inside of the storage area rises to pre-defined temperature, the air inlets and outlets will be opened using electrically powered actuators. The air inlets will be along the side of the building and outlets in the roof. The air inlet openings will be protected with external shield walls, erected until a height with sufficient protection against radiation.

Hot Cell for Spent Fuel Inspection and Repackaging

The Fuel Inspection Hot Cell (FIHC) will be a reinforced concrete enclosure. The thickness of the external walls of the FIHC will be sized to optimize doses for operating personnel and general public and not to exceed dose constraints.

The FIHC walls will incorporate lead glass windows to assist operator viewing of internal operations. A range of manipulator tools and interchangeable hoists/grabs will be parked inside the FIHC and will be capable of being moved to the required position in the FIHC, using through-wall manipulators. These manipulators will assist with in cell operations, including assistance when changing cell hoist lifting features.

The FIHC will be serviced by a dedicated ventilation extract system; this will comprise a duty and standby fan arrangement. The ”duty” fan will be sized to accommodate operations within the FIHC during SNF inspection and repackaging procedures. The “duty” fan will achieve the required ventilation throughput and will generate the necessary negative pressure within the cell. The standby fan will be a smaller unit. The standby fan will be sized to allow the FIHC ventilation to be reduced during times when the cell is not in use and does not contain fuel, whilst still maintaining a nominal negative pressure within the FIHC.

The FIHC ventilation extract system will utilise primary and secondary High Efficiency Particulate Air (HEPA) filters positioned within a local ventilation plant room, external to the FIHC. The HEPA filters will be arranged such that there will be two duty filters and one standby filter. The exhaust air after filtration will be discharged via a dedicated exhaust stack.

The FIHC will be designed with smooth lines to avoid the build up of contamination on surfaces and in equipment recesses. It will be lined with an appropriate decontaminable material. Remote decontamination equipment will be provided to bring contamination levels down to a level acceptable for man entry. The FIHC decontamination methods will be presented in Technical Design and will be addressed in Safety Analysis Report.

Auxiliary structures

Gate house

The main access to the ISFSF is through a vehicle and transport train inspection area (i.e. gate house), which has electrically and mechanically controlled gates, and a pedestrian gate leading to a gate house area. The gate house will be integrated with the security and administration building.

Security and administration building

To control access to the facility, a security and administration building will be erected immediately next to the inspection area, also as part of the security fencing system.

The security and administration building encompasses the facilities for security control:

- Access control area (with personnel access turnstiles outside the building, fixed walk-through metal detector, fixed devices to detect radioactive and explosive materials, X-ray device for personal effects or equipment);
- Security control room;
- Key card coding and issue room;
- Duty office.

Cars parking area

Next to the main entrance gate and gate house, a cars parking area will be constructed. The walkway will connect this area to the personnel entrance.

2.5.2. Cask Preparation for Storage and Storage

Two cask preparation positions are foreseen in the Cask Service Station in the Reception Hall. In these positions the cask will be prepared for storage. Here the seal plate and secondary lid will be welded on and any other necessary operations (works quality testing, mounting of cask protective plate etc.) are done.

Automatic submerged arc hot wire welding process is used for seal plate and secondary lid welding. After tacking the seal plate and the secondary lid respectively and testing of the tack welds, the multi-layer weld of the seal plate is produced. Equipment for welding dye penetration testing and ultrasonic testing will be provided.

The prepared for storage cask then will be transferred to Storage Hall and will be positioned into appropriate storage position.

2.5.3. Spent Fuel Inspection and Repackaging

The cask will be designed in such a way, that the operational lifetime of the ISFSF will be not less than 50 years. The conformance criteria for cask will be defined during Technical and Detailed Design stages. In the case that a cask is found to be defective during storage at ISFSF, the spent fuel can be repackaged inside the Hot Cell.

For nuclear fuel inspection and reloading the casks will be transferred from the Storage Hall into the Cask Service Station using the storage facility crane and appropriate lifting equipment.

The concept of Cask Service Station design foresees to provide an underpressure conditions during removing of secondary lid and seal plate in case of an unexceptional fuel repackaging. This underpressure makes sure that all possible radioactive effluents outgoing only through the ventilation system with HEPA filters.

Within the Cask Service Station, the secondary lid and seal plate will be removed in a controlled sequence of milling operations. Gas from cask cavity will be extracted and cask will be filled with nitrogen to ambient pressure. An additional gas tight plate (so called “alpha seal”) will be mounted above primary lid. The cask then will be transported from the Cask Service

Station to the trolley loading position adjacent to the FIHC. The loaded rail-mounted cask trolley will drive the cask into the FIHC entry port.

Inside FIHC the SNF bundles will be extracted from the original cask basket and will be placed into a second basket. The second basket will be resident in the FIHC prior to any fuel reloading operations. Once fuel transfer into second basket is completed, the emptied cask will be closed with primary lid and removed from FIHC entry port. A new empty cask will be transferred into FIHC entry port and SNF from the FIHC can be reloaded back into the new cask. Once repackaging is complete, the alpha seal will be mounted, the cask will be transferred to Cask Service Station for preparation for storage and subsequently to Storage Hall for interim storage.

Justification of the long term integrity of the SNF during handling and storage will be performed in the Safety Analysis Report and Technical Design.

For normal operations of the FIHC the ventilation system will maintain the cell at a depression, providing about 5 air changes per hour. Primary and secondary HEPA filtration will be provided for the extract ventilation of controlled access areas. Both primary and secondary filter banks will have 100 % standby capacity. The monitoring of off-gas from the FIHC and Cask Service Station will be performed in the common stack.

The FIHC will be designed to enable the inspection of SNF bundles only in the state that they are withdrawn as an assembly from the storage basket. The FIHC will not be capable of removing a bundle from an over pack cartridge nor be capable of disassembly of any part of a SNF bundle.

3. WASTE GENERATION AND TREATMENT

The structure of this Chapter of the EIA Report is similar to the structure of the approved EIA Programme and its content conforms to the regulatory table of contents.

During the construction of the ISFSF, only non-radioactive waste will be generated. During the operation of the ISFSF, small amounts of radioactive waste will be generated in the controlled access area. A significant advantage of the cask system proposed in this economic activity is that it generates minimal waste. This has been confirmed by previous experience.

3.1. Non-radioactive Waste

3.1.1. Solid Waste

Non-radioactive solid waste will be generated during construction and operation of the ISFSF.

Estimated overall production quantity of construction waste during construction phase of the ISFSF is as follows:

- Containers (20 m^3) with construction material (steel facades, insulation, brickwork, screed, sand, gravel): 20;
- Containers (20 m^3) with packaging material (paper, wood, plastic foils): 10.

Estimated production quantity per month of utility type waste during operation of the ISFSF is as follows:

- Containers (3 m^3) with mixed utility type waste (paper and cardboard, textile, wood, plastic foils, tins): 20;
- Containers (1 m^3) with organic kitchen-stuff for compost: 10.

Non-radioactive waste will be managed in accordance with the requirements of waste management legislation and regulations in force [1–4], INPP instruction [5] and permission on integrated prevention and control of pollution [6], and following requirements of technical regulation on Waste Removal (application attachment No. 18). It is necessary to note that earlier indicated ISFSF generated annual amounts of paper and carton waste (non-hazardous, code 15 01 02), plastic packages (non-hazardous, code 15 01 02), wooden packages (non-hazardous, code 15 01 03), mixed packages (non-hazardous, code 15 01 06), glass packages (non-hazardous, code 15 01 07) will comprise only 2 %, 1 %, 2 %, 0.5 % and 1.5 % respectively of the highest annual amounts allowed to be generated by INPP [6], absorbents, wipes, rags, filter materials, contaminated with hazardous chemical substances or oil products (H14 hazardous for environment, code 15 02 02) – 2 % of the highest annual amounts allowed to be generated by INPP [6], concrete (non-hazardous, code 17 01 01) – 2 %, bricks (non-hazardous, code 17 01 02) – 0.5 %, wood (non-hazardous, code 17 02 01) – 0,5 %, metal compounds (non-hazardous, code 17 04 07) – 1.5 %, cables (non-hazardous, code 17 04 11) – 0.5 %, mixed communal waste (non-hazardous, code 20 03 01) 1 % of the highest annual amounts allowed to be generated by INPP [6].

Possible impacts of the proposed economic activity on the environment components (water, air, soil etc.) are analysed in Chapter 6.

3.1.2. Effluents

The only source of non-radioactive effluents during the ISFSF operation will be household waste water and sewage from toilets, showers and washbasins from non-controlled areas. Estimated waste water discharge is about 4000 m^3 per year. Sewerage water system of the ISFSF will be connected early with the existing INPP system, which capacity is sufficient for additional sewerage water.

During construction the personnel on site will vary between 10 and 70 people, reaching a statistic average of 50 employees. A construction workforce of as many as 50 people could generate as much as 5 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 effluents will be allowed.

Estimated storm drain water discharge is about 8300 m^3 per year. Storm drain water will be collected by the installed system, connected with the INPP site installation.

Possible impact of non-radioactive effluents (including construction phase) on the environment components is analysed in Chapter 6.

3.1.3. Gaseous Emissions

The emergency diesel-generator will be the only source of controlled non-radioactive release at ISFSF site. In this section, the potential impact on the environment and cost of environment pollution due to operation of emergency diesel-generator is estimated.

Amounts of released pollutants can not be calculated using the methodology No. 30.2 [7] from the “List of methodologies for calculation of emission amounts” [8], which is intended for calculations when fuel burns up in steam-boiler. In our case the emergency diesel-generator is internal-combustion engine. Therefore the amounts of released pollutants were calculated using the methodology [9] approved by the Ministry of Environment for internal-combustion engines. Tax for pollution of environment was calculated according to the Law on Tax for Pollution of Environment [10] and resolution of the Government [11].

The backup power will be provided by the stationary emergency diesel-generator (DG) and will be limited to 24 hours. The power of DG is 80 kW, the annual consumption of diesel fuel is conservatively assumed to be 0.3 t.

Overall amount of polluting substances released into atmosphere from the internal-combustion engines is calculated using the following formulas [9]:

$$W = \sum_{k} \sum_{i} W_{(k,i)}, \qquad (1)$$

where:
W – overall amount of pollutants;
$W_{(k,i)}$ – amount of k pollutant after combustion of i type fuel;
k – polluting substances: CO, CH, NO_x, SO_2, solid particles;
i – fuel type: gasoline, diesel fuel, liquid gas from oil, compressed natural gas.

Amount of k pollutant after combustion of i type fuel is calculated as follows:

$$W_{(k,i)} = m_{(k,i)} \times Q_{(i)} \times K1_{(k,i)} \times K2_{(k,i)} \times K3_{(k,i)}, \quad (2)$$

where:
$m_{(k,i)}$ – comparative amount of k pollutant after combustion of i type fuel (kg/t);
$Q_{(i)}$ – amount of used i type fuel (t);
$K1_{(k,i)}$ – coefficient for evaluation of engine work conditions;
$K2_{(k,i)}$ – coefficient for evaluation of engine age;
$K3_{(k,i)}$ – coefficient for evaluation of engine design singularity.

In our case, coefficient *K1* was determined according to the fuel consumption index M<0.8 from Table 2 [9] as follows:

$K1_{(CO)} = 0.818$; $K1_{(CH)} = 1.02$; $K1_{(NOx)} = 0.914$; $K1_{(SO2)} = 1.0$; $K1_{(particles)} = 1.538$.

Because the new DG will be installed and used very rarely, coefficient *K2* was determined as 1.0 for all five pollutants according to the age index R<3 y from Table 4 [9].

Because the DG will comply with 91/542 EC (EURO II) requirements, coefficient *K3* was determined according to the engine design singularity p15 from Table 8 [9] as follows:

$K3_{(CO)} = 0.29$; $K3_{(CH)} = 0.31$; $K3_{(NOx)} = 0.39$; $K3_{(SO2)} = 1.0$; $K3_{(particles)} = 0.3$.

Comparative amounts $m_{(k)}$ of pollutants were determined according to the Table 1 [9] for diesel fuel as follows:

$m_{(CO)} = 130$; $m_{(CH)} = 40.7$; $m_{(NOx)} = 31.3$; $m_{(SO2)} = 1.0$; $m_{(particles)} = 4.3$.

Calculated amounts of pollutants and tax for environment pollution calculated according to [10, 11] are presented in Table 3.1.3-1.

Table 3.1.3-1. Calculated amounts of pollutants and tax for pollution of environment

Polluting substance	Amount of pollutant, kg/year	Tax tariff for 2005–2009, Lt/kg [10, Annex 1]	Annual tax, Lt
CO	9.3	0.013	0.12
CH	3.9	-	-
NO_x	3.3	0.587	2.29
SO_2	0.3	0.311	0.09
Solid particles	0.6	0.57	0.34
Total	**17.4**	**-**	**2.84**

As can be seen from Table 3.1.3-1, the total amount of pollutants is only 17.4 kg/year. It can be concluded that the emissions from DG operation are very low.

Possible impacts of mobile sources on the environment components (including construction phase) are analysed in Chapter 6.

3.2. Radioactive Waste

3.2.1. Solid Waste

Solid waste will be collected in plastic bags, tied up on top. There will only be a small amount of process low-active radioactive waste arising from cask preparation in the store, for example slag from submerged arc welding of the cask lids, material used for cask and equipment decontamination. Tissues from wipe tests on potentially contaminated surfaces will be stored in plastic bags. Solid waste would be placed in a transport container.

No secondary solid radioactive waste is generated by the cask during the long-term storage period. FIHC miscellaneous maintenance equipment will arise only occasionally.

The quantity of solid waste resulting from routine operation of the ISFSF is assessed to be not more than 20 standard drums (drum volume – 200 litres) per year with waste of the categories A–C.

The following waste amounts of the classes A–C are estimated to be from ISFSF decommissioning:

- 4 pcs. 200 litre drums with strippable coating from FIHC;
- 6 pcs. 200 litre drums with mixed material from dismantling;
- 1 steel plate container type IV (3.00 m x 1.70 m x 1.45 m) with rubble from building decontamination.

Such small amounts of radioactive waste from ISFSF decommissioning will have only negligible influence on disposal capacities of future repositories.

Mainly due to the high cobalt impurity content in the applied steels, the expected neutron activation of the most cask and basket components will be to such an extend that additional measures will be necessary for the decommissioning of those materials. More detailed substantiation of the neutron activation will be provided in Safety Analysis Report.

Solid radioactive waste generation during the operation and maintenance of the ISFSF are as follows. A proposal for the handling and treatment of each waste type is included.

3.2.1.1. Fuel assembly extension rods, central rods and caps

The extension rods, central rods and caps of mechanically damaged fuel assemblies only have to be considered within the scope of the ISFSF. Small amount of these rods and caps will be transferred into waste container and dispatched using the current INPP plant and equipment; this waste type will continue to be handled using the existing INPP procedures.

It is probable that during the cutting of non fuel components, an amount of metallic swarf could be generated. To counteract the loss of swarf to the pool forced flow devices (water suction) around the cutting heads will include localised filtration media to capture any major swarf contaminant.

The cutting equipment will be designed with consideration for ease of decontamination, modular dismantling and handling. End effectors and cutting media (e.g. slitting saw blades and filtration media) will be designed for ease of remote replacement and remote handling.

3.2.1.2. Cases for spent nuclear fuel

Cases for damaged and undamaged fuel currently reside within the cooling pools. After removal of the fuel, they will remain the responsibility of INPP and should be part of the cooling pool decommissioning. This also relates to the 32M-baskets not used for the dry fuel storage.

3.2.1.3. Material removed from cask seal welds

Material removed from cask seal welds during cask secondary lid and cask sealing plate removal in the FIHC will be collected at dedicated ventilation extract positions. The waste material will be monitored and will be put into sealable bags for transfer to the INPP appropriate waste treatment / storage facility.

3.2.1.4. Wipes generated during cask decontamination activities

Wipes generated during cask decontamination activities in the cask opening area will be bagged at the cask unbolting area for transfer to the INPP waste facility.

3.2.1.5. Weld slag

Material from cask closure welding operations will include weld slag, which will be bagged for transfer to the INPP waste facility.

3.2.1.6. Bagging materials

Transfer housings (usually bagging materials) used to transfer material out of the FIHC – these materials will be monitored, bagged and placed in the INPP transport container for transfer to the appropriate waste treatment / storage facility.

3.2.1.7. Hot Cell miscellaneous maintenance equipment

FIHC miscellaneous maintenance equipment will arise only occasionally. This range of materials covers replacement of seals, gaskets and consumable items such as lights and items replaced due to maintenance activities. These will be assessed, bagged and placed in the INPP transport container for transfer to the appropriate waste treatment / storage facility.

The TS [12] requires the possibility of fuel repackaging if a storage unit is found to be defective. The cask after fuel repackaging is not operational waste. The cask may, depending on the defect, be refurbished. Otherwise it should be a part of decommissioning waste. The emptied defective cask can be stored in the ISFSF until the decommissioning of facility. Decommissioning options are discussed in the chapter 1.5.3.

If the FIHC is operated, then the cell will be decontaminated after the cask routine has been completed. This decontamination will include (as necessary) dry vacuuming and swabbing of any contamination which could be found within the cell. The vacuum cleaner will include a receipt vessel to house any contaminated material. This receipt vessel will be designed for manual changing and will therefore be monitored and removed from the vacuum unit to allow these manual operations. Swabs and cleaning materials will be assessed prior to release from the FIHC and are also intended to be transferred (in sealed bags or special containers) for storage via the existing INPP LLW routes.

The quantity of radioactive waste resulting from the FIHC operation is assessed to be not more than 5 standard drums (drum volume – 200 litres) per year with waste of the categories A–C.

3.2.1.8. HEPA filters

The High Efficiency Particulate Air (HEPA) filters to remove aerosols from the FIHC will be monitored for radioactivity and the differential pressure across the filters. The filter cartridges will be manually discharged from the filter housings before the activity levels reach unacceptable levels, and will be loaded into sealable bags using manual change techniques. The filters will be monitored to ensure that they are below ILW levels and placed in the INPP transport container for transfer to the appropriate waste treatment/disposal facility.

3.2.1.9. Change room waste

Change room waste – overshoes, respirators, miscellaneous change room equipment. These will be put into sealable bags and placed in the transport container for transfer to the INPP appropriate waste treatment/disposal facility.

3.2.2. Liquid Waste

Waste water generated in the the controlled access area of ISFSF will arrise as follows:

- Sewage water from the showers and washbasins;
- Waste water from cleaning and decontamination of equipment and building structures;
- Condensation water from building structures, HVAC and Stack.

The wastewater will be collected in liquid waste collection tanks located in the storage facility. The wastewater from the tank will be sampled, chemical and radiological parameters will be measured. Depending on analysis results, the wastewater may be discharged to the ISFSF sewerage system (c.f. chapter 3.1.2) or will be sent to the INPP for treatment.

The the liquid waste handling system will be designed to be able collect and, if necessary, transfer for further treatment all liquid wate generated in the controlled access area of ISFSF. Container for liquid radioactive waste transfer will be a tank (capacity of at least 1 m³) mounted on a trailer. The radioactive effluents may be discharged into the environment only if the Permission for Releases of Radioactive Materials into Environment will be obtained in accordance with regulations in force. There will be no uncontrolled discharges of radioactive effluents into the environment from the proposed economic activity under normal operation conditions.

Survey boreholes (wells) for monitoring underground run-off water will be foreseen around the ISFSF as part of required environmental monitoring (see Section 8.3).

3.2.3. Gaseous Emissions

Gaseous radioactive emissions from main ventilation stacks of Reactor Units are expected during spent nuclear fuel transfer from Reactor Units to ISFSF phase. Gaseous radioactive emissions from ISFSF ventilation stack can be expected in case of spent nuclear fuel repacking at FIHC during interim spent fuel storage phase. 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 radioactive airborne emissions expected during normal operation of proposed economic activity are assessed in chapter 5.1, cf. Table 5.1.1-7 “Annual release of airborne activity into atmosphere through INPP main ventilation stacks” and Table 5.1.4-1 “Annual release of airborne activity into atmosphere through ISFSF ventilation stack”.

The radioactive emissions due proposed economic activity will be low. Highest emissions could be expected during spent nuclear fuel transfer to ISFSF phase (years 2008–2015) and concerns processing and handling of leaking fuel at Reactor Units. Releases due to processing and handling of damaged and experimental fuel (i.e. due to operation of DFHS), handling of intact fuel or fuel repacking at FIHC will be lower.

Releases due to processing and handling of leaking fuel at Reactor Units have been estimated conservatively. According to selected scenario, which assumes that all leaking fuel is processed and handled within a single year period, the annual radioactive emissions would not exceed 9.17×10^{13} Bq. Releases are governed by noble gas Kr-85 (8.79×10^{13} Bq) and gaseous H-3 (3.75×10^{12} Bq). Release of Cs-134 and Cs-137 are about 1.27×10^{9} Bq. As the leaking fuel normally will be processed and handled within several years period, the actual radioactive emissions due to proposed economic activity will be lower than assessed.

Radioactive emissions from INPP site are limited by conditions of Permission for Releases of Radioactive Material into Environment [13] issued by Ministry of environment.

Comparison of licensed conditions (for radionuclides relevant for this proposed economic activity only) with assessed releases due to proposed economic activity is presented in Table 3.2.3-1.

Table 3.2.3-1 Licensed conditions for radioactive emission into atmosphere from INPP site and assessed releases due to proposed economic activity

Radionuclide	Licensed conditions		Assessed releases			
	Limit, Bq/a	**INPP planned emissions, Bq/a**	**Intact fuel handling at RU** (1), **Bq/a**	**Leaking fuel processing and handling at RU** (2), **Bq/a**	**Damaged and experimental fuel processing at RU** (3), **Bq/a**	**Fuel reloading at FIHC** (4), **Bq/a**
H-3	2.39E+14	2.43E+12	6.94E+09	3.75E+12	7.69E+11	1.04E+11
Cs-134	1.33E+09	7.18E+07	4.42E+05	2.39E+08	3.79E+05	6.63E+05
Cs-137	1.39E+11	9.84E+08	1.91E+06	1.03E+09	1.84E+06	2.87E+06
Ce-144	7.86E+09	2.48E+07	0	0	2.03E+05	0

(1) – One year maximal increase of radioactive releases due to handling of all intact fuel at Reactor Units, cf. Table 5.1.1-7
(2) – One year maximal increase of radioactive releases due to handling of all leaking fuel at Reactor Units, cf. Table 5.1.1-7
(3) – One year maximal increase of radioactive releases due to operation of defective fuel handling system at Reactor Units, cf. Table 5.1.1-7. The DFHS will start operating after all undamaged (including leaking) fuel assemblies are emptied from the storage pools. Therefore releases into atmosphere from undamaged (including leaking) fuel handling and from DFHS will not occur at the same time and therefore shall not be summed
(4) – Annual releases due to reloading of the cask containing leaking fuel at FIHC of ISFSF, cf. Table 5.1.4-1. 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 plant operations.

It can be observed from Table 3.2.3-1 that assessed radioactive emissions due to proposed economic activity together with planned emissions for INPP site are considerably below licensed limits.

4. DESCRIPTION OF THE COMPONENTS OF THE ENVIRONMENT LIKELY TO BE AFFECTED BY THE PROPOSED ECONOMIC ACTIVITY

The environmental baseline data are presented in this chapter. Baseline information characterizes the conditions at the time the project is proposed. The environmental baseline data are used as a starting point in the prediction of likely impacts resulting from the proposed economic activity and of naturally occurring change in the environment, as input data for the design of the ISFSF (engineering, construction, safety measures, etc.), for the comparison of alternatives and for determining impact mitigation measures.

The analysis of potential radiological impacts on the environment under normal operation conditions is given in the Chapter 5 and in emergency situations is given in Chapter 9. The analysis of potential non radiological impacts on the component of the environment during construction and operation of ISFSF is presented in the Chapter 6.

Monitoring of radiological situation in the environment of INPP region is carried out in accordance with the regulatory approved environment monitoring programme. Description of the INPP radiological monitoring system and the present radiological state of the environment is presented in the chapter 8.

4.1. The Region and the Site Geology

4.1.1. Precambrian Crystalline Basement

The ISFSF site is located in the western margin of the East European Platform. It is located in the junction zone of two major regional tectonic structures: the Mazur-Belarus Rise and the Latvian Saddle that makes the structural pattern of the area rather complicated. The contemporary relief of the crystalline basement reflects movements over period of 670 million years. Several tectonic structures (blocks) of the lower order are distinguished in the surface of the Precambrian crystalline basement: the North Zarasai Structural terrace, the Anisimoviciu Graben, the East Druksiai Uplift, the Druksiai Depression (Graben) and the South Druksiai Uplift. The North Zarasai Structural terrace, the Anisimoviciu Graben and the East Druksiai Uplift are related to the Latvian Saddle. The South Druksiai Uplift belongs to the Mazur-Belarus Rise and the Druksiai Depression (Graben) is located within the junction zone of the two aforementioned regional structures [1, 2].

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 ISFSF 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 (Figures 4.1.1-1 and 4.1.1-2).

The Lower Cambrian is represented by quartz sandstone with inconsiderable admixture of the glauconite, siltstone and shale. The sandstone is of the different grain size with the 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 – 28–75 m and the total thickness of the Devonian sediments reaches 250 m [2].

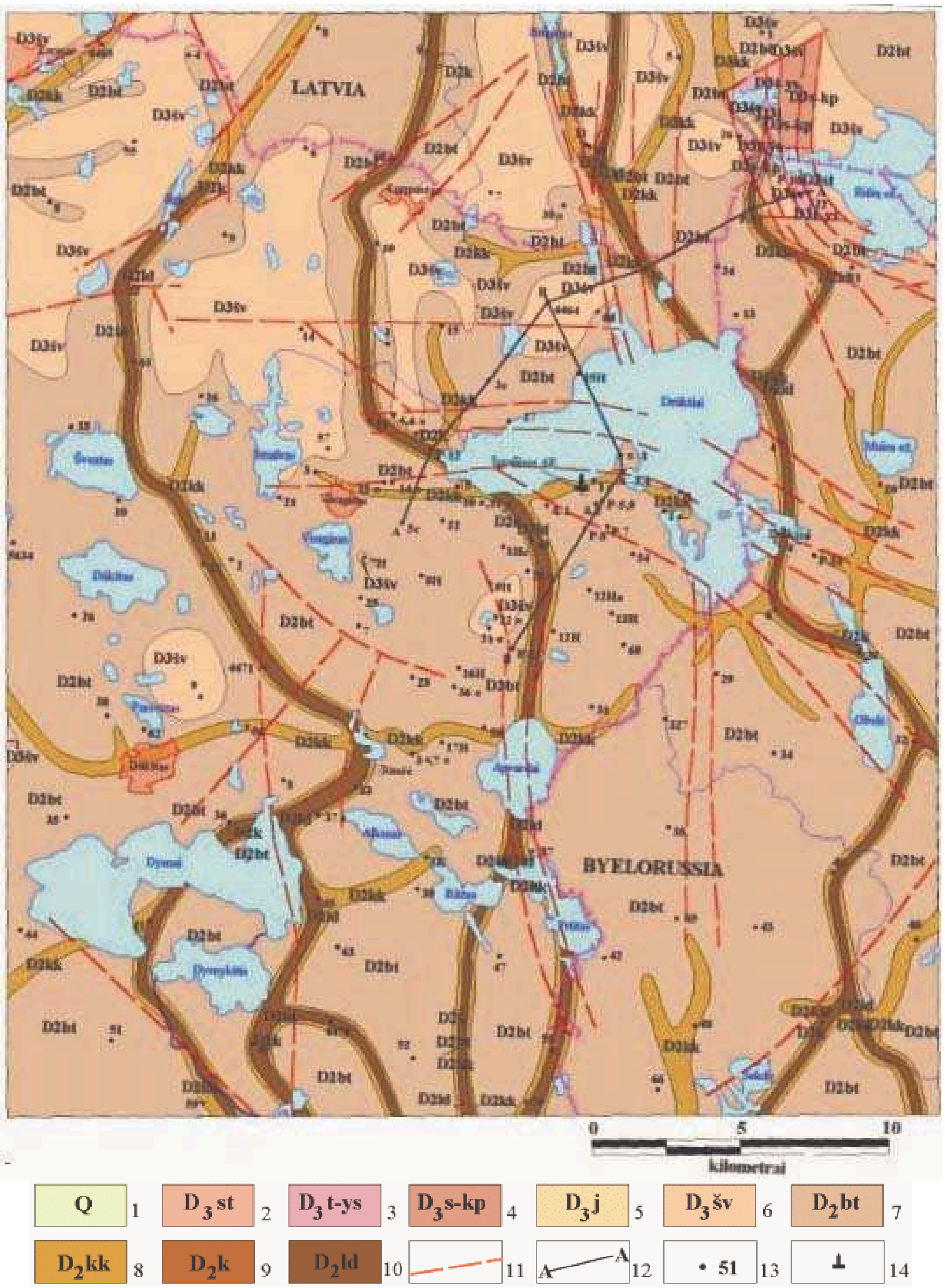


Fig. 4.1.1-1. Pre-Quaternary geological map of the ISFSF region [2]: 1 – Quaternary deposits (on the sections); Upper Devonian formations: 2 – Stipinai; 3 – Tatula–Istra; 4 – Suosa–Kupiskis; 5 – Jara; 6 – Sventoji; Middle Devonian formations: 7 – Butkunai; 8 – Kukliai; 9 – Kernave; 10 – Ledai; 11 – Fault; 12 –Line of geological-tectonical cross-section; 13 – Borehole; 14 – Ignalina NPP and ISFSF

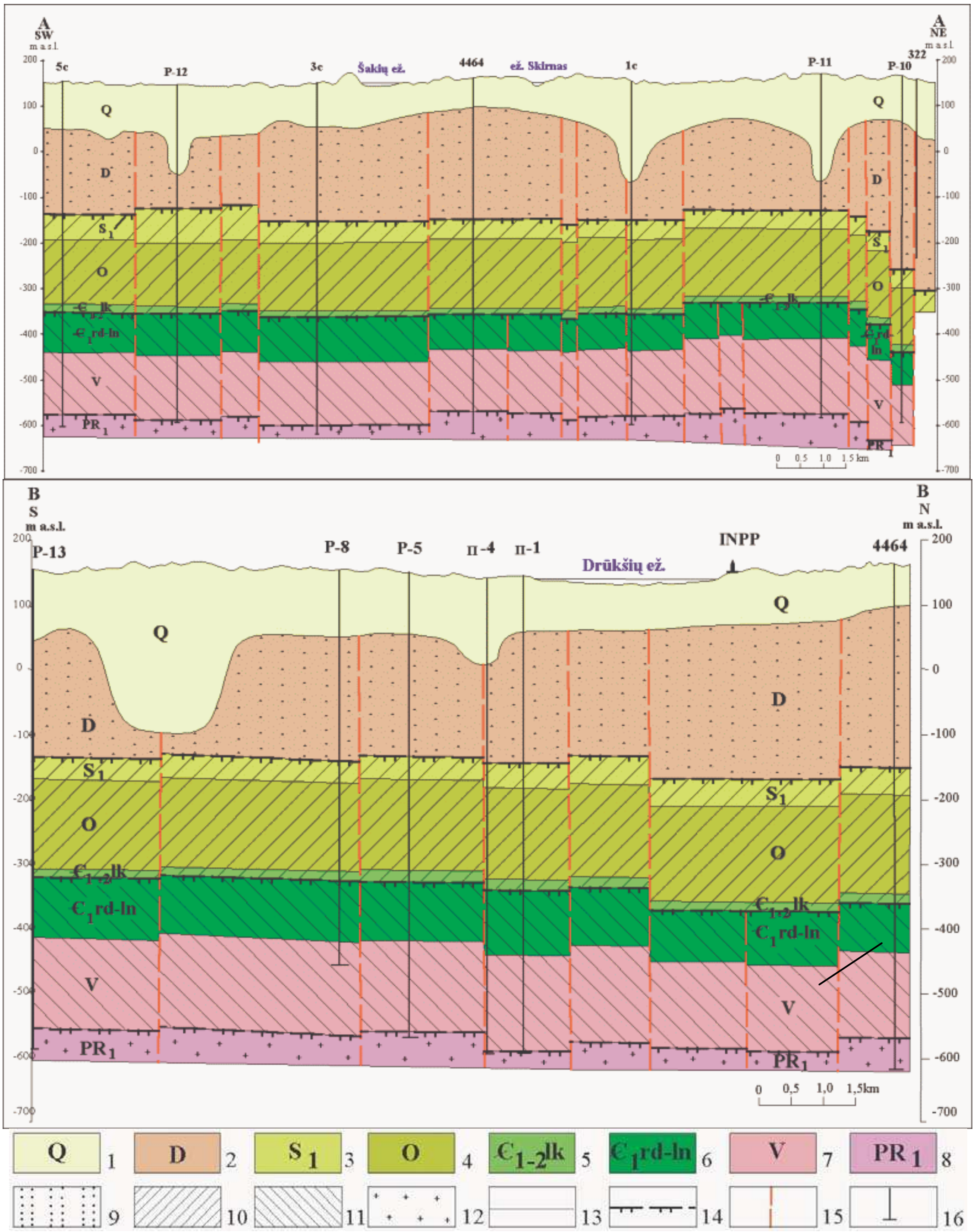


Fig. 4.1.1-2. Geological-tectonic cross-sections of the ISFSF region [2]: 1 – Quaternary: till, sand, silt and clay; 2 – Middle and Upper Devonian: sand, sandstone, siltstone, clay, domerite, dolomite, breccia; 3 – Lower Silurian: domerite, dolomite; 4 – Ordovician: limestone, marl; 5 – Lower and Middle 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

4.1.2. Quaternary Cover

Sub-Quaternary relief of the area is highly dissected by paleoincisions (Fig. 4.1.2-1). The thickness of the Quaternary cover varies from 62 up to 260 m.

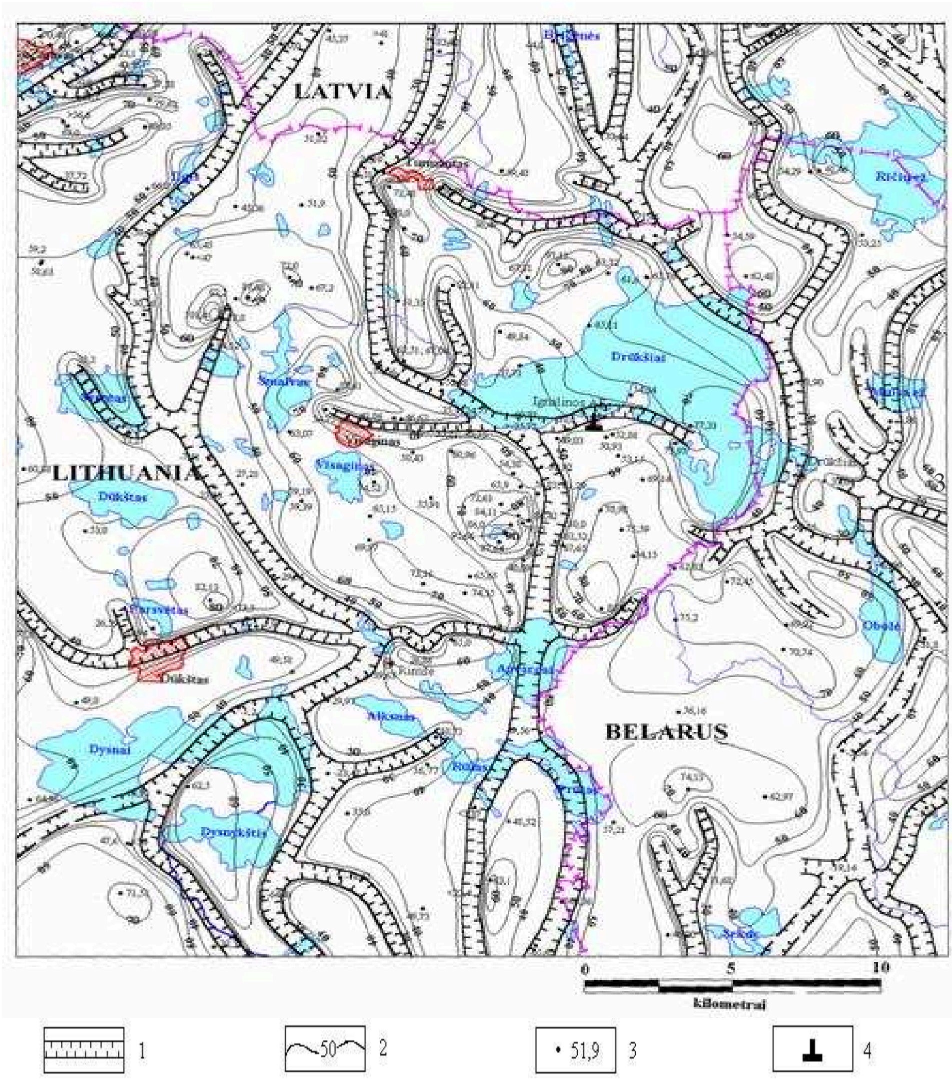


Fig. 4.1.2-1. Scheme of sub-Quaternary surface of the ISFSF area [2]: 1 – Paleoincision; 2 – Isohypse of pre-Quaternary surface, m; 3 – Boreholes and the absolute depth of the pre-Quaternary surface: 4 – INPP and ISFSF

The Quaternary deposits are of Pleistocene and Holocene age. The area is made up of glacial deposits (till) of the Middle Pleistocene Dzukija, Dainava, Zemaitija and Medininkai Formations, and of the Upper Pleistocene Upper Nemunas Formation (Gruda and Baltija). The intertill glaciofluvial (sand, gravel, cobble, pebble) and glaciolacustrine (fine-grained sand, silt, clay) sediments are detected in the area. The thickness of the intertill deposits varies from 10–15 m up to 25–30 m (Fig. 4.1.2-2). The interstadial deposits are composed of very fine-grained and fine-grained sand, silt and peat (Fig. 4.1.2-4 and 4.1.2-5). 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 [2].

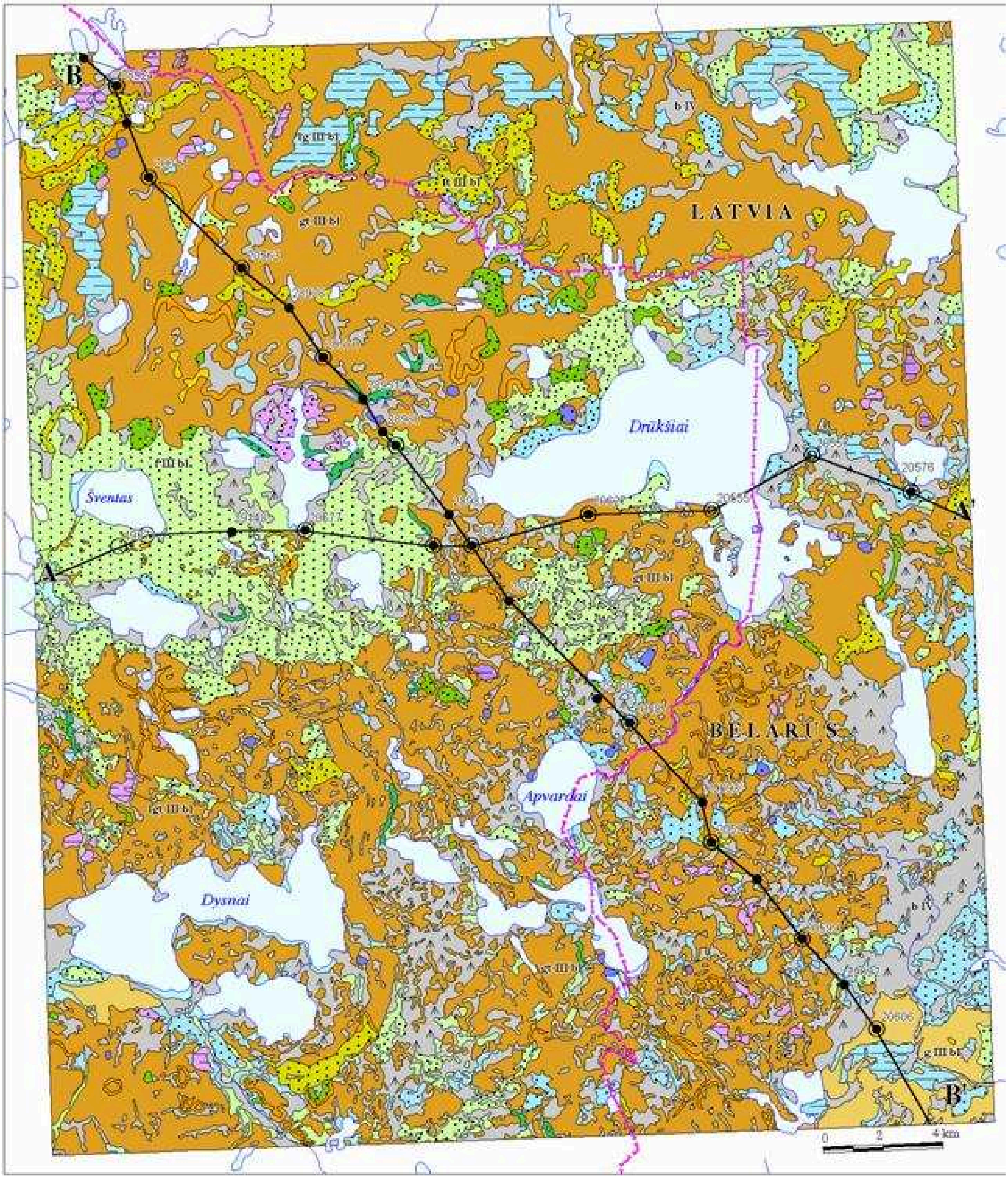


Fig. 4.1.2-2. Quaternary geological map of Ignalina NPP area (original scale 1:50 000, author: R. Guobyte [2]); legend see in Fig. 4.1.2-3

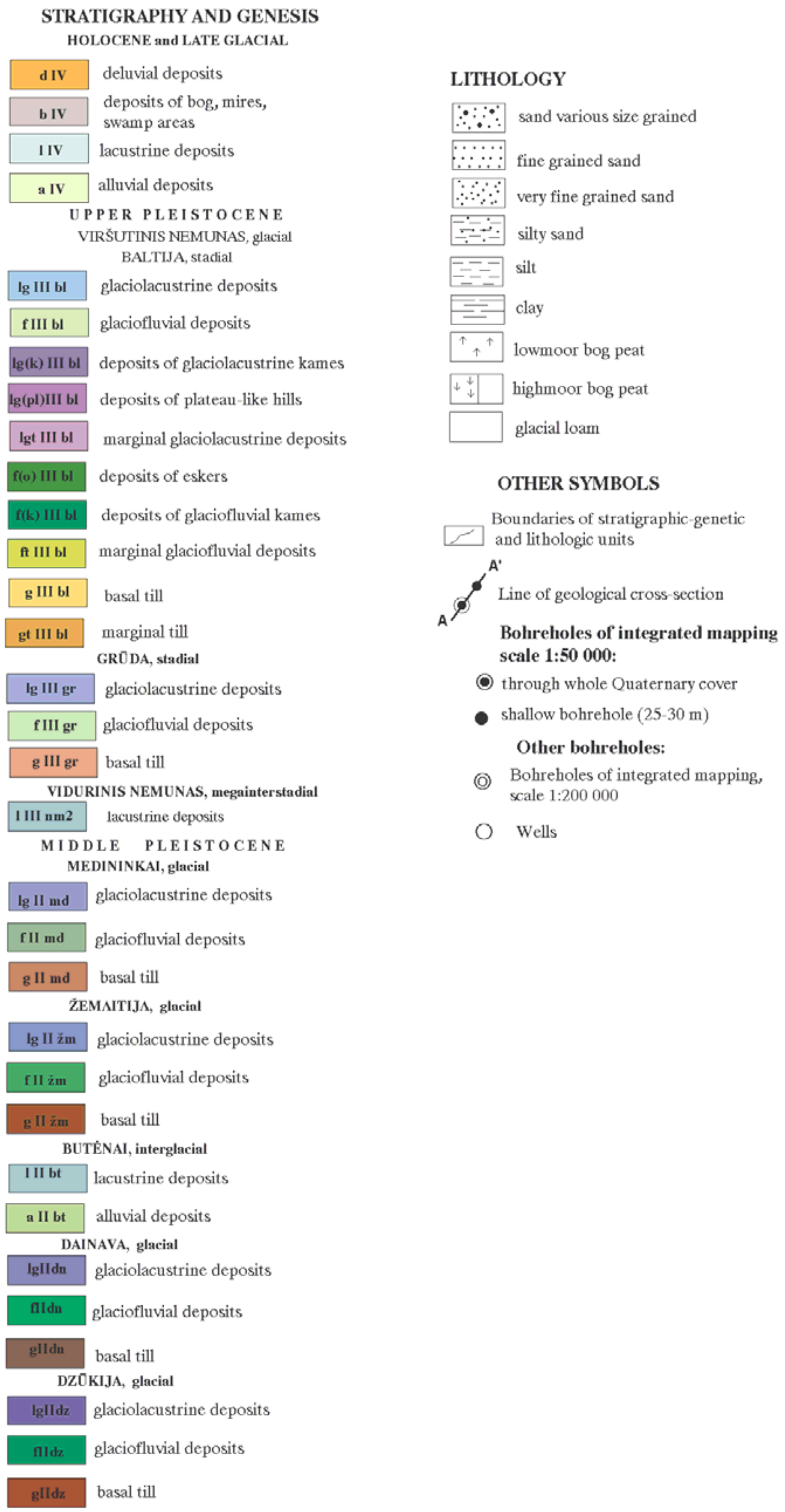


Fig. 4.1.2-3. Legend for Quaternary geological map and geological cross-sections of the region

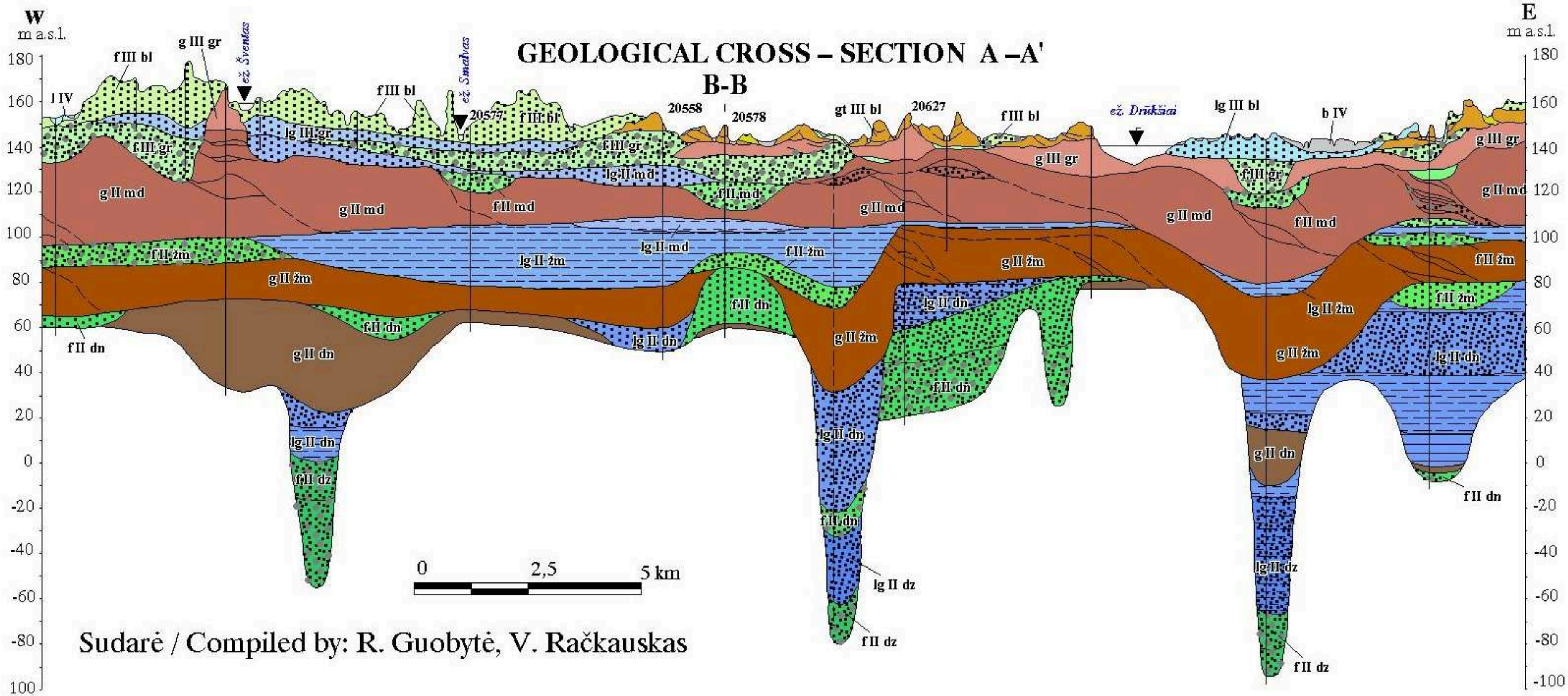


Fig.4.1.2-4. Quaternary geological cross-section A-A of the INPP and ISFSF area (original scale 1:50 000, authors: R. Guobyte, V. Rackauskas [2]); legend see in Fig. 4.1.2-3

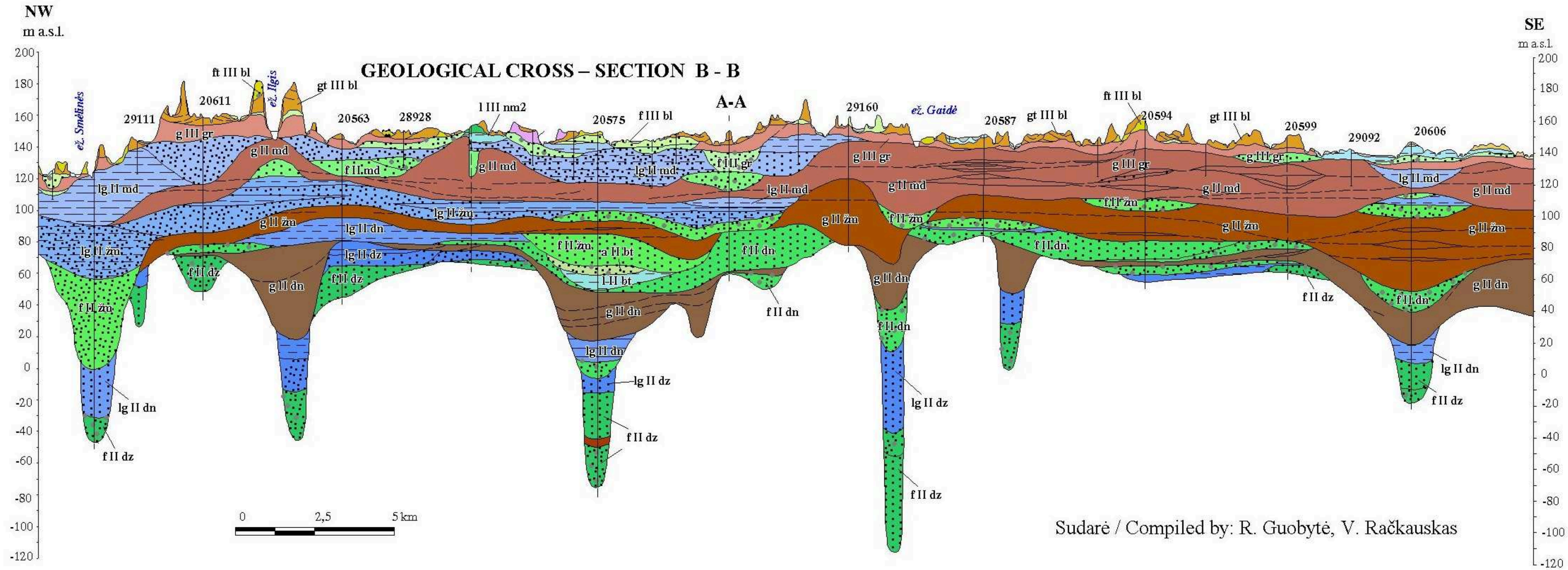


Fig.4.1.2-5. Quaternary geological cross-section B-B of the INPP and ISFSF area (original scale 1:50 000, authors: R. Guobyte, V. Rackauskas [2]); legend see in Fig. 4.1.2-3

Quaternary geology map of the ISFSF area is presented in Fig. 4.1.2-6.

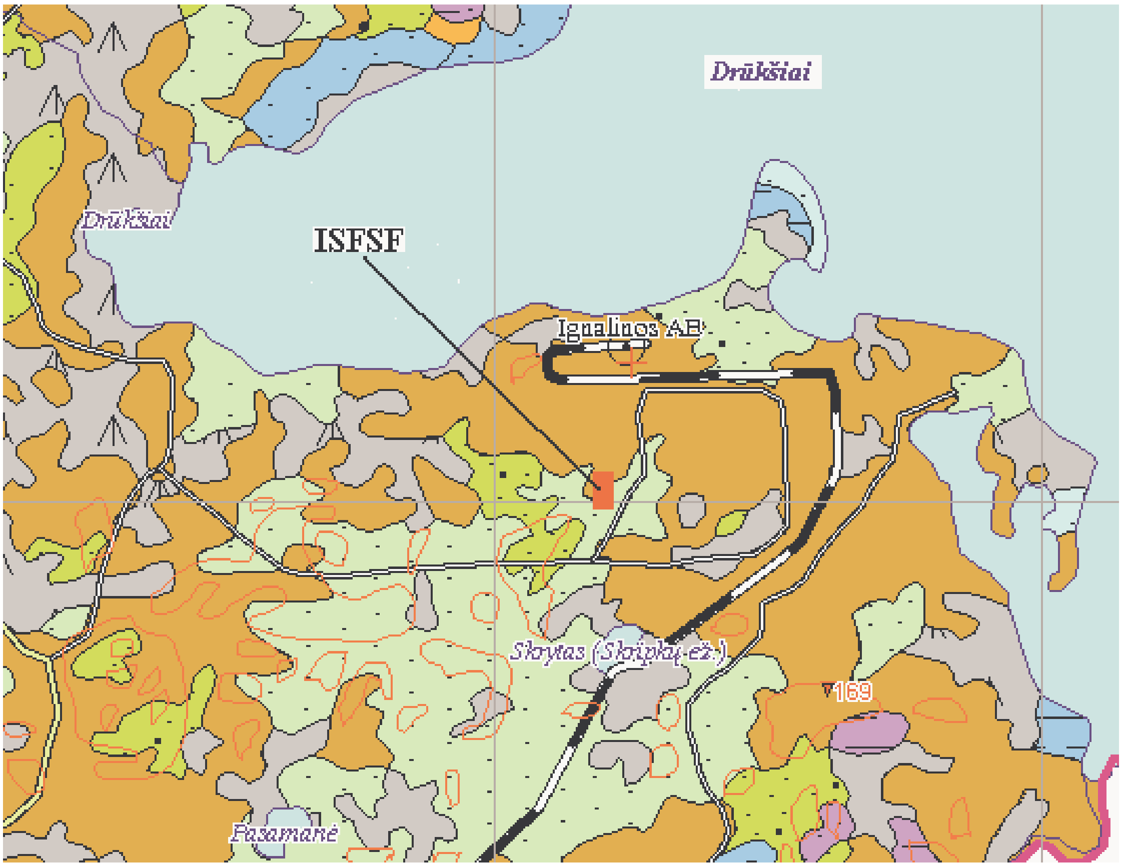


Figure 4.1.2-6. Quaternary geology map of the ISFSF area [2], (legend see in Fig. 4.1.2-3)

4.1.3. Geologic Structure of the ISFSF Site

For the most part, the surface of the ISFSF 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 [10].

The outside moraine (gtIII bl_o) of the Baltic stage lies underneath the mound soil and, in some cases, underneath 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 [10].

Within the ISFSF 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 underlaying (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 [10].

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 [10].

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 [10].

So, geologic/lithologic structure of the ISFSF site is complex: frequent changes in lithologic layers and their thickness, complex interbedding.

4.1.4. Tectonic Faults

Two types of faults were distinguished in the ISFSF 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.

The length of the faults is of 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 ISFSF area. Their length varies from 3–5 km to 15–18 km; the offset is of 15–20 m [2].

4.1.5. 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) [2, 3].

4.1.6. Seismic Activity

Lithuanian territory is traditionally considered as non-seismic or low seismic zone. It depends on geological structure of the territory and 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 (Fig. 4.1.6-1) [4].

Figure 4.1.6-1. Seismicity of Baltic States: circles – historical events from 1616 to 1965; hexagons – instrumental data from 1965 to 2004; triangles – operative seismic stations

The most recent seismic events with magnitude of 4.4 and 5.0 after 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 from 1616 [5]. In the INPP region 4 seismological observation stations were installed in 1999 (see Fig. 4.1.6-1). From then the Geological Survey of Lithuania according to agreement with INPP processes and analyses the data gathered in these stations.

According to available date the Geological Survey of Lithuania estimates that a design basis earthquake for the INPP area is the intensity of 6 grades on the MSK-64 scale. A beyond design basis earthquake for the INPP area is the intensity of 7 grades on the MSK-64 [8]. In the Technical Specification [9] as a design basis earthquake for the INPP area is also assumed to be the intensity of 6 grades on the MSK-64 scale with frequency 1 per 100 years (maximum ground acceleration $a_{max} = 0.5$ m/s^2 = 0.05 g). As a beyond design basis earthquake for the INPP area is assumed to be the intensity of 7 grades on the MSK-64 scale with frequency 1 per 10000 years ($a_{max} = 1$ m/s^2 = 0.1 g). The main periods are from 0.15 to 0.4 s [9].

The design basis earthquake with the intensity of 6 grades on the MSK-64 scale corresponds to the seismic level SL-1 of the European Macroseismic Scale EMS-98 of the IAEA. 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 ISFSF site [10].

The equipment, structures and systems of the ISFSF will be classified in accordance with the requirements of PNAE-G-5-006-87 [7].

The following criteria shall be used for design basis earthquake:

- Intensity: 6 grades on the MSK-64 scale;
- Frequency: 1 per 100 years;
- Soil category: class III;
- Acceleration factor on surface: a_{max} = 0.1 g;
- Acceleration factor at depth of 10 m: a_{max} = 0.075 g;
- The main periods: T_{max} = 0.15–0.4 s.

4.2. Geomorphology and Topography of the Site

From a geomorphological point of view the ISFSF 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 [2].

The ISFSF 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 of the site has an incline (156–162 m altitude) towards southwest [10] (see Fig. 1.4-5).

4.3. Climatology and Meteorology of the Region

4.3.1. Climate

The Lithuanian climate is characterised by middle climatic zone. The region concerned is located in the continental East Europe climate area. One of the main features of the climate in the region is the fact that no air masses are formed over this area. Cyclones are mostly connected with the polar front and determine continuous movement of air masses. The cyclones formed over the medium latitudes of the Atlantic Ocean move from the west towards the east through Western Europe and the ISFSF region is often located at the intersection of the paths of the cyclones bringing humid maritime air. The variation of maritime and continental air masses is frequent, therefore the climate of the region can be considered as a transient climate from the maritime climate of Western Europe to the continental climate of Eurasia [11].

In comparison with other Lithuanian areas, the ISFSF area is marked by big variations of air temperature over the year, colder and longer winters with abundant snow cover, and warmer, but shorter summers. Average precipitation is also higher.

The most useful climatic and meteorological data used for the EIA purposes are based on measurements performed by INPP meteorological station, located approximately at a distance 5.5 km to the west of ISFSF site.

4.3.2. Air Temperature

Monthly average temperatures in the ISFSF region are given in the Table 4.3.2-1.

Table 4.3.2-1. Monthly averaged air temperatures (°C) for the ISFSF region [12, 15]

Meteo-station and observation period	Month (s)												01–12
	01	02	03	04	05	06	07	08	09	10	11	12	Average
Dukstas, 1961–1990	-6.8	-5.9	-1.9	5.2	12.1	15.5	16.8	15.9	11.2	6.2	0.9	-3.8	5.5
Utena, 1961–1990	-6.0	-5.2	-1.2	5.5	12.2	15.6	16.8	15.9	11.4	6.6	1.4	-3.2	5.8
INPP, 1988–1999	-2.5	-2.2	0.3	6.6	12.4	16.5	17.9	16.5	11.3	6.0	-0.1	-3.1	6.6
INPP, 2000–2005	-3.6	-4.4	0.7	7.4	12.4	15.2	19.1	17.3	11.8	6.4	1.6	-3.3	6.7

The last decade of the 20th century (1988–1999) monthly averaged air temperature variation in the warm season (April–October) and the beginning of the cold season (November–December) does not differ from long-term (1961–1990) observations. However the second half of the cold season (January–March) during the last decade was warmer and the average air temperature for this period is higher by 2.3–4.3 K. The average monthly temperatures on the period 2000–2004 seem to indicate a slight increase from March to November. The seven successive warm winters (1988/1989 to 1994/1995) are identified as a unique climatic phenomenon for Lithuania.

Average calculated air temperatures of the coldest five-day period are –27 ºC. Absolute maximum of recorded temperature is 36 ºC and absolute minimum is –40 ºC. Absolute maximum of calculated temperature with a frequency of 1 in 10000 years is 40.5 ºC and absolute minimum of calculated temperature with a frequency of 1 in 10000 years is –44.4 ºC [8].

4.3.3. Atmospheric Precipitation

Monthly averages of precipitation for the ISFSF region are given in the Table 4.3.2-2.

Table 4.3.2-2. Monthly averages of precipitation (mm) for the ISFSF region [13–15]

Meteorological station and observation period	Month (s)												Total for months		
	01	02	03	04	05	06	07	08	09	10	11	12	01-12	11-03	04-10
Dukstas, 1961–1990	32	25	28	43	58	69	75	66	64	50	42	40	592	167	425
Utena, 1961–1990	39	31	37	47	53	69	73	75	66	50	57	53	650	217	433
Zarasai, 1961–1990	45	36	39	42	59	72	75	66	66	55	60	56	671	236	435
INPP, 1988–1999	41	41	46	33	55	84	60	64	70	66	58	57	676	244	432
INPP, 2000–2005	46	46	36	40	52	92	78	68	38	75	59	46	676	233	443

Results in the period 2000–2004 at INPP do not show significant differences in precipitations compared to the 1988–2000 period.

Average annual amount of precipitation in the ISFSF region is 638 mm. About 65 % of all precipitation takes place during the warm period of the year (April–October), and about 35 % during the cold period (November–March). Minimum precipitation occurs in January–March (40 mm per month) and maximum in June-August (70 mm per month).

Recorded extremes (maximum per-day precipitation for individual months) are presented in Table 4.3.2-3.

Table 4.3.2-3. Maximum-recorded per-day precipitation (mm) for individual months/years [13]

Meteorological station	Months												Max
	01	02	03	04	05	06	07	08	09	10	11	12	
Dukstas	18.8	13.2	23.4	19.2	52.4	42.4	28.6	48.8	35.2	30.7	20.2	11.4	52.4
	1989	1976	1979	1985	1980	1987	1987	1979	1978	1974	1983	1988	
Utena	17.1	18.1	24.2	34.7	45	99.0	54.2	67.6	37.9	41.6	36.2	23.0	99.0
	1958	1950	1930	1979	1982	1950	1960	1948	1953	1974	1960	1945	
Zarasai	22	21.6	34.3	40.7	55.9	52.6	55.5	82.7	60.1	44.3	46.8	23.7	82.7
	1959	1957	1979	1985	1955	1980	1955	1962	1950	1974	1930	1925	

Recorded maximum precipitation within 24 hours is 73.1 mm in July 1973. The average maximum in 24 hours is 39 mm.

4.3.3.1. Snow cover

Snow cover in the region is about 100–110 days per year. Average height of snow cover is 16 cm and maximum is 64 cm. Density of snow cover gradually increases from 0.2 to 0.5 g/cm^3 in the middle of March. Absolute maximum of recorded weight of snow cover is 120 kg/m^2 [8].

4.3.4. Wind Regime

Western and southern winds predominate. The strongest winds have western and south-east directions. The average annual wind speed is about 3.5 m/s, and maximal (gust) speeds can reach 28 m/s. No-wind conditions are observed on the average of 6 % of the time and last no more than one day (24 hours) in the summer, and no more than two days in the winter [11].

Wind rose at ISFSF region, based on local wind measurements [14, 15], is presented in Figure 4.3.4-1.

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

During a storm in 1998 a wind speed of 33 m/s was recorded [17].

The calculated average wind pressure is 0.18 kPa and the pulsation component of the wind load is 0.12 kPa. With the reliability coefficient of 1.4, the calculated value of uniform wind load is 0.42 kPa and extreme wind load (with a frequency of 1 per 10 000 years) is 1.05 kPa with the reliability overloading coefficient 2.5 [8].

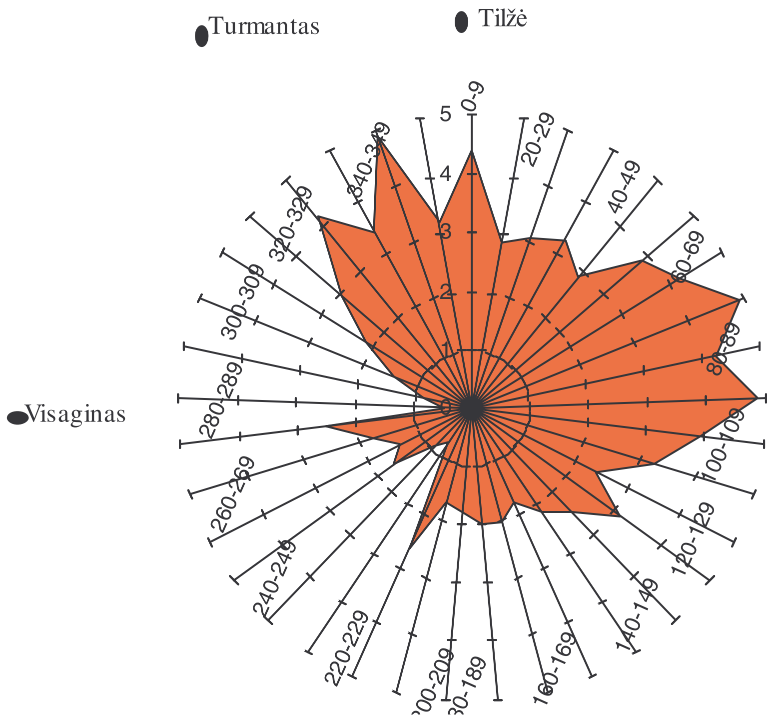


Figure 4.3.4-1. Wind rose at the ISFSF region (wind direction off ISFSF)

4.3.5. Hurricanes and Spouts

Spouts near the ISFSF site do not exceed class F-2 according to Fujita classification [16]. The probability of a class F-2 spout with 1 km^2 area is 1 in 61 667 years. The probability of a class F-1 spout is 1 in 43 023 years. The probability of a class F-0 spout is 1 in 10000 years [7].

The season of spouts begins at the end of April and ends in the first half of September. The direction of spout motion is from south-west to north-east in 75 % of the cases. The average length of spout shift trajectory is 20 km and the length varies from 1 to 50 km. Average width of the spouts is 50 m with variations from 10 to 300 m. Calculated maximum spout velocity with a frequency of 1 in 10000 years is 39 m/s [8].

The following data is normally used for calculations:

- Maximal rotation speed of the spout wall is 105 m/s;
- Pressure differential between centre of the funnel and the fringe region of the spout is 135 kPa [6].

4.3.6. Fog and Atmospheric Impurities

In the ISFSF area, fog can be observed any day of the year. The average number of days with fog is 45 and the maximum – 62 days. Fog absorbs different impurity (noxious gases, smoke and dust) and, combined with high humidity, increases corrosion intensity, reducing the distance of visibility and impeding transportation [6].

The maximum dusting is observed in May, and the minimum – in December. The oscillations of the total sulphur compounds in the atmosphere have the following annual distribution: the lowest values are observed in the summer and autumn and highest ones – during the cold period of the year [11].

4.3.7. Ground Freezing

The freezing of the ground usually begins in the first part of December and lasts to the middle of April. The average depth of the frost line reaches about 50 cm, and with a maximum extending to 110 cm depending on the composition of the ground and its humidity [11].

4.3.8. Lightning

Average number of storms with lightning is 11 per year. Four storms monthly are usually observed in July–August, and 1–2 storms – in other relatively warm months.

Average duration of storm is 2 hours, and a maximum – 4 hours. Average duration of storm with lightning in the course of year is about 22 hours [17].

4.4. Hydrogeology and Hydrology of the Region and the Site

4.4.1. Aquifers and their Interconnections

The Ignalina NPP region (and the ISFSF site as well) is 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 [2].

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 [2].

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.

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 [2].

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 [2].

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 3.5 km to the southwest from the ISFSF site [19].

4.4.2. 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 [19].

4.4.3. Hydrological Conditions in the Region

The Ignalina NPP region is drained into watersheds of the rivers of Nemunas (Sventoji) and Daugava. The Sventoji river 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 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 Dysna and Druksa watershed with the Druksiai lake (Druksiai lake–the present effluent Prorva–from the Drisveta (or Druksa) watershed–Dysna), (Fig. 4.4.3-1, Table 4.4.3-1).

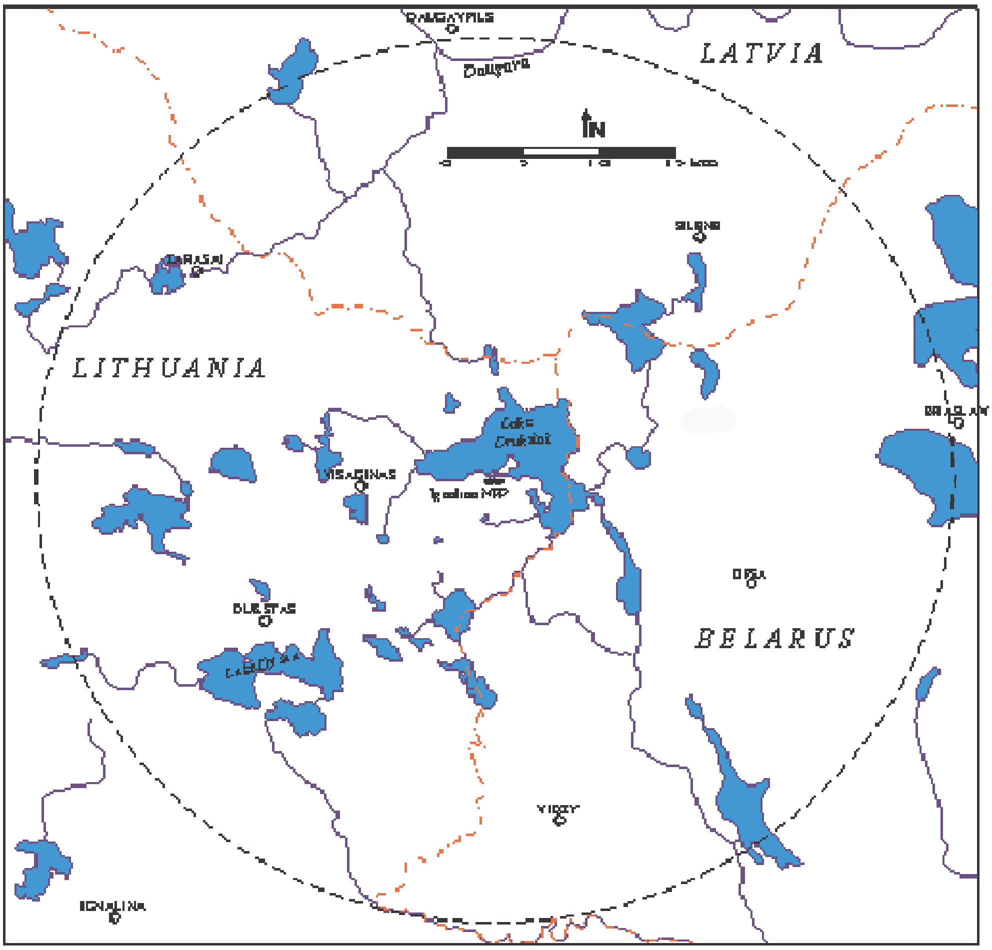


Figure 4.4.3-1. The main elements of hydrographical network in a 30 km radius zone around the Ignalina NPP

Table 4.4.3-1. 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	0.0	44.5	620.9	90
Laukesa	Daugava	2.3	29.1	274.9	95
Stelmuze	Daugava	3.8	7.8	48.3	100

The lake Druksiai is the biggest lake in Lithuania. 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 maximum depth of the lake is 33.3 m, with an average of 7.6 m, and a dominant value of 12 m. The length of the lake is 14.3 km, the maximum width is 5.3 km, and the perimeter is 60.5 km. Drainage area of the lake is small, only 564 km^2 [21].

There are a lot of lakes in the Ignalina AE 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 the lake Druksiai and 1 river that outflows it (the Prorva). The main rivers which flow into the lake Druksiai are Ricianka (area of catchment: 156.6 km^2), Smalva (area of catchment: 88.3 km^2) and Gulbine (area of catchment: 156.6 km^2).

Inflow of rivers Ricianka and Druksa into the southern part of the lake Druksiai contributes the most of surface discharge into the lake (74 %). The rest of the surface discharge into the lake constitutes from inflow of rivers Smalva and Gulbine in the western part of the lake. Discharge from the lake Druksiai takes place by the river Prorva in the southern part of the lake [22].

The Ignalina NPP 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 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 dry season (June–February) is 100–140 mm. The minimal runoff of warm season is 2 l/s/km^2; and of cold season – 3 l/s/km^2.

4.4.4. Groundwater in the ISFSF Site

The shallow groundwater in the ISFSF site was found locally in the descent areas, in the mound (tplIV), in the sediments of wetlands (bIV), and in till (gtIIIblo) 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 [10].

The first confined intertill aquifer is located in fluvioglacial (fIIIbl-gr, fIII-IIgr-md) sediments. Below the uplifted parts of the ISFSF 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 ISFSF site and therefore can be considered as a local aquitards. The regional aquitard consists of till (gIImd) sediments. Hydraulic conductivity of water bearing sediments is 0.8–63.5 m/d [10].

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 [10].

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 [18] recommends assessing the potential impact on the drinking water sources in the vicinity. For this purpose the study [19] 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 [20]) of the waterworks of Visaginas town with the ISFSF and the SWTSF. The of detailed investigations and modeling results [19] 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 water exploitation resources which is 31 000 m^3/d).

The study for justification of the groundwater water monitoring structure for the ISFSF and SWTSF site [23] 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 shallow groundwater 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 shallow groundwater 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/d.

Modeling results show that the flow of fresh groundwater within 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 aquifer and 0.15–0.2 % to the Sventoji-Upininkai aquifer 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.

4.5. Biodiversity in the Neighbourhood of the Site

4.5.1. NATURA 2000 Habitats

NATURA 2000 is a network of protected areas of European Community importance covering fragile and valuable natural habitats and species of particular importance for the conservation of biological diversity within the territory of the EU.

According to the Law on Protected Areas of the Republic of Lithuania [41] the areas of NATURA 2000 are divided into the Areas of Importance for the Protection of Birds (AIPB) and Areas of Importance for Habitat Protection (AIHP). Creating the AIHP, first of all the potential

AIHP are selected based on scientific criteria and research and the list of them is submitted to European Commission (EC). When the EC approves the list of potential AIHP, the Member States start creating them. Creating the AIBP, first of all the most suitable areas are selected based on scientific criteria and research. Based on the selected areas, the national protected areas are created in Lithuania and later the status of protected areas of European Community importance is given to them (part 2, article 24 of the Law on Protected Areas [41]).

A large part of the lake Druksiai and a part of other territories (a part of the Smalvos protected hydrographical reserve and two areas along the Druksa river) are approved as NATURA 2000 areas (Fig. 4.5.1-1). EC has also approved the list of potential AIHP which includes the Smalvos landscape protected reserve. The complex of Dysnai and Dysnykstis lake area is approved as AIBP by the Resolution No. 339 of the Government of the Republic of Lithuania dated 2004-04-08 [42]. These areas are located far from the ISFSF (the Smalvos landscape protected reserve – at about 10 km from the ISFSF, and the complex of Dysnai and Dysnykstis lake area – at about 12 km from the ISFSF).

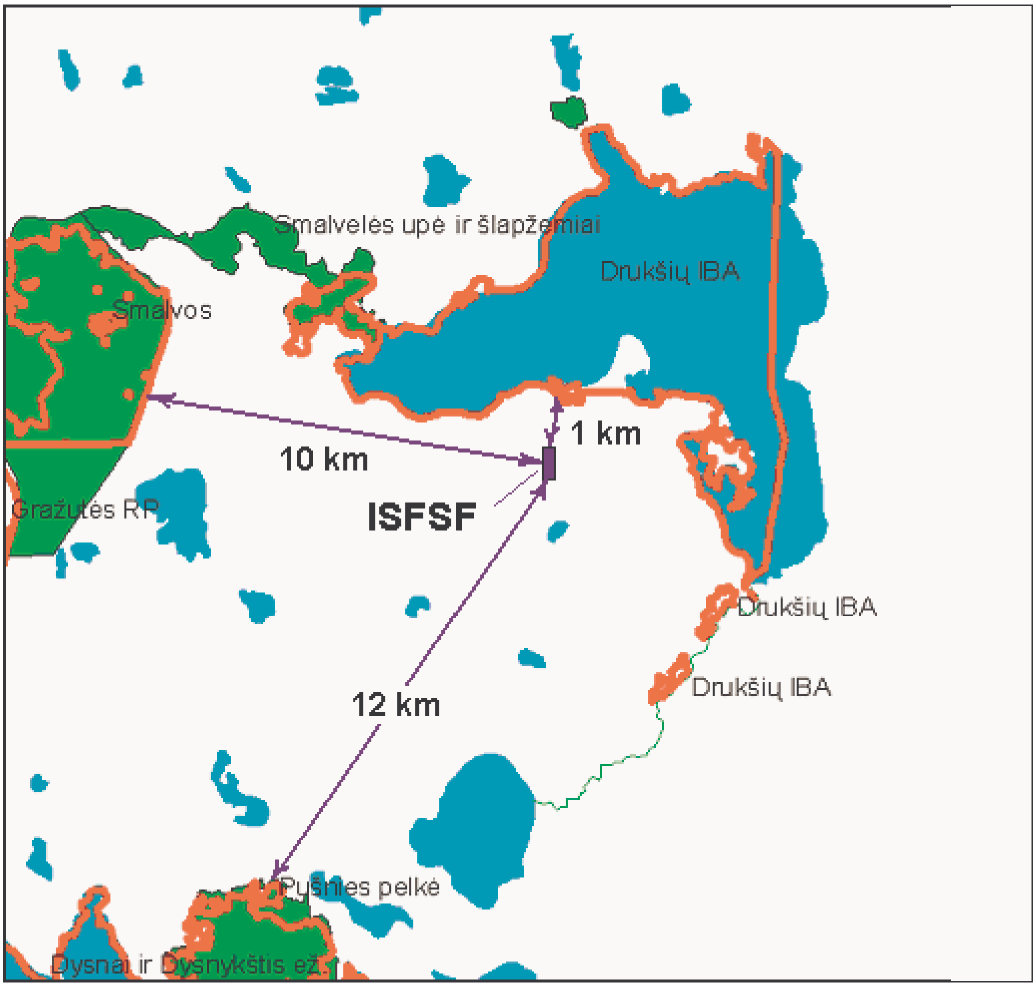


Figure 4.5.1-1. NATURA 2000 territories proposed by the Lithuanian Government to the European Commission (perimeters in red)

The proposed Druksiai NATURA 2000 territory covers 3612 ha, in which the various habitats are described in the Table 4.5.1-1.

Table 4.5.1-1. Habitats in the Druksiai NATURA 2000 territory

CORINE land cover code	Land cover	Area, hectares	%
2.1.1.	Non irrigated arable land	10.9	0.30
2.4.2.	Complex cultivation patterns	7.8	0.21
2.4.3.	Land principally occupied by agriculture, with significant areas of natural vegetation	26.8	0.74
3.1.1.	Broad leaved-forest	17.9	0.50
3.1.3.	Mixed forest	34.7	0.96
3.2.4.	Transitional woodland-scrub	69.0	1.91
4.1.1.	Inland marshes	4.6	0.13
5.1.2.	Water bodies	3441	95.2

Species of ornithological importance are (species included in Lithuanian Red Book [39] are highlighted in bold):

- As qualifying species: the **Bittern** (*Botaurus stellaris*);
- As of European importance [40]: **Black-throated Diver** (*Gavia arctica*), Marsh Harrier (*Circus aeruginosus*), **Spotted Crake** (*Porzana porzana*), **Little Crake** (*Porzana parva*), **Black Tern** (*Chlidonias niger*), **Bluethroat** (*Luscinia svecica*);
- As of national importance: 11 breeding species: **Eurasian Hobby** (*Falko subbuteo*), **Black Grouse** (*Tetrao tetrix*), **Eurasian Pygmy Owl** (*Glaucidium paserinum*), **Grey-headed Woodpecker** (*Picus canus*), **Green Woodpecker** (*Picus viridis*), **White-backed Woodpecker** (*Dendrocopos leucotos*), **Citrine Wagtail** (*Motacilla citreola*), **Great White Egret** (*Egretta alba*), **Red-breasted Merganser** (*Mergus serrator*), **Corn Bunting** (*Miliaria calandra*), **Goosander** (*Mergus merganser*); and also Cormorant (*Phalacrocorax carbo*).

The threats mentioned are the overgrowing of the islands present on the lake, predation and recreational developments.

Habitats and species encountered in and around the lake are presented hereafter.

4.5.2. Druksiai Lake Habitats

4.5.2.1. Lake Flora

Before the development of significant activities in the area, lake Druksiai was of the mesotrophic type. The addition of thermal and sanitary wastewater releases made the lake water quality evolve to an almost eutrophic state and different ecological zones have formed in lake Druksiai.

Studies were conducted on this large scale phenomenon, among which the Lithuanian State Research [24] was an in-depth assessment of INPP impact on the local ecology.

69 water macrophyte species were found during the investigations of lake Druksiai in 1996–1997. Among them 58 Angiosperms[1], 8 Charophytes[2], 3 Bryophyta[3] species were listed.

[1] Plants with flowers, in which the ovum is completely included in a closed ovary.
[2] Vegetal species intermediate between algae and mosses.
[3] Nonflowering plants characterized by rhizoids (rather than true roots) and having little or no organized vascular tissue; bryophyta include mosses.

16 species were not found in this lake earlier [24].

The following vegetation associations (with mention of the CORINE[4] and EUNIS[5] code and protection status[6] as appropriate) are found:

- Helophytes, with the *Phragmitetum australis* (common reed beds, 53.11, *C3.21*) and the *Scirpetum lacustris* (common clubrush beds, 53.12, *C3.22*), usually at small water depth;
- Aquatic associations such as the *Potamogetonetum lucentis and Potamogetonetum perfoliati* (large tall pondweed beds in free, deep water, 22.421, *C1.33*), the *Potamogetonetum friesii* (small pondweed communities in less deep, usually sheltered waters, 22.422, *C1.33*);
- Limneids, with the *Nitellopsidetum obtusae* (floating yet rooted vegetation, 22.442, *C1.33*, non prioritary) develop very well in the littoral of the lake.

The communities rare for Lithuanian water bodies were found as follows:

- *Scolochloetum festucaceae* (water-fringe grass beds, in eutrophic waters, 53.15, *C3.25*);
- *Nitelletum opacae* (eutrophic river vegetation in Palaearctic regions, 24.44, *C2.34*, non prioritary);
- *Zanichellietum palustris* (typical of brackish waters, 23.211, *C1.54*).

The presence of some associations typical of eutrophic, and even brackish water, confirm the ecological effect of wastewater releases (both organic and minerals releases) on the lake water quality and subsequent biological changes.

Abundance of filamentous green algae was also registered. Sometimes macrophyte communities are being shocked by these algae. In comparison with the data from the earlier investigation, macrophyte species content has not changed extremely but a significant decrease of areas covered by charophytes and an increase of areas overgrown by helophytes and other aquatic species was observed.

The biggest changes in macrophyte vegetation were noticed in the littoral of lake Druksiai near the ISFSF. *Charophyta* are totally extinct and just species common to eutrophicated water bodies (*Phragmites australis*, *Glyceria maxima*, *Ceratophyllum demersum*, *Myriophyllum spicatum*) are still growing.

According to the complex hydrobiological investigations on lake Druksiai about the great changes in planktonic organism community, tendencies of those changes in different ecological zones were evaluated in 1993–1997 [24]. The normal seasonal succession of planktonic organisms' abundance and biomass became undetermined because of anthropogenic impact.

The amount of species of most dominant planktonic organisms in 1993–1997 decreased 2–3 times in comparison with pre-INPP operation: phytoplankton – from 116 to 40–50, zooplankton – from 233 to 139. The amount of benthic algae species in littoral zone was 215.

The primary production of phytoplankton in lake Druksiai increased from 22–50 mgC/m^3/day in 1993 to 470–590 mgC/m^3/day in 1997. The highest intensity of primary production (1290 mgC/m^3/day) was determined in the south-eastern part of the lake, eutrophicated by the releases from the Visaginas municipal wastewater treatment plant. The amount of chlorophyll "a" increased as well and reached 70–113 mg/l in 1996–1997. There is a large scale fluctuation in amino acids and organic acids material, indicating instability in the ecosystem.

[4] CORINE = **CO**-o**R**dination of **IN**formation on the **E**nvironment, established in 1985.
[5] EUNIS = European Nature Information System.
[6] There can be: no particular status, non prioritary or prioritary status of protection.

4.5.2.2. *Lake Fauna*

The abundance and biomass of fish increase from the oligotrophic towards the eutrophic state. They decrease in dystrophic[7] lakes. During the process of eutrophication, fish communities are rapidly changing: the number of Salmonidae and Coregonidae fish decreases, whereas the abundance and biomass of Percidae and Cyprinidae fish increase [25].

The ecosystem of lake Druksiai already underwent an active anthropogenic impact before INPP commissioning. Even then there were found higher concentration of nitrogen in the south-western bay of the lake where sewerage from Visaginas was discharged [24].

The zoobenthos also changed. Once the INPP entered into operation, there was a massive outspread of *Dressina polymorpha* [26].

The factors that have an effect on the evolution of fish populations are:

- Inputs of sedimentary substance (from the increase of the lake water level due to the construction of a dam on the Prorva river and, consequently, an active erosion of the lake banks);
- Water temperature, in particular the optimum temperature for fish populations;
- The average biomass of phytoplankton;
- The average concentration of dissolved nitrogen and phosphorus.

The season of the year, the ecological features of the fishes, the time of the day, the abundance of nutrition organisms, and season and day migrations determine also the areas of location and concentration of fishes [27].

With the increased sedimentation of terrigenic[8] materials and organic substances (particularly in deep water areas of the lake), anaerobic conditions increased in the sediments. This phenomenon allowed the production of sulphide and sulphurous hydrogen, which are toxic to many hydrobionts[9] [28]. Dissolved oxygen decreases were also observed, in particular during summer periods and at depth over 15 m [29].

On the basis of research data obtained in 1981–1982, the average biomass of zoobenthos in the lake was about 3.2 g/m³ [14]: the resources of forage were rather low [30].

In the observation period before the launch of INPP (1950–1984), 26 species of fish from 11 families as listed in Table 4.5.2-1. They are common or rather common in Lithuania [31].

Sheatfish were on the brink of extinction before the beginning of the INPP construction [30]. At that time, about 40 % of the biomass of ichthyocenosis was made of stenothermic[10] fish species (smelt and vendace) [32] and about 55 % of the fish population was made of bleak, perch, bream and roach. Roach was prevailing. The average biomass was 108 kg/ha.

The evolution of fish species populations at the end of the construction of INPP (in 1983 with, as a result, a deteriorated gas regime of the near-bottom layer) was such as:

- The biomass of smelt decreased three times;
- The biomass of vendace decreased more than 130 times.

The total biomass of all fishes increased up to 122.6 kg/ha.

In the first years of INPP operation (in 1984–1986), the total biomass remained almost the same though sharp changes occurred in the biomass of some fish species:

- The biomass of smelt decreased 50 times since the last period;
- The biomass of bleak, bream and pike decreased by 10–50 %;

[7] Habitats that have a moderate nutritive capacity are defined as mesotrophic, those with a little capacity are said oligotrophic and finally those with a toxic capacity are dystrophic.
[8] Coming from the soil (after works, from erosion phenomena, ...)
[9] Organisms living in water
[10] Capable of living or growing only within a limited range of temperature

- The biomass of perch increased by 25 %;
- The biomass of roach increased by 100 %, as a result of an increase in their growth rate.

Table 4.5.2-1. Lake Druksiai fishes inventoried in the pre-operating period of INPP, during the research period of 1993–1999 and until the 2005 (species included into Lithuanian Red Book are highlighted in bold)

Families	**Species**		
	In the pre-operating period [30]	**During the period 1993–1999 [30, 31]**	**Until the 2005 [39]**
Cyprinidae	Roach (Rutilus rutilus) **Bleak** (Alburnus alburnus) **Belica** (Leucaspius delineatus) **Dace** (Leuciscus leuciscus) Carp (Cyprinus carpio) Ide (Leuciscus idus) **Rudd** (Scardinius erythrophthalmus) **Minnow** (Phoxinus phoxinus) **Tench** (Tinca tinca) Silver bream (Blicca bjoerkna) Bream (Abramis brama) Crucian carp (Carassius carassius) **Gudgeon** (Gobio gobio)	Roach (Rutilus rutilus) **Bleak** (Alburnus alburnus) In little proportion *No more observed* In little proportion In little proportion **Rudd** (Scardinius erythrophthalmus) *No more observed* **Tench** (Tinca tinca) Silver bream (Blicca bjoerkna) Bream (Abramis brama) In little proportion In little proportion	Roach (Rutilus rutilus) Bleak (Alburnus alburnus) Belica (Leucaspius delineatus) No more observed In little proportion In little proportion Rudd (Scardinius erythrophthalmus) No more observed Tench (Tinca tinca) Silver bream (Blicca bjoerkna) Bream (Abramis brama) In little proportion In little proportion
Percidae	Perch (Perca fluviatilis) Ruff (Gymnocephalus cernuus) **Pike-perch** (Stizostedion lucioperca)	Perch (Perca fluviatilis) Ruff (Gymnocephalus cernuus) *No more observed*	Perch (Perca fluviatilis) Ruff (Gymnocephalus cernuus) *No more observed*
Coregonidae	**Vendace** (Coregonus albula) **European whitefish** (Coregonus lavaretus)	**Vendace** (Coregonus albula) *No more observed*	Vendace (Coregonus albula) *No more observed*
Osmeridae	**Smelt** (Osmerus eperlanus m. relicta)	In little proportion	In little proportion
Esocidae	**Pike** (Esox lucius)	**Pike** (Esox lucius)	Pike (Esox lucius)
Cobitididae	**Loach** (Cobitis taenia)	In little proportion	In little proportion
Gadidae	**Four-bearded rockling** (Lota lota)	In little proportion	In little proportion
Anguillidae	Common eel (Anguilla anguilla)	*No more observed*	*No more observed*
Cottidae	**Freshwater sculpin** (Cottus gobio)	*No more observed*	*No more observed*
Gasterosteidae	Three-spined stickleback (Pungitius pungitius)	*No more observed*	*No more observed*
Siluridae	Sheatfish (Silurus glanis)	*No more observed*	*No more observed*

With the start of the second reactor (in 1987–1989), the thermal load of the lake increased again and the total biomass reached 140 kg/ha. The total biomass increase was due to the increase in the biomass of such previously not abundant eurythermal[11] and thermophile[12] fish species as roach and others.

The species observed during the period 1993–1999 are listed in Table 4.5.2-1; about 99 % of the ichthyomass of the lake was made of the populations of 10 fish species: roach, perch, silver bream, bream, Vendace, bleak, rudd, ruff, pike and tench [30]. The biomass varied between 150.3 and 172.1 kg/ha. Since 1950, the total biomass increased by 50 %.

Eurythermal species such as perch and previously non abundant species such as silver bream, rudd and tench greatly increased, on the detriment of stenothermal cryophilic[13] fish species. The total biomass of stenothermal fish species decreased about six times compared to the period 1950–1975.

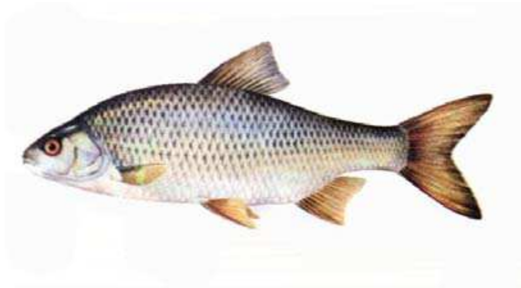
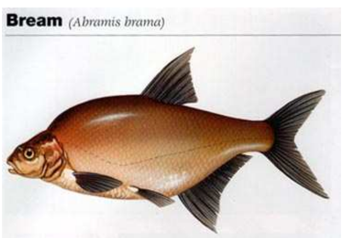
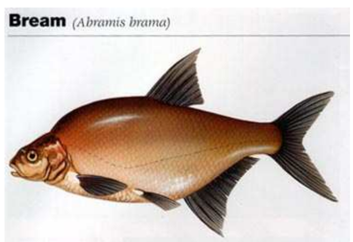
In the period 1994–1999, the average biomass of eurythermal fishes increased by 2.3 times compared to the pre-INPP period. On the opposite, the relative biomass of stenothermal species was on the average only 4.3 % of the total fish biomass of the lake [30]. The smelt population abundance has become so reduced that it is on the brink of elimination from the lake [27].

The changes occurred mainly after the first years of INPP operation, and then the successive changes slowed down. During the last years the lake fish community has changed insignificantly. The partially stable state of the lake fish community is fragile and in most cases depends on the INPP operation regime [30].

There were also some adaptations among some species populations. Vendace population partially adapted to the changed environmental conditions and its abundance in the recent years is quite high and constant. The survival and partial rehabilitation of Vendace (stenothermal fish) indicates that some fish species may become acclimated to the disrupted thermal and eutrophic conditions in the lake [27].

Effects on the gonads production were observed on 40 % of the fish population and even 2 % of the fishes became hermaphrodites.

The result of the fish population evolution is illustrated on Fig. 4.5.2-1.

Before	**Nowadays**
Dominant  *Roach*	
Important 	

[11] Fish species that can tolerate a wide range of temperatures.
[12] Organisms that can live in warm conditions.
[13] Those have an affinity for or growing at low temperatures.

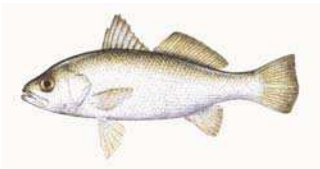
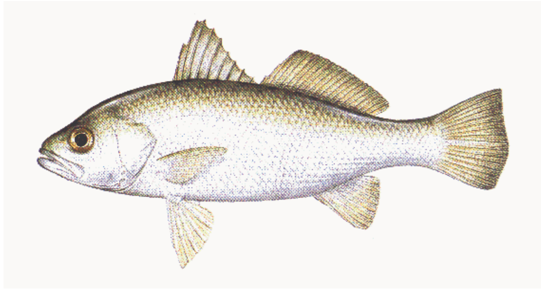
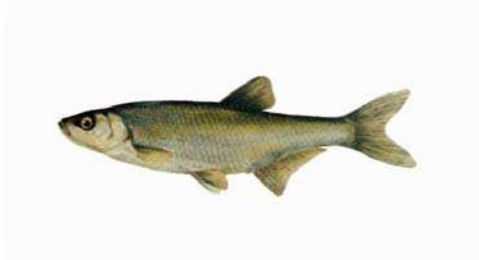
 *Perch*	
Significant  *Bleak*  	 (Smelt on the brink of elimination) 

Figure 4.5.2-1. Fish population evolution before and after INPP construction and operation – the size of the picture of one specie is proportional to the specie population evolution and the order of pictures is the order of relative biomass of species

It was found out that the frequency of cytogenetic damage, emerged as a specific radionuclide-caused effect in aquatic organisms inhabiting lake Druksiai, is slightly above the background level and is 5 times lower than the same damage in Swiss lake Murten in the surroundings of which there are 2 nuclear power plants in function. The effect of INPP on reproductive system of fish present in lake Druksiai is much lower than it is in fish from the environs of Forsmark and Oskarshamn NPPs in Sweden. According to the values of studied ecotoxicity parameters, Lake Druksiai belongs to the category of weak toxicity water bodies, where biological effects can be compensated by the adaptation mechanisms of living organisms.

The research data of many years (1989–1996) on biotesting of INPP waste waters, the water of lake Druksiai and its bottom sediments have shown that discharges waters entering the lake are more or less harmful to hydrobionts. The wastewater of municipal sewerage and industrial-rain sewerage are the most polluting. The toxicity of lake Druksiai water depends not on radioactive but chemical substances constantly entering with waste waters.

As a conclusion, it was determined that the functional and structural changes in lake Druksiai biota are mostly caused by thermal and chemical pollution.

After INPP Units final shutdown the thermal heat discharges will be ceased to the lake, but discharges of municipal sewerage could not change significantly (depending on the evolution of Visaginas during and after the decommissioning process).

4.5.3. Surface Habitats

Habitats pertaining to the proposed NATURA 2000 area of lake Druksiai are presented in Table 4.5.1-1.

During the State Research, a survey of the flora associations was made in the lake Druksiai watershed [33]. The mapping of these associations is illustrated at Figure 4.5.3-1.

The following description provides further information on the different vegetation associations encountered in the watershed of the lake (Table 4.5.3-1).

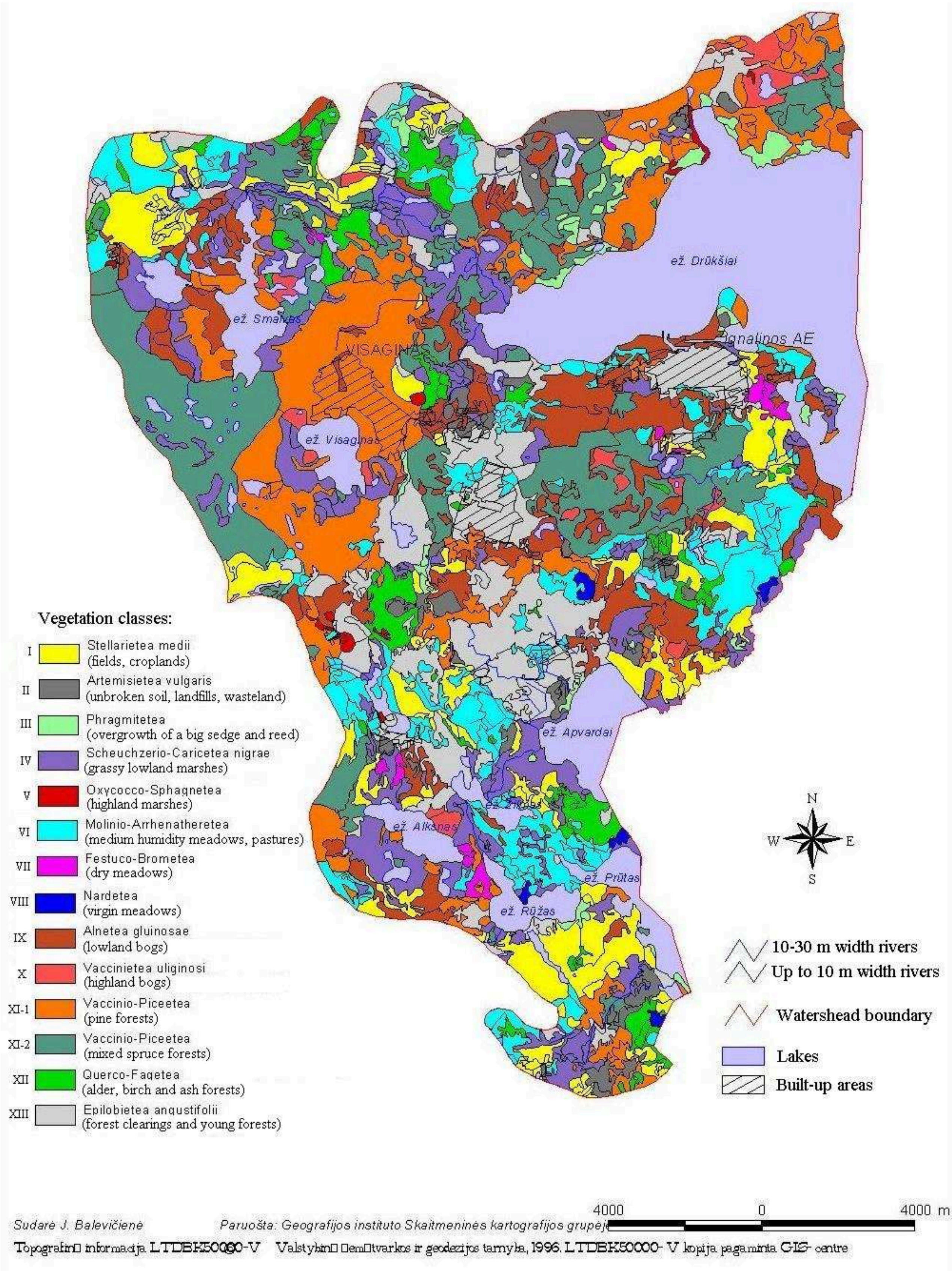


Figure 4.5.3-1. Vegetal associations in the lake Druksiai watershed [34]

Table 4.5.3-1. List of vegetation association inventoried in the watershed of lake Druksiai (habitats included in the habitat EU directive[14] are highlighted in bold in the table)

Legend No. (see Fig. 4.5.3-1)	Vegetation class Vegetation order	Area (ha)	Representation,%
I	Stellarietea medii *Aperion spicae-venti* *Digitario-setarion*	2491	10.1
II	Artemisietea vulgaris *Dauco-melilotion* *Convolvulo-agropyrion repentis* *Onopordion acanthii*	775	3.1
III	Phragmitetea australis *Caricion elatea Pignatii* *Phragmition australis*	401	1.6
IV	Scheuchzerio-caricetea nigrae *Caricion nigrae* *Caricion lasiocarpae* ***Caricion davallianae***	2915	11.8
V	Oxycocco-Sphagnetea *Sphagnion magellanici*	79.5	0.32
VI	**Molinio-Arrhenetheretea elatioris** *Calthion palustris* *Cynosurion cristati* *Arrhenaterion elatioris*	2759	11.2
VII	**Festuco-Brometea erecti** *Mesobromion erecti*	187	0.75
VIII	Nardetea strictae *Violion caninae*	72.2	0.29
IX	Alnetea glutinosae *Alnion glutinosae* *Salicion cinereae*	2738	11.1
X	**Vaccinietea uliginosi** *Ledo-Pinion* *Betulion pubescentis*	387	1.6
XI-1	**Vaccionio-Piceetea** *Dicrano-Pinion sylvestris*	3905	15.8
XI-2	**Vaccionio-Piceetea** *Vaccinio-Piceion abietis*	3826	15.5
XII	Querco-Fagetea sylvaticae ***Alno-Padion avii***	1055	4.3
XIII	Epilobietea angustifolii *Carici piluliferae – Epilobion angustifolii*	3144	12.7

In more details (with mention of the CORINE code and protection status as appropriate):

I. The Stellarietea medii are composed of nitrogen rich meadows, that result from fallow manure practices, quite common in Lithuania, with :
- the *Aperion spicae-venti* order = arable land occupied by ruderal species,

[14] Habitats included in the Directive 92/43/EEC are subject to particular conservation rules for fauna and flora, in the so-called Areas of Special Conservation, currently in the process of designation under the NATURA 2000 Network.

- the *Digitario-setarion* order = ruderal[15] species that accompany cultivated land, on nitrogen rich soils;

II. The <u>Artemisietea vulgaris</u> are habitats of xerophile (dry) fallow land, in which:
- the *Dauco-melilotion* = semi-xerophile habitat for perennial species,
- the *Convolvulo-agropyrion repentis* = fallow land for perennial, ruderal, meso-xerophile, psychrophilic (cold weather with extremes) species,
- the *Onopordion acanthi* = xerophile fallow land for perennial[16] species;

III. The <u>Phragmitetea australis</u> are usually marshes covered with reed or related species (as Carex sp.), present on the northern bank of the lake Druksiai, in which:
- the *Caricion elatea Pignatii* = large peaty areas containing Carex species,
- the *Phragmition australis* = stabilized reed populations;

IV. The <u>Scheuchzerio-caricetea nigrae</u> are holarctic (from the botanical north boreal region) bog lowlands, dominant on the south-west bank of the lake Druksiai and also present on the south-east bank, in which:
- the *Caricion nigrae* = on acid, little aerated soils,
- the *Caricion lasiocarpae* = primary bog where vegetation grows at the surface of oligrotrophic or meso-oligotrophic water,
- the *Caricion davallianae* = on alkaline soils (**alkaline fens, 54.2, *D4.1E*, non prioritary**);

V. The <u>Oxycocco-Sphagnetea</u> are psychrophilic heath areas, more or less peaty, with:
- the *Sphagnion magellanici* = highland bogs on acid soils;

VI. The <u>Molinio-Arrhenetheretea elatioris</u> are European meadows **(lowland hay meadows, 38.2, *E2.2*, non prioritary)**, present on the south-east bank of the lake, in which:
- the *Calthion palustris* = hygrophile, event shortly inundable meadows on middle altitudes,
- the *Cynosurion cristati* = semi-dry, pastured,
- the *Arrhenaterion elatioris* = meadows with high herbs on fresh and humid soil, in plains and hills;

VII. The <u>Festuco-Brometea erecti</u> are alkaline meadows, in which:
- the *Mesobromion erecti* = semi-dry and semi-thermal calcareous meadows, potentially rich in orchids **(34.3222, *E1.26*, prioritary);**

VIII. The <u>Nardetea strictae</u> are Middle-European and boreal-alpine acidophilic meadows, with:
- the *Violion caninae* = psychrophilic meadows in plains and hills;

IX. The <u>Alnetea glutinosae</u> are hydric thickets with shrubs, in plains and hills, on peaty soils, in which are the *Alnion glutinosae* and the *Salicion cinereae*; this formation is dominant on the south-east bank of the lake;

X. The <u>Vaccinietea uliginosi</u> **(44A, *G1.51*, prioritary)** are bog woodlands, psychrophilic heath areas, more or less peaty, in the boreal and mountain regions with:
- the *Ledo-Pinion* = coniferous dominated woods of bogs,
- the *Betulion pubescentis* = forests of birch colonizing bogs of reduced peat activity in the boreal, sub boreal zones;

[15] A plant that grows on wasteland, old fields, waysides, etc.
[16] Species that remain continuously during all seasons (like trees or plants that survive thanks to its roots during winter)

XI. The Vaccionio-Piceetea are boreal-alpine evergreen, needle-tree woods, dominant on the north and north-west bank of the lake, and present on the south-west bank, with:
- the *Dicrano-Pinion sylvestris* (**42.521, *G3.42***) = thermal pine yards on siliceous soils, in slopes and ravines,
- the *Vaccinio-Piceion abietis* (**42.2, *G3.1***) = coniferous forests dominated by spruce;

XII. The Querco-Fagetea sylvaticae semi-hygrophile forests, in which:
- the *Alno-Padion avii* (**44.3, *G1.2*, prioritary**) = alder and ash-tree alluvial forests on soils regularly inundated though correctly aerated;

XIII. The Epilobietea angustifolii are pre- or post-sylvan shrubs in the Atlantic or middle-European region, with:
- the *Carici piluliferae – Epilobion angustifolii* = forest clearings on acid soils occupied by herbs such as fireweed and Carex pilulifera.

The State Research [24] showed negative changes in the vegetation of the INPP region. Anthropogenous changes were observed: the invasion of alien plant species showing instability of native communities; many places overgrown with pyrogenic and ruderal flora were noticed instead of former natural meadows and forests. These changes were mostly registered in the surroundings of lake Druksiai.

The information on local land-tenure and biotopes around the ISFSF site is presented in Figure 4.5.3-2. ISFSF construction site is now recultivated (planted with pine seedlings) former soil buffer dump. Approximately 50 % of the site territory is represented by highland marshes and other 50 % – by lowland bogs (Figure 4.5.3-2).

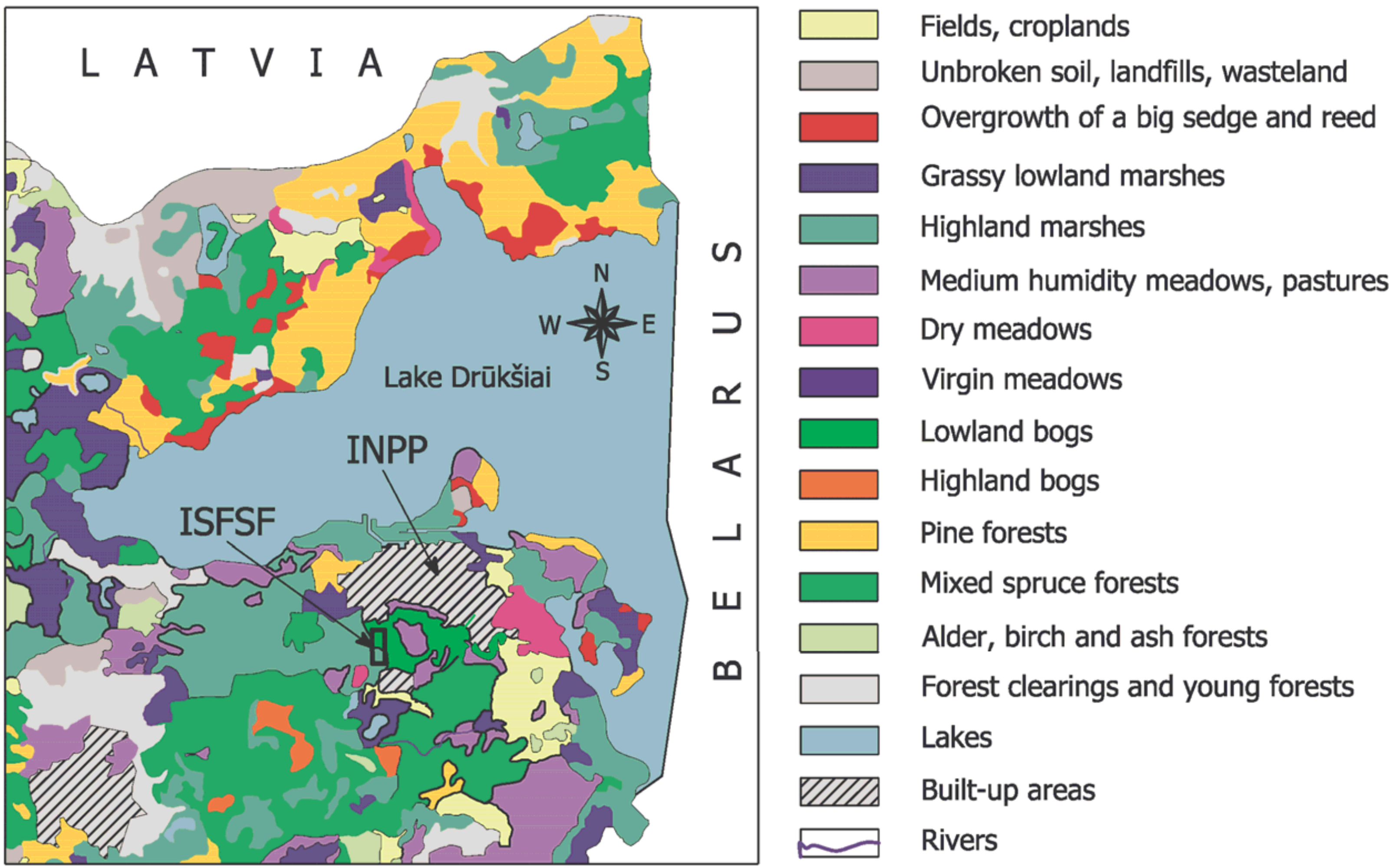


Figure 4.5.3-2. Local land-tenure and biotopes around the new ISFSF site

4.5.4. The Use of Biological Resources

Visaginas municipality's territory has increased to 5841 hectares: 69 hectares – private property, 2 hectares – one individual property, 1488 hectares – national forests and water, and almost 833 hectares – property for privatisation.

Dot wood manufacturing, light industry and agriculture developed over the years. New foreign companies are coming to Visaginas to establish their offices, because of cheap manpower and good infrastructure.

With the construction and start-up of the INPP, the consumption of agricultural products of the region increased. But the impact was not very important because Visaginas has no enterprises of agricultural products processing. The INPP directly encourages the producers and processors of agricultural products by buying up their products [35].

After the building of Visaginas and INPP, the distribution of surrounding forests into protective categories has changed. The INPP and Visaginas directly possess 1250 ha of forests. There were an attempt to pass these forests to the Ignalina local department of forestry but the latter declined because of the bad status of these forests.

New plans are to develop new agriculture, forestry and fishery.

The hunting economy of the region was little affected: the pasturing and hunting areas of game animals were slightly decreased. Visaginas has 30–40 hunters, which is a small number for such a town.

However, gathering of mushrooms (e.g. chanterelles) and forest fruits (berries) is very popular in the region and feeds local markets.

Fishing is widespread in the region; amateur fishing is authorized in the lake. Annual catches were estimated at 18 tons per year in the pre-operating period and to 41 tons per year in the period 1986–1990 [36].

4.6. Soil

The territory of the ISFSF site has been technogenically damaged in the past (there has been a constructional waste dump), but recently it was glided and recultivated (planted with seeding of conifer). Approximately 50 % of the territory is represented by highland marshes and other 50 % – by lowland bogs. Highland marshes mostly are psychrophilic heath areas, more or less peaty, on acid soils. Lowland bogs mostly are on peaty soils.

The ISFSF site is mainly covered with the mound soils (dusty sand, clay with organic admixture and locally found constructional waste). The thickness of the mound is 0.3–3.2 m. Interhills are marshy. The zone of the bog bank is covered with the wetland sediments (well decomposed peat, clay with organic admixture and organogenic dust). The thickness of this layer is 0.8–5.9 m [10].

4.7. Landscape

The landscape of the lake Druksiai watershed is characterised by the relief formed during glacial periods, consisting of picturesque mountain ridges, ravines, lakes, and plains as well as by pine forests and vast water meadows (Fig. 4.7-1).

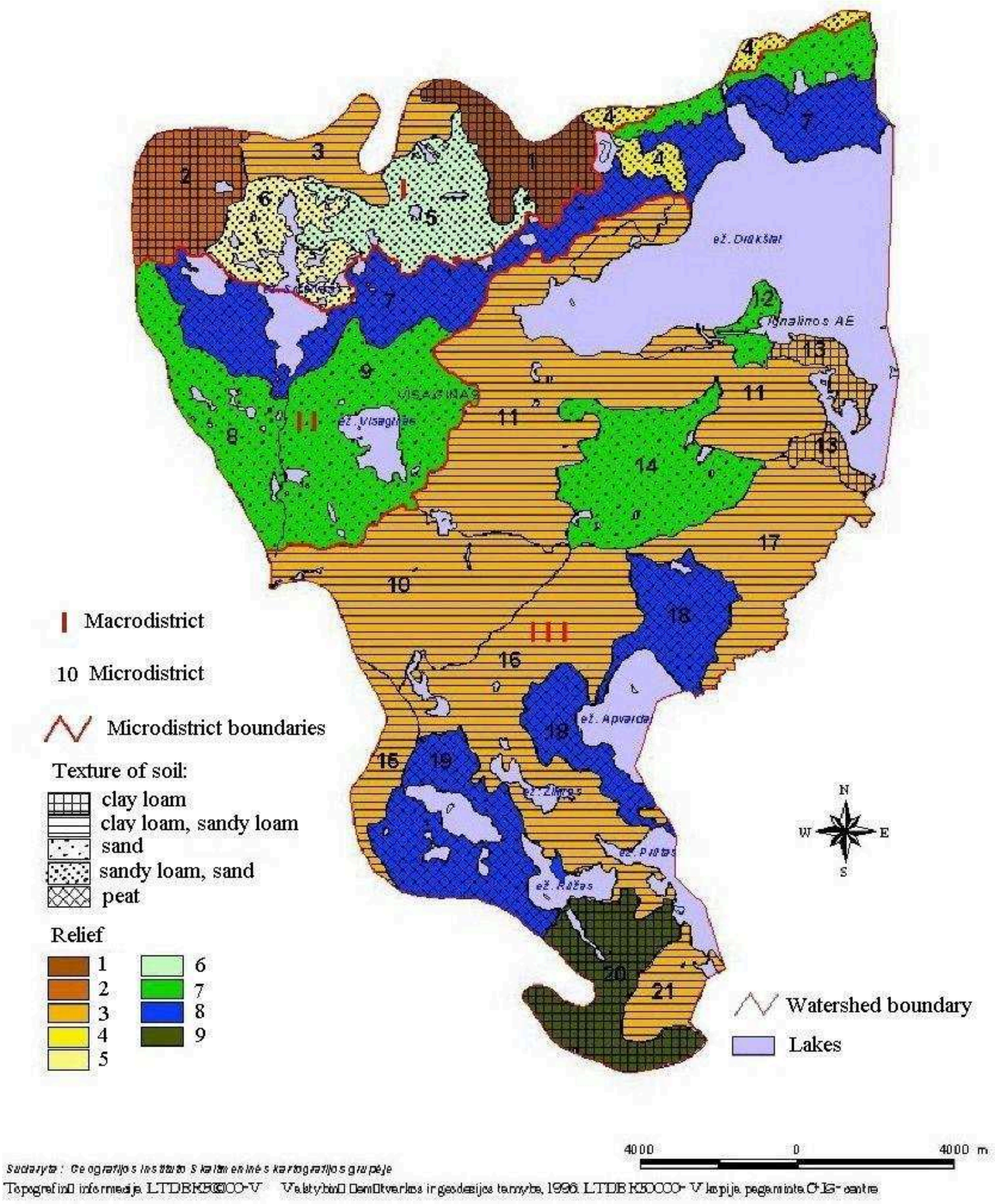


Figure 4.7-1. Landscapes types in the lake Druksiai watershed [34]

The landscape in the lake Druksiai watershed has degraded because of the building and operation of INPP, Visaginas town and related infrastructure. Today, the landscape can be characterized as industrial near the INPP: power production units, ancillary facilities, partly build third unit (industrial ruin), operative spent fuel storage facility, domestic wastewater treatment plant, ducts for the urban warming system of Visaginas and the electricity transmission lines.

At greater distance, landscape is mainly composed of forests and wetlands. Residential areas are made of small villages with traditional houses. The lake Druksiai is a major natural landscape element, with associated activities (fishing, recreational).

The most valuable landscape areas are located far away from ISFSF (about 15 km at the northwest), with the Grazutes Regional Park which covers 29471 hectares and is aimed at preserving the landscape of the Sventoji river basin with its lakes, forests, its natural ecosystem as well as the cultural heritage values, maintaining them and rationally using them. Pine forests (72 %) and birch forests (17 %) prevail in the Park. The average forest age is 65 years.

The Smalvos protected hydrographical territory (6 km at the northwest of ISFSF) also presents landscape value with its undulated relief and particular ecological formations.

The panorama of landscape at the ISFSF site is given in Fig. 4.7-2.

Figure 4.7-2. Panorama of landscape at the ISFSF site (the former soil buffer dump)

The potential impact of construction of new ISFSF on landscape is assessed in Subchapter 6.6.

4.8. Social and Economic Environment

4.8.1. Demography

4.8.1.1. Population evolution in the ISFSF region

Visaginas is a part of the Ignalina district (Fig. 4.8.1-1). The construction of the INPP made a big impact on the demography in this district. In 1979 the total population of the Ignalina district was 37 800, and then in 1989 it rose to 59 700, while the population in the country-side decreased from 21 600 to 18 200 [6].

Figure 4.8.1-1. Ignalina and Zarasai districts

The main cause of the increase of population in the Ignalina district was migration to Visaginas. This also led to a significant shift in the nationality of the population of the Ignalina district. In 1979 the percentage of Russians and Russian speakers was about 26 %; in 1989 it had increased to about 53 %. This immigration was concentrated in the city of Visaginas which consisted of about 92 % Russians and Russian speakers [6].

4.8.1.2. Current population distribution

In beginning of 2003 the total population of INPP region (the municipality of Visaginas – 59 km^2, the Ignalina district – 1 496 km^2 and the Zarasai district – 1 334 km^2) was 73 900 (in Visaginas – 28 600, in Ignalina and Zarasai districts accordingly 22 700 and 22 600). It was 40.4 % of Utena County and 2.1 % of Lithuania population.

In the town of Visaginas, the death rate is more than half as low as the average of the districts due to the younger age structure of the population, however, the birth rate is lower too and more rapidly decreasing than in the Ignalina and Zarasai districts; up to 2002, the population evolution (in terms of natural balance[17], not taking immigration/emigration into account) was positive in Visaginas, and negative in the Ignalina and Zarasai districts (Table 4.8.1-1).

[17] Measured as the difference Birth Rate–Death Rate.

Table 4.8.1-1. Birth and death rates, population evolution, 2000–2002

Territory	Birth rate per 1000 residents			Death rate per 1000 residents			Population evolution per 1000 residents		
	2000	2001	2002	2000	2001	2002	2000	2001	2002
Lithuania	9.8	9.1	8.6	11.1	11.6	11.8	-1.3	-2.5	-3.2
Utena county	8.8	8.1	7.1	13.5	13.7	14.5	-4.7	-5.6	-7.4
Visaginas	7.3	8	6.2	5.5	6.2	5.2	1.8	1.8	1
Ignalina district	9	7.6	7.8	17.1	17.8	21.4	-8.1	-10.2	-13.6
Zarasai district	10.3	8.9	8.3	18.9	16.2	18	-8.6	-7.3	-9.7

During the last years, a decrease of population in the INPP region is observed. In the year 2002 the total population of the region decreased by 1400 (1.9 %), since 1999 – even 10100 (12 %). During 2002–2003 the most population decreased in Visaginas – 400 (1.4 %). Two processes – natural population evolution and migration, determine this population decreasing. In the year 2002, 501 people more died as was born in INPP region (in the year 2001 – 358). During the last years, a clear tendency of emigration is observed in the INPP region. The emigration had the greatest effect on the population of Visaginas that decreased by 436 people in 2002.

The main information about the population distribution in the region of 30 km is presented in Table 4.8.1-2 and Fig. 4.8.1-2.

About 38 thousands of inhabitants of Daugavpils (Latvia) have to be included into the 30 km radius zone because 30 % of territory of Daugavpils stretches at a distance from 27 to 30 km from INPP (Fig. 4.8.1-2). Within the 30 km radius the density of population is about 48 people/km^2. This is lower than the nominal density of population of 56.7 people/km^2 in Lithuania. In fact, population density in the INPP region is one of the lowest in Lithuania [17].

Within the sanitary protected area (R = 3 km) there are neither farmsteads nor inhabitants.

Table 4.8.1-2. Population distribution (thousands) [17]

Radius of circle \ Direction of segment	N	NE	E	SE	S	SW	W	NW	Amount of inhabitants	
									in the ring	in the circle
30 km	38.9	0.8	8.8	1.4	1.8	2.4	2.3	0.9	57.3	135.9
25 km	1.4	1.1	2.5	2.6	4.7	1.6	1.4	8.7	24.0	78.6
20 km	0.5	0.4	1.4	1.3	1.3	2.9	0.9	0.7	9.4	54.6
15 km	0.6	0.8	1.0	0.9	0.9	1.3	0.4	1.0	6.9	45.2
10 km	0.5	0.6	0.7	0.5	1.0	0.5	34.0	0.3	38.1	38.3
5 km	-	-	-	-	0.1	-	-	0.1	0.2	0.2
3 km	-	-	-	-	-	-	-	-	-	-
Total in the segment	**41.9**	**3.7**	**14.4**	**6.7**	**9.8**	**8.7**	**39**	**11.7**	**Total 135.9**	

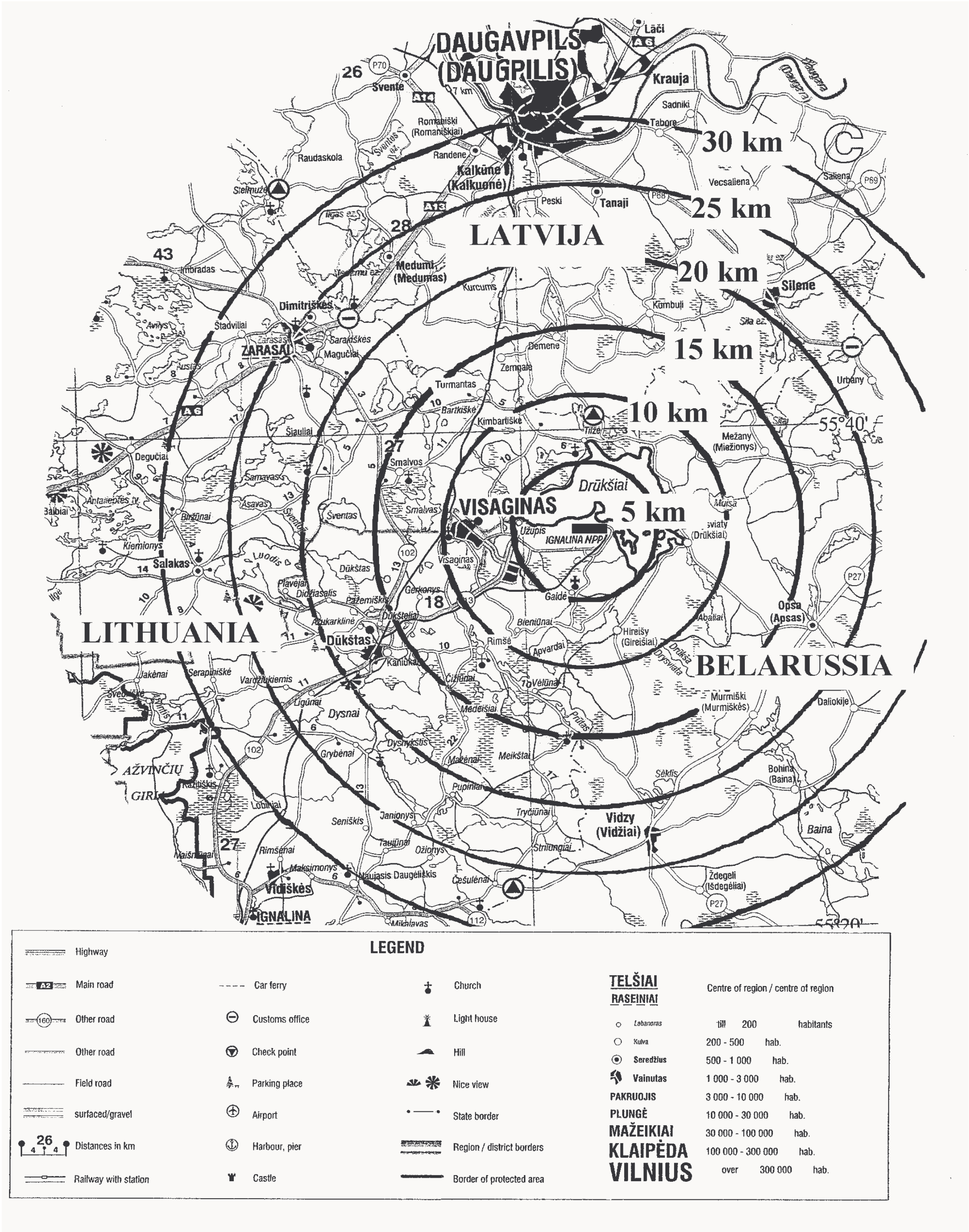


Figure 4.8.1-2. Population distribution in 5, 10, 15, 20, 25 and 30 km zones [17]

4.8.2. Economic Activities

From the economic point of view the INPP region is an insufficiently developed region in Lithuania (the town of Visaginas makes the exception). Agriculture and forestry of low intensity dominate in the region (for example, the intensity of cattle breeding is about 1.4 times lower than on the average in Lithuania). No important minerals (with the exception of quartz sand) are found in the region. The turnover of the retail trade in the region is 1.5, and the volume of services is more than 2.5 times lower than on the average in the country.

Apart the INPP, other large-scale industrial enterprises are absent in the INPP region. Joint-stock company "Business News" annually publishes a list of Lithuanian business leaders. Only INPP (8th position) and clothes/garment factory "Visatex" (296th position) are in the list (400 positions) of year 2003. The enterprises present in the region are mainly small and medium enterprises.

Within the 10 km radius (see Fig. 4.8.1-2) there are no large commercial pursuits. At the 5 km distance to the southwest direction with respect to INPP there is the former construction-industrial establishment. In the vicinity of this establishment there are, among others, training centre of frontier guard, fire protection service.

INPP region municipalities' aggregative index of manufacturing is presented in Table 4.8.2-1. The index takes into account industry, agriculture, building and service, it analyses produced products in all sectors. The index calculation includes these indicators (per inhabitant): industrial production, realized building works, agricultural products and rendered services. These indicators have weight numbers according their importance: industry – 0.3, building and service – 0.25 and agriculture – 0.2.

Table 4.8.2-1. INPP region municipalities' aggregative index of manufacturing, 2001 [36]

Territory	Sold industrial production, Lt per inhabitant	Realized building works, Lt per inhabitant	Sold agricultural products, Lt per inhabitant	Rendered service, Lt per inhabitant	Aggregative production index	Position of municipality in Lithuania
Lithuania	6319	789	459,6	1424	1,00	
Visaginas	2180	1173	1,2	732	0,60	41
Ignalina district	696	461	221,1	472	0,36	55
Zarasai district	745	251	398,3	470	0,37	54

At present business and industry potential existing in INPP region is practically not employed and region is losing competitive activity for investment attraction. A positive factor for business development in the region is the infrastructure created for business support. This business support system is oriented to services of local small and medium enterprises.

The town of Visaginas has an urban type labour force – a younger age structure (residents under 41 years of age account for 67 %), better educated people and greater variety of professional training. Ignalina and Zarasai districts have a rural type labour force – an older age structure, lower education and a small variety of professional training. Individuals capable of working within working age in the town of Visaginas account for 66 %, that is, 22.2 thousand people; in Ignalina district – 52 %, that is, 12.9 thousand people and in Zarasai district – 53 % (13 thousand people). However, available job vacancies cannot answer to work demand, so that Visaginas unemployment is a bit higher than actual Lithuania's unemployment level [38].

4.8.3. Amenities

Water supply of INPP is made by lake Druksiai which provides for service water. Drinking water used on the site is produced from underground water wells of Visaginas.

Treatment plant for sewage water is located one km to the south from the INPP. Household effluents from INPP and Visaginas arrive in this plant. Next to it are ponds used as biological treatment. The treated (yet containing pollution) water is released in the Skripki lake, which is nowadays considered as a secondary source of organic contamination of water which is then released in the lake Druksiai through the Vosyliskiai streamlet.

4.8.4. Roads, Railroads and Air Tracks

The nearest motorway passes 12 km to the west of the ISFSF. This motorway joins the city of Ignalina with those of Zarasai, Dukstas and has an exit to the highway connecting Kaunas–St. Petersburg. The entrance of the main road from the INPP to the motorway is near the town of Dukstas (Fig. 4.8.4-1). There is another exit to Vilnius–Zarasai motorway. The extension of the road from INPP to Dukstas is about 20 km.

The main railroad line Vilnius–St. Petersburg passes 9 km to the west of the ISFSF (Fig. 4.8.4-1).

Figure 4.8.4-1. Road and railway network

More than 20 international air tracks cross the Lithuanian air space (Fig. 4.8.4-2). 30 airports of civil, military and mixed purpose are located in the country.

There are 3 zones where flights are prohibited in Lithuania: territory 5.4 miles (10 km) around INPP, 3 miles around "Achema" factory in Jonava and Mazeikiai oil refinery. In addition, there are 8 zones, linked in to 5 areas with some restrictions for flights (mostly due to the military purposes). Seven dangerous zones are defined due to the terrain military activities (military polygons). The highest concentration of such territories is in the Northern and South-Western (Jonava–Marijampole–Alytus) part of Lithuania (Fig. 4.8.4-3).

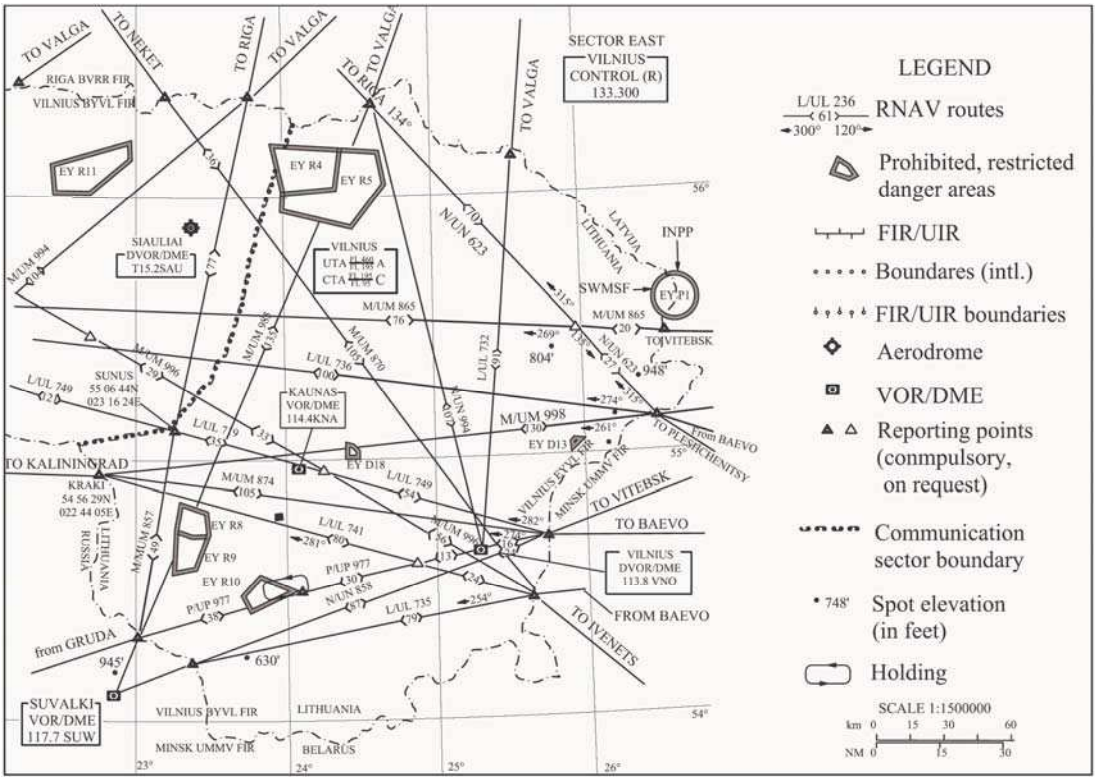


Figure 4.8.4-2. Air tracks of the Republic of Lithuania

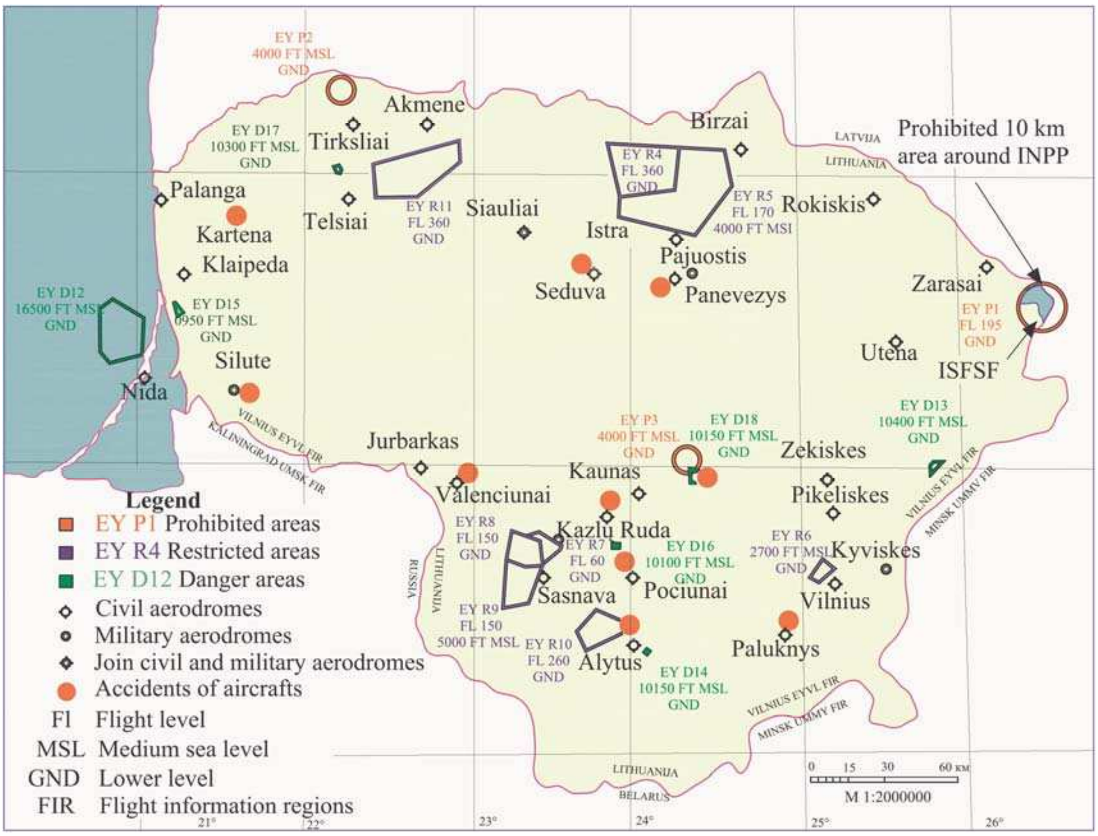


Figure 4.8.4-3. Airports, forbidden, restricted and dangerous areas in Lithuania

As can be seen from Fig. 4.8.4-3, the network of lowest density is in the North-Western and North-Eastern parts of Lithuania. The highest concentration of airports is in Vilnius–Kaunas–Marijampole area and in Panevezys–Palanga area.

On average there are 1 or 2 civil aeroplanes (Dassault Mystere Falcon F-900, Boeing 737-900 or Boeing 747-400) flying per day in air track M865. The minimum distance of the track from INPP is 10–15 km. On average 6 civil aeroplanes of two types "Tupolev" TU134 and TU154 fly per day at a speed of 900 km/h in track P727 in the Republic of Belarus (the minimum distance from INPP is 15–20 km).

In addition to the above data Lithuanian military aircraft, foreign military aircraft, air photography planes realising the OPEN SKIES programme and VIP planes can fly aperiodically in the forbidden EYP1 zone.

According to the data of Administration of civil aviation, there were around 40 accidents of aircrafts in Lithuania during last decade. The highest number of accidents has taken place in the surroundings of airdromes of air clubs. These accidents did not cause the damage for the buildings on the ground. The big airplanes, which crossed Lithuanian air space or landed here, have not experienced any accident.

4.8.5. Blast Wave

Identified sources in the vicinity of ISFSF are as follows:

- Hydrogen receiver: 8 tanks, each tank volume – 80 m^3, pressure – 10 kgf/cm^2, distance – 1.25 km;
- Stock of acetylene vessels: 200 acetylene vessels, each vessel volume – 40 1, pressure – 20 kgf/cm^3, distance – 1.7 km;
- Diesel fuel storage: volume – 1000 m^3, distance – 0.8 km;
- Gas pipeline: gas flow – 4000 m^3/h, diameter of pipe – 180 mm, pressure in the pipeline – 6 bars, distance – 600 m.

4.9. Ethnic and Cultural Conditions, Cultural Heritage

The following territories are protected in the distance of 10 km around INPP and ISFSF: Smalvos protected hydrological reserve, Tilzes geomorphological reserve, and Smalvos landscape protected reserve (Figure 4.9-1). Pusnies protected territory is at the distance of about 12 km from the new ISFSF.

Additionally to these protected territories, NATURA 2000 areas (see Chapter 4.5.1) were proposed by the Authorities. Once approved by the European Commission, these areas shall be considered as protected territories as well.

No archaeological remains were detected during the works carried out for construction of the INPP and ancillary facilities. During the construction of INPP, the site located within the boundaries of the plant underwent large excavations works and earth movements that revealed no outstanding elements as regards the architectural and archaeological heritage. As a result, there is assurance that no elements of the archaeological heritage will be affected by the ISFSF construction. There are no objects of cultural heritage, ethnic or cultural conditions that could be negatively impacted by the ISFSF.

Figure 4-9-1. Protected territories (indicated in dark green) and objects of cultural heritage in the distance of 10 km around the INPP and ISFSF

There are seven cultural heritage objects in the vicinity of the INPP: Petriskes settlement antiquities I, Petriskes mound, Petriskes settlement antiquities II, Grinkiskes settlement antiquities III, Grinkiskes settlement antiquities II, Grinkiskes settlement antiquities I and Stabatiskes manor place (Figure 4.9-2).

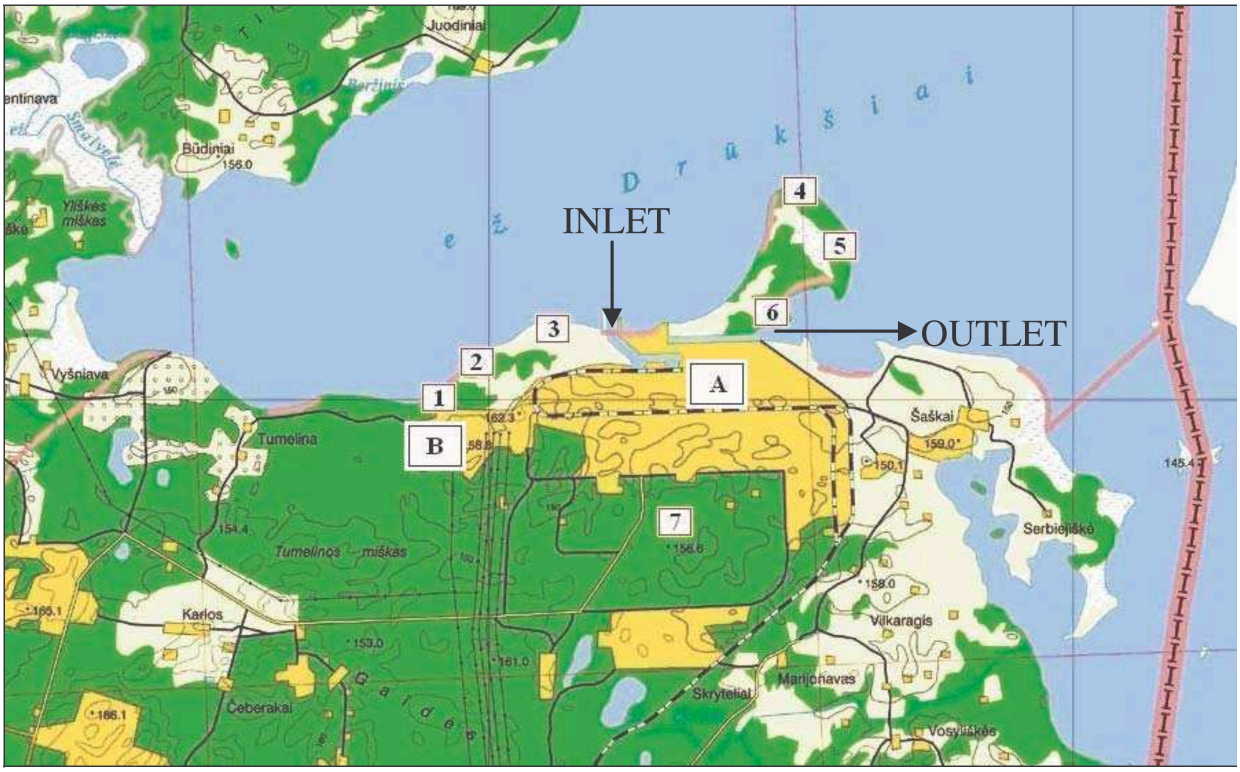


Figure 4.9-2. Cultural heritage objects in the vicinity of the INPP Reactor Units (A) and switchyard (B): 1 – Petriskes settlement antiquities I; 2- Petriskes mound; 3 – Petriskes settlement antiquities II; 4 – Grinkiskes settlement antiquities III; 5 – Grinkiskes settlement antiquities II; 6 – Grinkiskes settlement antiquities I; 7 – Stabatiskes manor place

5. RADIOLOGICAL IMPACTS ON THE ENVIRONMENT AND IMPACT MITIGATION MEASURES

Potential radiological impact sources (risks) resulting from normal operation of proposed economic activity and which could lead to environmental impact are addressed in this chapter of EIA Report with purpose to demonstrate that proposed economic activity by virtue of its nature and environmental impacts may be carried out in the chosen sites. Therefore activities and operations, which could cause potential impact on environment, are subject of investigation and assessment.

By this proposed economic activity radiological impact on environment potentially could be produced by release of airborne activity (aerosols, noble gases etc.) generated during operational processes and due to irradiation from structures and installations containing radioactive material or being contaminated by radioactive material. There will be no uncontrolled discharges of radioactive effluents into the environment from the proposed economic activity under normal operation conditions.

EIA not addresses cask design safety issues. Performing the EIA it is assumed that cask will be designed to meet all design conditions and functional requirements as specified in the Ignalina NPP issued "Technical Specification for Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Unit 1 and 2" [1]. The nuclear fuel sub-criticality, heat removal, cask mechanical strength and stability and other cask safety issues shall be assured by appropriate Technical Design and will be analyzed and justified in Safety Analysis Report.

Possible impact mitigation measures are also proposed where appropriate. The actual impact mitigation measures shall be analyzed and justified in Safety Analysis Report considering Technical Design aspects.

In this chapter a potential radiological impacts due to normal operation of proposed economic activity are analyzed. Summary of potential radiological impacts and conclusions made can be directly found in chapter 5.3.3. Emergency situations are addressed in chapter 9.

5.1. Potential Impact on Environment due to Release of Airborne Activity

5.1.1. Potential Releases to Environment from the Reactor Units

During normal operation of proposed economic activity:

- Possible radioactive releases during processing of leaking SFA in the existing Hot Cell;
- Possible radioactive releases during handling of over pack cartridges, bundles and baskets with leaking spent nuclear fuel;
- Possible radioactive releases during processing of mechanically damaged and experimental fuel assemblies and collecting of fuel debris;
- Possible releases into existing ventilation system of radioactive gasses during drying and evacuation of the cask cavity.

Possible releases into defined premises of Reactor Unit could result in exposure of operating personnel. In the case of activity exhaust through Reactor Unit ventilation system into atmosphere, such releases could result in exposure of the members of population.

The summary of activity potential release sources, activity migration pathways and potentially threatened objects is presented in Table 5.1.1-1. Considering nature of spent fuel handling operations it can be concluded that annual amount of generated airborne activity is proportional to amount of fuel bundles, which will be handled annually at the Reactor Units.

Table 5.1.1-1 Activity potential release sources, activity migration pathways and potentially threatened objects due to processing and handling of SNF at Reactor Units

Operation	**Potential activity release sources**	**Activity migration pathways**	**Threatened objects**
Processing of leaking SFA in the existing Hot Cell	Gases from leaking (defective) fuel rods	Activity will be released into hot cell chamber and will be collected by existing ventilation system. After filtration, certain amount of activity could be exhausted through Reactor Units main ventilation stacks.	Activity, released into atmosphere can result exposure of the members of population.
Handling of over pack cartridges, bundles and baskets with leaking spent nuclear fuel	Gases from leaking (defective) fuel rods	Primary media where activity is released is water of the fuel storage pools. From water surface of open pools radioactive gases and aerosols can be released into environment of the Storage Pools Hall. Activity, released from fuel storage pools will be collected by existing Storage Pools and Storage Pools Hall ventilation systems. After filtration, certain amount of activity could be exhausted through Reactor Units main ventilation stacks.	Activity, released into environment of the Storage Pools Hall can result exposure of personnel operating in Storage Pools Hall. Activity, released into atmosphere can result exposure of the members of population.
Processing of mechanically damaged and experimental fuel assemblies; collecting of fuel debris	Gases from leaking (defective) fuel rods; Fuel particles from mechanically damaged fuel rods; Gases and fuel particles from cutting of experimental fuel rods	Primary media where activity is released is water of the fuel storage pools. From water surface of open pools radioactive gases and aerosols can be released into environment of the Storage Pools Hall. Activity, released from fuel storage pools will be collected by existing Storage Pools and Storage Pools Hall ventilation systems. After filtration, certain amount of activity could be exhausted through Reactor Units main ventilation stacks.	Activity, released into environment of the Storage Pools Hall can result exposure of personnel operating in Storage Pools Hall. Activity, released into atmosphere can result exposure of the members of population.
Drying and evacuation of the cask cavity	Gases from leaking (defective) fuel rods; Gases from spontaneously leaked fuel rods	Activity will be released directly into existing ventilation system. After filtration, certain amount of activity could be exhausted through Reactor Units main ventilation stacks.	Activity, released into atmosphere can result exposure of the members of population

5.1.1.1. Assessment of potential activity release sources

This chapter provides assessment of potential activity release sources relevant for normal operation of proposed economic activity at the Reactor Units. Output from this chapter in following (i.e. chapter 5.1.1.2) is used for assessment of activity migration pathways and activity release into environment where exposure of personnel and population can be expected.

Estimation of potential annual releases due to processing and handling of leaking fuel

Various fractions of activity can be released from leaking fuel during various steps of SFA processing (Hot Cell) and fuel bundle handling (loading into the basket, basket transfer, loading into the cask, cask vacuum drying etc.). This assessment does not makes any particular assumptions on release fractions which might be expected at particular fuel processing and handling step. As it can be seen from identified activity migration pathways, cf. Table 5.1.1-1, potentially maximal annual release of activity at the location where maximal dose can be expected shall be a basis for conservative assessment of exposure of personnel and public.

About 3 % of the existing and planned spent nuclear fuel is identified as defective. These SFA contain leaking fuel rods and will be processed in the existing Hot Cell. Then fuel bundles will be loaded into the cask. The rough estimation gives the total number of $36000 \times 0.03 = 1080$ leaking fuel bundles. The cask loading with leaking fuel will be limited. Up to 30 leaking fuel bundles can be loaded in one cask. Thus, about $1080 / 30 = 36$ casks will contain leaking fuel. In assessing of annually released activity it is conservatively assumed that all leaking fuel bundles will be handled within period of one year.

Existing investigations of INPP leaking fuel conclude that in majority of cases one leaking rod could be expected per FA (i.e. one leaking rod per two fuel bundles) [2], [3], [4]. Probability of having two leaking rods in one FA is lower by about one – two orders (since the main cause of fuel rod leakage in RBMK reactors is solid particles of corrosion products [5] in reactor coolant system, the simultaneous leakage of two fuel rods in the same FA can be treated as independent events). However in this assessment it is conservatively assumed that each leaking FA contains two leaking rods (i.e. one leaking rod per one fuel bundle).

The RBMK fuel release analysis [6] shows that the greater part of fission products accumulated inside a fuel rod is found in solid phase. Only Kr-85 and H-3 occur in gaseous phase. To a small degree in free state under fuel rod cladding there are present halogens and alkali metals, which release from under cladding through leaks may bear witness to loss of integrity by a fuel rod. Among these radionuclides Cs-137 has the longest half-life (~ 30 years). Whilst one would expect that no more than 0.01% of total content may release from the fuel rod at a storage temperature, a changed concentration of Cs-137 may testify that fuel leaking has occurred. The remaining radionuclides contained in irradiated fuel with long half-life (Ba-137, Sr-90) are in solid phase and practically do not leave fuel through cladding defects.

The release fraction of 0.01% for Cs radionuclides is used in existing INPP safety cases for RBMK-1500 SNF handling accidents [7], [8], [9] while it is also indicated that about 0.5% of Cs activity could be accumulated in the gap [8]. Information on Cs release fractions is available from INPP measurements of Cs activity release into the water of leaking fuel storage over packs [2]. The values of short term (6-18 days) release fraction of Cs from leaking SFA are distributed within a range of three orders with geometrical mean of 0.001%. Long term (of several years) release fractions as compare with short term release, in general are higher by factor of 10 with geometrical mean value of 0.01%.

The release fractions for noble gases and halogens (I) are higher. Existing INPP safety cases for RBMK-1500 SNF handling accidents uses release fraction of 1% for Kr-85 and <1% for Iodine [8], [9]. Other studies quote for potentially higher release fractions. The report [2] indicates that generation of gaseous activity during irradiation of RBMK-1500 fuel is about 5.7% and also is higher as compared to RBMK-1000 fuel case. Post reactor research results of RBMK-1000 uranium-erbium oxide SFA shows that under cladding activity of gaseous Kr and Xe could be up to 7% [10]. These results are in line with noble gas release measurements performed during INPP hot tests (vacuum drainage) of CONSTOR RBMK-1500 casks [4].

There are no Lithuanian requirements for assessment of activity content, which could be released from leaking rods. According to Technical Specification [1] requirements an appropriate international standards have to be used in such a case.

The fuel of RBMK is fundamentally no different to the fuel of light water reactors, for which a sound database has been collected using experimental results obtained both in the Russian Federation and in other countries (U.S., Japan) [11]. The fraction of fission product inventory in gap therefore is selected following recommendations of U.S. Nuclear Regulatory Commission Regulatory Guide 1.183 [12], which conservatively envelops results of existing RBMK fuel investigations. An exception is made for gap release fraction of Cs where lower value is selected (the same as it is used in existing INPP safety cases) considering fuel cooling in storage pools before any further processing and handling takes place. As it is indicated above, selected release fraction is supported by existing INPP measurements of Cs activity release into the water of leaking fuel storage over packs. The selected fractions of fission product release are indicated in Table 5.1.1-2.

Table 5.1.1-2. Fractions of released fission products

Radionuclides	**Gap fraction, %**
H-3	10
Kr-85	10
I-129	5
Cs-134	0.01
Cs-137	0.01

The annual release of activity from leaking fuel is calculated as follows:

$$A_{LFG} = \frac{A_{FA} \times GF}{N_{RA}} \times N_{LFR} \times N_{LFB},$$

where:

A_{FA} – activity of specific radionuclide per FA of 2.8% enrichment of U-235, Table 2.1.3-1 (it is conservatively assumed that all SNF is of 2.8% enrichment of U-235, cf. chapter 2.1.3);

GF – fraction of released fission product (gap release fraction), Table 5.1.1-2;

N_{RA} = 36, number of fuel rods per FA;

N_{LFR} = 1, number of leaking fuel rods per fuel bundle;

N_{LFB} = 1080, total number of leaking fuel bundles.

The activity release calculation results are summarized in Table 5.1.1-3.

Table 5.1.1-3. Potential amount of annually released activity due to processing and handling of leaking fuel at Reactor Units

Radionuclide	**Annual release of activity, Bq**
H-3	3.75E+12
Kr-85	8.79E+13
I-129	2.18E+08
Cs-134	2.39E+11
Cs-137	1.03E+12
Total	**9.29E+013**

Estimation of potential annual releases due to processing of damaged and experimental fuel and collecting of fuel debris

Only a small amount of defective fuel (i.e. only mechanically damaged) and experimental fuel assemblies have to be processed using damaged fuel handling system. It is identified [1] that processing amount of the damaged fuel handling system limits to 59 mechanically damaged and 24 experimental fuel assemblies.

The damaged fuel handling system will start operating after all undamaged (including leaking) fuel assemblies are emptied from the storage pools. The only one damaged fuel handling system will be provided by this proposed economic activity. When the damaged and experimental fuel will be processed at Reactor Unit 1, the system then will be transferred and installed in the pool of Reactor Unit 2. The processing of the fuel will not be performed at the same year, cf. Figure 1.5-1. Therefore the estimation of maximal potential annual releases is based on maximal amount of damaged and experimental fuel stored in one of Reactor Units. In assessing of annually released activity it is conservatively assumed that all damaged and experimental fuel bundles stored in Reactor Unit will be handled within period of one year.

The damage of SFA may be minor e.g. slight damage without the loss of integrity of the cladding; or it may be more significant and result in distorted fuel assemblies, fuel bundles and fuel rods with the potential loss of fuel pellets from within the cladding. Only a certain number of mechanically damaged fuel assemblies are associated with planned fuel rods banding and clamping operations, which could result in release of activity from fuel rods. It is estimated [1] that there will be in total 18 of such heavy damaged fuel assemblies stored in pools of Reactor Unit 1 and 10 – in pools of Reactor Unit 2.

The original damage to the fuel rod has resulted in the rod deforming such that a fuel pellet could be crushed inside the rod. Any subsequent mal-operation of the consolidation clamp, prior to fitting of the restraint band, then could result in rupture of the rod and the release of the fuel pellets debris and fission gas from within the rod. Such defected fuel commonly shows 2-3 damaged fuel rods of this nature while in single cases a greater number of damaged rods can be expected [1]. For the purpose of assessment of annual releases it is conservatively assumed that in average 5 damaged fuel rods are ruptured in the fuel assembly. Damage of considerable greater number of the fuel rods shall be considered as an exceptional single case and therefore is addressed in chapter 9 "Emergency situations" (cf. chapter 9.3 "Dose assessment for the accidental breaking of fuel rods within a fuel bundle").

The annual release of fission gas from fuel cladding is calculated as follows:

$$A_{DFG} = \frac{A_{FA} \times GF}{N_{RA}} \times N_{DFR} \times N_{DFA},$$

where:

N_{DFR} = 5, number of damaged fuel rods per fuel assembly;

N_{DFA} = 18, maximal number of damaged FA stored in one of Reactor Units.

Other denotations are defined in the text above.

In case of rupture of fuel rod cladding, certain amount of fine particles could be released. Damage to the fuel rod will be localized such that the fragments from a maximum of 5 fuel pellets may be damaged and released. The mass of pellet is 15 g thus giving a maximum of 75 g of fuel pellet fragments released into the storage pool water. The produced debris is associated with fuel fragments rather than with fine particles. However, it is conservatively assumed that about half (36 g as in case of "fuel bundle cutting through" accident, see chapter 9) of produced debris will be in form of fine particles, which could produce airborne activity. The annual release of activity due to damage of fuel matrix is calculated as follows:

$$A_{DFP} = \frac{A_{FA} \times (1 - GF)}{M_{FA}} \times M_{FP} \times N_{DFA},$$

where:

M_{FA} = 126 kg, mass of Uranium dioxide per fuel assembly, Table 2.1.1-1;

M_{FP} = 0.036 kg, mass of produced fine particles.

Other denotations are defined in the text above.

Some existing at INPP experimental SFA contain 4 separate fuel rods of ~7 m in length and therefore can not be processed using existing INPP equipment and installations. Rods are loaded with fuel of 4.4 % initial enrichment of U-235. These experimental SFA will be processed (experimental rods will be cut through allowing separation of FA into two fuel bundles and then fuel bundles will be over packed) using damaged fuel handling system. There are 18 experimental fuel assemblies stored in pools of Reactor Unit 1 and 6 – in pools of Reactor Unit 2 [1].

The annual release of fission gas from experimental fuel rods cladding is calculated as follows:

$$A_{EFG} = A_{EFA} \times GF \times N_{EFA},$$

where:

A_{EFA} – activity of 4 experimental fuel rods of 4.4% enrichment of U-235, Table 2.1.3-1;

N_{EFA} = 18, maximal number of experimental FA stored in one of Reactor Units.

Other denotations are defined in the text above.

The annual release of activity due to damage of experimental fuel matrix is calculated as follows:

$$A_{EFP} = \frac{A_{EFA} \times (1 - GF)}{M_{EFA}} \times M_{EFP} \times N_{EFA},$$

where:

M_{EFA} = 23.6 kg, mass of Uranium dioxide per 4 experimental fuel rods, cf. chapter 2.1.2;

M_{FP} = 0.012 kg, mass of produced fine particles.

Other denotations are defined in the text above.

New fuel debris collection equipment is provided by this proposed economic activity for collection and removal of resident and accidentally lost (during handling operations) fuel pellets and fuel debris from the pools. Design will ensure that fuel collection and over packing operations will not affect integrity of pellet. Temperature of pools water is low therefore fission products confined within fuel matrix will not be released. No additional release of activity is expected during collection of fuel debris.

The activity release calculation results due to processing of damaged and experimental fuel are summarized in Table 5.1.1-4.

Table 5.1.1-4. Potential amount of annually released activity due to processing of mechanically damaged and experimental fuel

Radionuclide	Annual release of activity, Bq
H-3	7.69E+11
Kr-85	1.76E+13
Y-90	1.76E+12
Sr-90	1.76E+12
Rh-106	3.16E+11
Ru-106	3.16E+11
Sb-125	4.87E+10
I-129	3.12E+07
Cs-134	5.18E+11
Cs-137	2.52E+12
Ba-137m	2.32E+12
Ce-144	2.78E+11
Pr-144	2.78E+11
Pm-147	1.24E+12
Eu-154	5.67E+10
Eu-155	2.39E+10
Np-237	4.17E+06
Pu-238	2.87E+10
Pu-239	4.41E+09
Pu-240	1.19E+10
Pu-241	1.49E+12
Am-241	1.56E+10
Am-242m	7.60E+07
Am-243	3.21E+08
Cm-242	3.85E+08
Cm-243	1.68E+08
Cm-244	2.51E+10
Total	**3.13E+13**

Estimation of potential annual releases due to handling of intact fuel

No damage to the intact fuel is expected under normal operation conditions of proposed economic activity. Potentially there is a possibility that due to vacuum drainage and evacuation of cask cavity some of intact fuel rods will spontaneously leak. In case of spontaneous fuel rod leak the free gas inventory accumulated in the cavity of fuel rod with decay time of at least five years can be released. The probability of a spontaneous fuel rod leak occurring during cask drying is assessed based on present cask loading experience to be less than 10^{-2} per cask. Until end of the year 2005 about 330 GNS storage casks have been loaded with DWR, BWR, VVER and RBMK-1500 spent fuel. About 25 % of the casks had been loaded with RBMK-1500 fuel. In total only two fuel rod leaks have been reported (none for RBMK-1500 fuel). Therefore, it is conservatively assumed that up to 2 fuel rods in total could spontaneously leak during cask vacuum drying operations performed at Reactor Units. Also, it is conservatively assumed that all spontaneous leaks occur within the same year. The total annual release of activity is calculated as follows:

$$A_{SLG} = \frac{A_{FA} \times GF}{N_{RA}} \times N_{SLR},$$

where:

N_{SLR} = 2, total number of spontaneously leak fuel rods.

Other denotations are defined in the text above. The activity release calculation results are summarized in Table 5.1.1-5.

Table 5.1.1-5. Potential amount of released activity due to spontaneously fuel rods leak during drying and evacuation of the cask cavity

Radionuclide	**Annual release of activity, Bq**
H-3	6.94E+09
Kr-85	1.63E+11
I-129	4.03E+05
Cs-134	4.42E+08
Cs-137	1.91E+09
Total	**1.72E+11**

5.1.1.2. Assessment of airborne activity release into environment

Basing on estimation of potential activity release sources, cf. chapter 5.1.1.1 above, this chapter groups releases from potential activity sources according to potential activity migration pathways, considers activity migration specific and provides estimation of airborne activity releases into environments where exposure of personnel and population can be expected.

Estimation of airborne activity release into environment of Storage Pools Hall

Airborne activity release into environment of Storage Pools Hall can be expected in case of, cf. Table 5.1.1-1:

- Handling of over pack cartridges, bundles and baskets with leaking spent nuclear fuel within fuel storage pools;
- Processing of mechanically damaged and experimental fuel assemblies using DFHS.

In both cases primary media where activity is released from nuclear fuel is water of the fuel storage pools. From water surface of open pools radioactive gases and aerosols can be released into environment of the Storage Pools Hall and can result exposure of personnel operating in Storage Pools Hall. As the damaged fuel handling system will start operating after all undamaged (including leaking) fuel assemblies are emptied from the storage pools, two conservative scenarios of personnel exposure are considered:

- One year maximal increase of radioactive releases into environment of Storage Pools Hall due to handling of leaking fuel. This scenario considers bounding case assuming that all leaking fuel is handled within the single year of proposed economic activity. Actually, the leaking fuel will be handled within several years period and annual releases will be lower as estimated there. Also, in assessing of releases into environment of Storage Pools Hall it is conservatively assumed that all potentially available activity from leaking fuel has been released into water of storage pools.

- One year maximal increase of radioactive releases due to operation of defective fuel handling system. This scenario considers bounding case when after all not damaged (including leaking) fuel is emptied from the storage pools, the mechanically damaged and experimental fuel located in Reactor Unit is processed and handled within the single year of proposed economic activity. Actually, the defective fuel handling system can operate within several years period and annual releases will be lower as estimated there.

Estimation of potential release of airborne activity into environment of Storage Pools Hall considers specificity of activity release from the surface of the pools. The following assumptions have been used while calculating airborne activity releases from the surface of the pools:

- The retention of noble gas Kr-85 and gaseous H-3 in the pools water is negligible (i.e. decontamination factor of 1). Overall effective decontamination factor for gaseous I-129 is 200 (i.e. 99.5% of the total iodine released is retained by the water). The Cs is dissolved in the water of the pools. These decontamination factors are based on recommendations [12].
- The magnitude of release of dissolved and particulate radionuclides from the surface of the pools water into the Storage Pool Hall working environment, due to the Storage Pool Hall ventilation air flow over the pools, is determined by a release fraction of 5.0×10^{-7} per day for actinides and 2.0×10^{-7} per day for fission products. These release fractions are being based on data used in UK nuclear industry and are applicable for activity releases from covered spent nuclear fuel storage ponds.

The UK release fraction data relates to long term (up to 5 years) measurements taken over the surface of ponds (open and covered) containing spent fuel assemblies (including oxide type fuel). The conditions under which the measurements were made (fuel type along with long term measurements of pond water activity and the local airborne activity) are directly comparable with the conditions at INPP Storage Pools Hall. Also, selected release fractions account for the extract flow conditions across the pools surface as relevant in INPP case. Additional conservatism is introduced by assuming:

- The swarf collection unit fails to capture any fuel particulate released into the pools water;
- All fuel particulate material is within a respirable range when finally released from the pools water into the ventilation system or working area;
- Assessment does not consider permanent SP water cleaning (i.e. activity reduction) by existing INPP SP water cleaning system.

Therefore it can be concluded that selected method for estimation of activity long term release fractions from the storage pools water is applicable for INPP Storage Pools Hall conditions and is conservative in nature.

Estimations of potential annual releases of airborne activity into environment of Storage Pools Hall are summarized in Table 5.1.1-6.

Table 5.1.1-6. Annual release of airborne activity into environment of Storage Pools Hall

Radionuclide	One year maximal increase of radioactive releases due to handling of all leaking fuel, Bq/a	One year maximal increase of radioactive releases due to operation of damaged and experimental fuel handling system, Bq/a
H-3	3.75E+12	7.69E+11
Kr-85	8.79E+13	1.76E+13
Y-90	0	1.28E+08
Sr-90	0	1.28E+08
Rh-106	0	2.31E+07
Ru-106	0	2.31E+07
Sb-125	0	3.56E+06
I-129	1.10E+06	1.58E+05
Cs-134	1.74E+07	3.79E+07
Cs-137	7.54E+07	1.84E+08
Ba-137m	0	1.70E+08
Ce-144	0	2.03E+07
Pr-144	0	2.03E+07
Pm-147	0	9.02E+07
Eu-154	0	4.14E+06
Eu-155	0	1.75E+06
Np-237	0	7.61E+02
Pu-238	0	5.25E+06
Pu-239	0	8.06E+05
Pu-240	0	2.18E+06
Pu-241	0	2.72E+08
Am-241	0	2.85E+06
Am-242m	0	1.39E+04
Am-243	0	5.86E+04
Cm-242	0	7.03E+04
Cm-243	0	3.07E+04
Cm-244	0	4.59E+06
Total	**9.17E+13**	**1.83E+13**

Estimation of airborne activity release into atmosphere through Reactors Units main ventilation stacks

Airborne activity release into atmosphere through Reactors Units main ventilation stacks can be expected during all operations of proposed economic activity at Reactor Units, cf. Table 5.1.1-1. Three scenarios of expected maximal releases are distinguished to consider specificity of spent nuclear fuel handling and processing activity:

- One year maximal increase of radioactive releases due to vacuum drying of intact fuel. This scenario provides the most conservative estimation of potential releases into atmosphere assuming that all statistically probable spontaneous fuel leaks have been occurred during the one year period of proposed economic activity.

- One year maximal increase of radioactive releases due to processing and handling all leaking fuel. This scenario considers bounding case assuming that all leaking fuel is processed and handled within the single year of proposed economic activity. Actually, the leaking fuel will be processed and handled within several years period and annual releases will be lower as estimated there. In assessing of releases into atmosphere it is conservatively assumed that all potentially available activity from leaking fuel has been released during cask vacuum drying operation where most direct activity route through Reactor Unit ventilation system into atmosphere is possible. Assumptions on all or partial activity release during fuel processing in hot cell or during fuel handling in the storage pools provides with additional barriers on activity migration route (such as Hot Cell exhaust filtering system or water layer within storage pools) and leads to less conservative estimations.
- One year maximal increase of radioactive releases due to operation of defective fuel handling system. This scenario considers bounding case when after all not damaged (including leaking) fuel is emptied from the storage pools, the mechanically damaged and experimental fuel located in Reactor Unit is processed and handled within the single year of proposed economic activity. Actually, the defective fuel handling system can operate within several years period and annual releases will be lower as estimated there.

Estimation of potential release of airborne activity into atmosphere through Reactors Units main ventilation stacks considers specificity of activity release from the surface of the pools and specificity of existing INPP ventilation system.

The following assumptions have been used while calculating airborne activity releases into atmosphere through the ventilation system of Reactor Units:

- The magnitude of the release of fine particles into atmosphere through INPP ventilation system (and subsequently through the main ventilation stack) is determined by decontamination factor of existing operational filters. The decontamination factor of 1000 is assumed which corresponds to standard separation efficiency of existing operational filters (99.9 %) [13];
- No retention of activity by filtering for gases (H-3, Kr-85 and I-129) is assumed.

The following assumptions have been used while calculating airborne activity releases from the surface of the pools (which is when captured by Storage Pools ventilation system and is routed into atmosphere through the main ventilation stack):

- The retention of noble gas Kr-85 and gaseous H-3 in the pools water is negligible (i.e. decontamination factor of 1). Overall effective decontamination factor for gaseous I-129 is 200 (i.e. 99.5% of the total iodine released is retained by the water). The Cs is dissolved in the water of the pools. These decontamination factors are based on recommendations [12].
- The magnitude of release of particulate radionuclides from the surface of the pools water is determined by a release fraction of 5.0×10^{-6} per day for actinides and 2.0×10^{-6} per day for fission products. These release fractions are being based on data used in UK nuclear industry and are applicable for activity releases from open spent nuclear fuel storage ponds, cf. explanations in sub-chapter above.

Estimations of potential annual releases of airborne activity into atmosphere are summarized in Table 5.1.1-7.

Table 5.1.1-7. Annual release of airborne activity into atmosphere through INPP main ventilation stacks

Radionuclide	One year maximal increase of radioactive releases due to handling of all intact fuel, Bq/a	One year maximal increase of radioactive releases due to handling of all leaking fuel, Bq/a	One year maximal increase of radioactive releases due to operation of damaged and experimental fuel handling system, Bq/a
H-3	6.94E+09	3.75E+12	7.69E+11
Kr-85	1.63E+11	8.79E+13	1.76E+13
Y-90	0	0	1.28E+06
Sr-90	0	0	1.28E+06
Rh-106	0	0	2.31E+05
Ru-106	0	0	2.31E+05
Sb-125	0	0	3.56E+04
I-129	4.03E+05	2.18E+08	1.79E+05
Cs-134	4.42E+05	2.39E+08	3.79E+05
Cs-137	1.91E+06	1.03E+09	1.84E+06
Ba-137m	0	0	1.70E+06
Ce-144	0	0	2.03E+05
Pr-144	0	0	2.03E+05
Pm-147	0	0	9.02E+05
Eu-154	0	0	4.14E+04
Eu-155	0	0	1.75E+04
Np-237	0	0	7.61E+00
Pu-238	0	0	5.25E+04
Pu-239	0	0	8.06E+03
Pu-240	0	0	2.18E+04
Pu-241	0	0	2.72E+06
Am-241	0	0	2.85E+04
Am-242m	0	0	1.39E+02
Am-243	0	0	5.86E+02
Cm-242	0	0	7.03E+02
Cm-243	0	0	3.07E+02
Cm-244	0	0	4.59E+04
Total	**1.70E+11**	**9.17E+13**	**1.83E+13**

5.1.2. Potential Releases to Environment during Cask Transfer from the Reactor Unit to ISFSF

No activity airborne release is expected during cask transfer from the Reactor Units to ISFSF under normal operation conditions. The leak tightness of cask primary lid will be tested prior to cask transfer. The cask lid cavity will be protected by protective plate. Cask transfer will be short in time. During transfer under normal operation conditions the cask leak tightness is assured. The cask safety will be assured by appropriate Technical Design and will be justified in Safety Analysis Report.

5.1.3. Potential Releases to Environment during Cask Preparation and Storage at the ISFSF

No activity airborne release is expected during cask preparation and storage at the ISFSF under normal operation conditions. The leak tightness of cask primary lid will be tested prior to cask transfer. Cask preparation for storage operation includes welding of sealing and second lids without violating of primary lid tightness. After welding of the lids, the double-barrier welded lid system, together with the double-barrier design of the cask body, will ensure tightness of activity during long-term storage. During cask preparation and storage under normal operation conditions the cask leak tightness is assured. The cask safety will be assured by appropriate Technical Design and will be justified in Safety Analysis Report.

5.1.4. Potential Releases to Environment from Operation of the Fuel Inspection Hot Cell

The requirement for a Fuel Inspection Hot Cell (FIHC) at ISFSF is to allow for inspection and repackaging of spent fuel in the unlikely event of degradation of a storage cask such that safe containment and/or shielding can no longer be confirmed. The occurrence of a fuel repackaging operation is very low – there has been no requirement for the repackaging of spent fuel stored in GNS storage casks during presently more than 4000 cask storage years (corresponding to about half of the expected ISFSF cask storage years) – and is conservatively assumed to be less than 10^{-1} per year for ISFSF. Although it is not anticipated that a cask will fail during its storage life, the FIHC design throughput will be based on a maximum of one cask per year.

No damage to fuel is expected under normal operation conditions. Probability for additional fuel rod leaks arisen during the storage period is very low due to the cladding temperature limitation and the inert atmosphere of the cask cavity. Potential activity release sources could be the cask loaded with leaking fuel rods.

The leaking fuel rods loaded into the cask have been degassed during vacuum drying at Reactor Units. However, for conservative estimation of potential airborne activity the same residual free gaseous radioactivity in leaking rods is assumed as it was assessed in releases from Reactor Units, cf. chapter 5.1.1.1. Considering cask load limit for leaking fuel bundles, the estimated releases as presented under chapter 5.1.1.1 (for 1080 fuel bundles) are scaled for 30 leaking fuel bundles.

During the different steps of the repackaging procedure the free gaseous radioactivity inventory of the cask cavity is released via the off-gas duct of the ISFSF service area ventilation system (servicing the Cask Service Station and the Hot Cell) and the ISFSF stack to atmosphere. The ventilation system will be equipped with double HEPA filtration system providing a total decontamination factor at least of 10000. Therefore the aerosols and fine particles if such will be produced during fuel reloading are to be captured by filtration system. Filtering effect is not considered in estimation of release of gases (H-3, Kr-85 and I-129).

The potential annual releases to atmosphere from operation of the FIHC are summarized in Table 5.1.4-1.

Table 5.1.4-1. Annual release of airborne activity into atmosphere through ISFSF ventilation stack

Radionuclide	Annual releases due to reloading of the cask containing leaking fuel, Bq/a
H-3	1.04E+11
Kr-85	2.44E+12
I-129	6.04E+06
Cs-134	6.63E+05
Cs-137	2.87E+06
Total	**2.55E+012**

5.1.5. Methods to Assess the Impacts and Estimation of Potential Impact due to Release of Airborne Activity

5.1.5.1. Annual exposure of personnel due to release of airborne activity into environment of Storage Pools Hall

Airborne activity released into environment of Storage Pools Hall during spent fuel handling and processing operations will result inhalation and external exposure doses for operating personnel.

The Storage Pools Hall is ventilated. The Storage Pools Hall air volume is 26800 m^3 and air exchange time is 28 minutes. The annual air exchange rate is:

$$V_{SPH} = 26800 \times \frac{365.25 \times 24 \times 60}{28} = 5.03 \times 10^8 \ \mathrm{m}^3.$$

The annually averaged activity concentration in the environment of Storage Pools Hall is calculated:

$$C_{SPH} = \frac{Q}{V_{SPH}};$$

where:

Q – annual release of airborne activity into environment of Storage Pools Hall, Table 5.1.1-6.

V_{SPH} – annual Storage Pools Hall air exchange rate, see above.

The annual operator effective dose due to inhalation and external exposure may be determined using the following equation:

$$E = C_{SPH} \times t \times \left(B \times e_{inh} + e_{sub}\right);$$

where:

$t = 6.12 \times 10^6$ s, exposure time (assumes 1700 h working year);

$B = 3.3 \times 10^{-4}$ m^3/s, breathing rate for workers, [14];

e_{inh} – inhalation committed effective dose factor for workers, Sv/Bq, [15]. Data used in calculations are presented in Table 5.1.5-1;

e_{sub} – the effective dose factor for immersion, (Sv/s)/(Bq/m^3).

Dose factor for noble gas Kr-85 is taken from [15]. Dose factors for other radionuclides, not provided by [15] are taken from [16]. The effective dose values given in [16] have been estimated from the effective dose equivalent values for immersion in the cloud, given in [17], plus the corresponding weighted skin dose component, to provide an approximation to effective dose. Additional account of the contribution from radioactive progeny with half-lives less than 30 min has also been taken where appropriate. Therefore dose conversion factors from [16] are compatible with [15]. Data used in calculations are presented in Table 5.1.5-1.

The dose calculation results are summarized in Table 5.1.5-1.

Table 5.1.5-1. Potential annual exposure of operating personnel due to release of airborne activity into environment of Storage Pools Hall

Radio-nuclide	e_{inh}, **Sv/Bq**	e_{sub}, **(Sv/s)/(Bq/m^3)**	**One year maximal effective dose due to handling of all leaking fuel, Sv/a**	**One year maximal effective dose due to operation of damaged and experimental fuel handling system, Sv/a**
H-3	0	3.31E-19	1.51E-08	3.09E-09
Kr-85	0	2.55E-16	2.72E-04	5.44E-05
Y-90	1.70E-09	8.24E-16	0	8.77E-07
Sr-90	1.50E-07	9.82E-17	0	7.72E-05
Rh-106	0	1.14E-14	0	3.20E-09
Ru-106	6.20E-08	1.14E-14	0	5.75E-06
Sb-125	4.50E-09	2.06E-14	0	6.52E-08
I-129	5.10E-08	3.80E-16	2.26E-07	3.24E-08
Cs-134	9.60E-09	7.61E-14	6.87E-07	1.49E-06
Cs-137	6.70E-09	2.76E-14	2.05E-06	5.00E-06
Ba-137m	0	2.92E-14	0	6.02E-08
Ce-144	4.90E-08	3.49E-15	0	3.99E-06
Pr-144	3.00E-11	2.79E-15	0	3.13E-09
Pm-147	4.70E-09	8.87E-18	0	1.70E-06
Eu-154	5.00E-08	6.34E-14	0	8.34E-07
Eu-155	6.50E-09	2.54E-15	0	4.57E-08
Np-237	2.10E-05	1.05E-15	0	6.41E-08
Pu-238	4.30E-05	5.39E-18	0	9.05E-04
Pu-239	4.70E-05	4.44E-18	0	1.52E-04
Pu-240	4.70E-05	5.07E-18	0	4.10E-04
Pu-241	8.50E-07	7.29E-20	0	9.27E-04
Am-241	3.90E-05	8.24E-16	0	4.46E-04
Am-242m	3.50E-05	3.31E-17	0	1.95E-06
Am-243	3.90E-05	2.21E-15	0	9.16E-06
Cm-242	4.80E-06	6.02E-18	0	1.35E-06
Cm-243	2.90E-05	5.98E-15	0	3.58E-06
Cm-244	2.50E-05	5.39E-18	0	4.60E-04
Total annual effective dose			**2.75E-04**	**3.47E-03**

It can be concluded that potential annual expose of operating personnel due to release of airborne activity into environment of Storage Pools Hall is low. During the most of spent fuel handling operations, associated with proposed economic activity, the expected effective annual dose for member of operating personnel would be below 1 mSv. Higher annual doses can be expected during operation of defective fuel handling system. The expected maximal one year effective dose for member of operating personnel would be below 4 mSv.

5.1.5.2. Annual exposure of population due to release of airborne activity into atmosphere from Reactor Units

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 was calculated using the dose conversion factors and the multiplication factors for the different emission heights as recommended by Lithuanian normative document [18]. These nuclide specific conversion factors give a relation between a nuclide specific constant long term activity release and the dose caused to a critical group member of the population at the location of the highest predicted exposure (that means highest predicted radionuclide concentration in air and at ground level and eating the highest predicted contaminated food). Conversion factors are derived using the Gaussian atmospheric diffusion model, considering a meteorological statistic of INPP site of several years and taking into account the site-specific life style and nutrition features of critical group members together with all pathways of external and internal exposure:

- In the case of farmers – external exposure from immersion in the cloud and radionuclides deposited on the ground as well as re-suspension of deposited radionuclides and internal exposure due to inhalation and ingestion of radionuclides in the food stuffs;
- In the case of fishermen – the external dose, resulted by radionuclides in the lake water and in the coastal zone sediments as well as the internal dose resulted by the fish used for food;
- In the case of gardeners – external dose resulted by the exposure from radionuclides deposited in the irrigated soil as well internal dose due to consumption of food from irrigated garden and inhalation of re-suspended particles.

The annual effective dose to critical group member then is calculated:

$$E = Q \times DCF \times K_{VS},$$

where:

Q – annual release of airborne activity into atmosphere from Reactor Units main ventilation stack, Table 5.1.1-7;

DCF – dose conversion factor for unit of released activity [18]. Data used in calculations are presented in Table 5.1.5-2.

K_{VS} = 1, multiplication factors for emission height of Reactor Unit's main ventilation stack, [18].

The document [18] does not provide dose conversion factors for some of radionuclides which are identified in potential releases. These radionuclides are Rh-106, Ba-137m, Y-90, Sb-125, Ce-144, Pm-147, Np-237, Pu-238, Pu-241, Cm-242, Cm-243, Cm-244, Am-241, Am-242m and Am-243. Rh-106 and Ba-137m are very short lived radionuclides with decay half life of 29.9 s and 2.6 min. respectively. Only external exposure due to submersion into radioactive cloud shall be considered as potential impact source from release of these radionuclides. Y-90 with decay half life of 2.67 days to some extent also could be considered as short lived. Decay half life of remaining radionuclides varies from 163 days (Cm-242) to 2.14×10^{6} years (Np-237) and impact assessment shall include dose evaluation from external and internal exposure pathways.

The dose conversion factor of Pu-239 [18] is selected as representative for conservative estimation of potential exposure doses from releases of radionuclides not covered by [18] (with exception for Rh-106 and Ba-137m). The Pu-239 is long lived radionuclide with higher ingestion and inhalation dose factors [15]. The screening dose calculation factors for discharges into the atmosphere provided in IAEA document [16] demonstrate that Pu-239 is a conservative option for radionuclides in question.

The external exposure doses resulting form release of very short lived Rh-106 and Ba-137m is calculated using concentration at the location of the highest predicted exposure as used in defining dose conversion factors for [18] (with correction for decay) and effective dose factors for immersion (cf. Table 5.1.5-1).

The dose calculation results are summarized in Table 5.1.5-2.

Table 5.1.5-2. Potential annual exposure of critical group member due to release of airborne activity from Reactor Units

Radionuclide	*DCF,* Sv/Bq	One year maximal effective dose due to handling of all intact fuel, Sv/a	One year maximal effective dose due to handling of all leaking fuel, Sv/a	One year maximal effective dose due to operation of damaged and experimental fuel handling system, Sv/a
H-3	1.80E-21	1.25E-11	6.75E-09	1.38E-09
Kr-85	4.50E-23	7.33E-12	3.96E-09	7.91E-10
Y-90	3.80E-16	0	0	4.88E-10
Sr-90	7.00E-17	0	0	8.98E-11
Rh-106	6.84E-23	0	0	1.58E-17
Ru-106	7.80E-18	0	0	1.80E-12
Sb-125	3.80E-16	0	0	1.35E-11
I-129	1.20E-15	4.83E-10	2.61E-07	2.14E-10
Cs-134	8.30E-17	3.67E-11	1.98E-08	3.14E-11
Cs-137	1.20E-16	2.29E-10	1.24E-07	2.20E-10
Ba-137m	1.75E-22	0	0	2.97E-16
Ce-144	3.80E-16	0	0	7.71E-11
Pr-144	1.30E-22	0	0	2.64E-17
Pm-147	3.80E-16	0	0	3.43E-10
Eu-154	4.40E-17	0	0	1.82E-12
Eu-155	1.60E-18	0	0	2.80E-14
Np-237	3.80E-16	0	0	2.89E-15
Pu-238	3.80E-16	0	0	1.99E-11
Pu-239	3.80E-16	0	0	3.06E-12
Pu-240	3.80E-16	0	0	8.27E-12
Pu-241	3.80E-16	0	0	1.03E-09
Am-241	3.80E-16	0	0	1.08E-11
Am-242m	3.80E-16	0	0	5.28E-14
Am-243	3.80E-16	0	0	2.23E-13
Cm-242	3.80E-16	0	0	2.67E-13
Cm-243	3.80E-16	0	0	1.17E-13
Cm-244	3.80E-16	0	0	1.74E-11
Total annual effective dose		**7.69E-10**	**4.15E-07**	**4.75E-09**

It can be concluded, that potential annual expose of critical group member due to release of airborne activity from Reactor Units is very low. The expected maximal annual effective dose to the member of critical group of population would be below 5×10^{-4} mSv.

5.1.5.3. Annual exposure of population due to release of airborne activity into atmosphere from operation of the Fuel Inspection Hot Cell

Due to nature of cask preparation for repacking and fuel repacking operations (evacuation of cask cavity, relatively short time fuel reloading process and low probability of annual fuel repacking occurrence) a short time release of activity via ISFSF ventilation stack may be expected. Assumption in short time release of airborne activity leads to more conservative estimation of potential exposure in comparison to assumption of prolonged activity release.

The dose to the member of population due to short term release of activity into atmosphere can be calculated as follows:

$$E = Q \times C \times \left(B \times e_{inh} + e_{sub}\right);$$

where:

Q – short term release of airborne activity into atmosphere, Table 5.1.4-1;

C – the cloud dispersion coefficient (i.e. time integrated concentration) for the ventilation stack of the ISFSF, s/m^3;

B = 3.3×10^{-4} m^3/s, breathing rate for member of population [14];

e_{inh} – inhalation committed effective dose factor for general public, Sv/Bq [15]. Data used in calculations are presented in Table 5.1.5-3;

e_{sub} – the effective dose factor for immersion, (Sv/s)/(Bq/m^3), [15]. Data used in calculations are presented in Table 5.1.5-3.

The cloud dispersion coefficient and hence public dose is dependant upon a number of variables, including weather type, distance from release point to exposure point and height of release point. For the purpose of conservative assessment of the public dose (i.e. exposure of critical group member) a weather conditions and exposure point location leading to highest value of ground level concentration of activity have been assumed. The dispersion coefficient has been taken from [19] for a 30 minute release and stack height of 30 m. Within 500 m zone around ISFSF site the maximal value for the dispersion coefficient is therefore C = 2.0×10^{-4} s/m^3 under category weather A conditions.

The dose calculation results are summarized in Table 5.1.5-3.

Table 5.1.5-3. Effective dose to a critical group member at the location of maximal exposure due to release of airborne activity from the ISFSF

Radionuclide	e_{inh}, Sv/Bq	e_{sub}, (Sv/s) / (Bq/m^3)	Annual effective dose due to reloading of the cask containing leaking fuel, Sv/a
H-3	0	3.31E-19	6.90E-12
Kr-85	0	2.55E-16	1.24E-07
I-129	5.10E-08	3.80E-16	2.03E-08
Cs-134	9.60E-09	7.61E-14	4.30E-10
Cs-137	6.70E-09	2.76E-14	1.28E-09
Total annual effective dose			**1.46E-07**

It can be concluded, that potential annual exposure of critical group member due to release of airborne activity from ISFSF is low. The expected maximal annual effective dose at the location of maximal exposure would be below 2×10^{-4} mSv.

Within distance 500–2000 m around ISFSF site the highest exposure is expected in case of category E weather conditions. The dispersion coefficient (C = 3.1×10^{-5} s/m^3) is lower than for the case of maximal exposure location. Therefore the exposure dose outside the existing INPP sanitary protection zone will be lower by factor of 6.5 as it is assessed in Table 5.1.5-3.

At the distance of 2000 m from the ISFSF (border of existing INPP sanitary protection zone) the highest exposure is expected in case of category F weather conditions. The dispersion coefficient (C = 1.7×10^{-5} s/m^3) is lower than for the case of maximal exposure location. Therefore the exposure dose outside the existing INPP sanitary protection zone will be lower by factor of 11.8 as it is assessed in Table 5.1.5-3.

5.2. Potential Impact due to Irradiation from Structures and Installations Containing Radioactive Material or being Contaminated by Radioactive Material

The impact resulting from direct irradiation is considered to be relevant to any member of population including any member of critical groups. Therefore distinction between different critical groups like farmers, fishermen, gardeners etc. [18] is not made. Particular exposure conditions depend on situation and scenarios considered and are defined in appropriate chapters where dose calculation methodology is explained.

5.2.1. Potential Impact from Activities at Reactor Units

5.2.1.1. Estimated collective doses to personnel due to external irradiation during normal operation of the proposed economic activity

The EIA report presents preliminary assessment of collective exposure of the personnel during handling of SNF and casks at the Ignalina NPP Reactor Units. The assessment is based upon the INPP experience of handling the existing CONSTOR and CASTOR casks, taking into consideration key features of the new type CONSTOR® RBMK1500/M2 casks and additionally planned operations of casks and SNF handling. Such analogy is partly possible as the design limit values for the external radiation fields of the new type CONSTOR® RBMK1500/M2 casks do not differs from the design limit values of the existing casks (e.g. surface dose rate of the cask should not exceed 1 mSv/h). Handling of SNF is performed at the same halls of reactor units.

Since EIA is performed before the Technical Design of the proposed economic activity is available, the main purpose of such assessment is to show that personnel exposure resulting from existing and additional operations of the proposed economic activity will not exceptionally increase, and, therefore, can be limited using necessary shielding, remote-controlled equipment, appropriate operational procedures etc.

Exposure of the supporting personnel is not additionally assessed in the EIA report, as the existing Ignalina NPP practice shows that (in case of appropriate organization of working activity) exposure of the supporting personnel is always lower than that of the operating personnel, directly handling SNF and casks.

The detailed personnel exposure (individual and collective doses) due to handling of new type CONSTOR® RBMK1500/M2 casks and due to other operations introduced by proposed economic activity can be assessed only in Safety Analysis Report considering Technical Design issues. According to the requirements of legal acts in force, Safety Analysis Report is a part of Technical Design and shall as well be presented to Authorities for review and evaluation.

Cask handling and loading at Reactor Units

It is required by Technical Specification [1] to achieve a throughput of one CONSTOR® RBMK1500/M2 cask every 18 days per Reactor Unit. This gives up to 20 CONSTOR® RBMK1500/M2 casks per year for each Reactor Unit and up to 40 casks per year from both Reactor Units.

It is considered that CONSTOR® RBMK1500/M2 casks will use the existing 32M fuel-baskets with 51 SFA (102 fuel rod bundles), but will be additionally equipped with a stationary ring basket which increase the cask capacity to 91 spent fuel assemblies (182 fuel rod bundles). The ring basket will contain 80 channels for fuel rod bundle storage.

During the period from 22 March 1999 till 20 September 2000, 20 CASTOR RBMK1500 casks were loaded at INPP Reactor Unit A-1 and transferred to the available Spent Fuel Dry Storage Facility (SFDSF). Also inspection activities by IAEA specialists and containment tests of the casks were performed. The value of collective dose from total exposure (gamma and neutron) to all personnel during all these activities with 20 CASTOR RBMK1500 casks from Reactor Unit A-1 was 151.25 man-mSv (including 117.56 man-mSv to the personnel of SFDSF) [20]. It should be mentioned that the two first casks during “hot tests” were loaded several times (cask No. 20 – 2 loads, cask No. 18 – 3 loads).

In such a way, the mean value of collective dose from total exposure (gamma and neutron) to all personnel during all activities with one CASTOR RBMK1500 cask was 7.56 man-mSv per cask (including 5.89 man-mSv to the personnel of SFDSF) [20]:

151.25 man-mSv / 20 casks = 7.56 man-mSv per cask;

117.56 man-mSv / 20 casks = 5.89 man-mSv per cask.

Total number of personnel that took part in all activities with 20 CASTOR RBMK1500 casks was 234 persons (including 137 persons from SFDSF personnel). The mean number of all personnel during all activities with one CASTOR RBMK1500 cask was 11.7 persons per cask (including 6.85 persons per cask from SFDSF personnel):

234 persons / 20 casks = 11.7 persons per cask;

137 persons / 20 casks = 6.85 persons per cask.

So, the mean individual dose for the personnel was 0.65 mSv per one CASTOR RBMK1500 cask (0.86 mSv per cask for the personnel of SFDSF) and did not exceed the design value of 2.8 mSv per cask [20]:

7.56 / 11.7 = 0.65 mSv per cask;

5.89 / 6.85 = 0.86 mSv per cask.

During the period from 30 January 2001 till 21 July 2005, 60 CONSTOR RBMK1500 casks were loaded at INPP Reactor Units and transferred to the available Spent Fuel Dry Storage Facility (SFDSF). Also inspection activities by IAEA specialists and containment tests of the casks were performed. The value of collective dose from total exposure (gamma and neutron) to all personnel during all these activities with 60 CONSTOR RBMK1500 casks at Reactor Units and within Building 130 was 204.8 man-mSv (including 192. 6 man-mSv to the personnel of SFDSF and Centralized Maintenance Workshop (CMW)) [20].

In such a way, the mean value of collective dose from total exposure (gamma and neutron) to all personnel during all activities with one CONSTOR RBMK1500 cask was 3.41 man-mSv per cask (including 3.21 man-mSv to the personnel of SFDSF and CMW) [20]:

204.8 man-mSv / 60 casks = 3.41 man-mSv per cask;

192. 6 man-mSv / 60 casks = 3.21 man-mSv per cask.

Total number of personnel that took part in all activities with 60 CONSTOR RBMK1500 casks was 1035 persons (including 756 persons from SFDSF and CMW personnel). The mean number of all personnel during all activities with one CONSTOR RBMK1500 cask was 17.25

persons per cask (including 12.6 persons per cask from SFDSF and CMW personnel):

1035 persons / 60 casks = 17.25 persons per cask;

756 persons / 60 casks = 12.6 persons per cask.

So, the mean individual dose for the personnel was 0.198 mSv per one CONSTOR RBMK1500 cask (0.255 mSv per cask for the personnel of SFDSF and CMW) and did not exceed the design value of 1.3 mSv per cask [20]:

3.41 / 17.25 = 0.198 mSv per cask;

3.21 / 12.6 = 0.255 mSv per cask.

It can be conservatively assumed that the mean value of collective dose from total exposure of personnel during all activities with CONSTOR RBMK1500 cask at Reactor Units is 3.5 man-mSv per cask. During loading, handling and preparation of CONSTOR® RBMK1500/M2 casks, new operations will be introduced. Main new operation will be transfer of 80 fuel bundles from 32M basket into ring basket. The estimate shows that the rate will be about one bundle every 30 minutes and average time for 80 fuel bundle transfer into ring basket of CONSTOR® RBMK1500/M2 cask will be about 40 hours. One operator and one supervisor are required, located mainly at the control panel. It is proposed the location of this panel to be in a radiation field of between 9 to 13 μSv per hour. In this estimation it is conservatively assumed a radiation field of 15 μSv/h. The additional personnel dose during main additional operations with CONSTOR® RBMK1500/M2 cask is preliminary estimated to be about 1.3 man-mSv per cask. The total collective dose per CONSTOR® RBMK1500/M2 cask is estimated to be 3.5 man-mSv + 1.3 man-mSv = 4.8 man-mSv. It is conservatively assumed that total collective dose for routine operation with CONSTOR® RBMK1500/M2 cask including radiation protection, decontamination and work surveillance personnel will be 5 man-mSv per cask.

For handling, loading and preparation of 40 casks per year at both Reactor Units the total collective dose for INPP personnel is preliminary estimated to be: 5 man-mSv per cask × 40 casks = 200 man-mSv. The detailed personnel exposure will be assessed in Safety Analysis Report considering Technical Design issues.

Leaking fuel handling at Reactor Units

It is estimated in Technical Specification [1] that the amount of existing and anticipated future SFA with cladding leakage but without mechanical damage will be 420. Conservatively there is assumed that 540 SFA or 1080 fuel bundles to be handled will contain leaking fuel rods. Up to 15 leaking SFA (30 fuel bundles) can be loaded in one cask and 36 casks (about 18 % of the 201) will contain leaking fuel rods. SFA with cladding leakage and minor mechanical defects with only a few exceptions will be handled by the existing Hot Cell and handling equipment and placed into the 32M baskets. Collective dose for INPP personnel during handling of SFA with cladding leakage and minor mechanical defects (including processing in existing Hot Cell) is conservatively estimated to be 0.1 man-mSv per SFA. The total collective dose for INPP personnel is preliminary estimated to be: 0.1 man-mSv/SFA × 540 SFA = 54 man-mSv.

Damaged and experimental fuel processing and fuel debris collection

SFA with major mechanical defects or SFA which is likely to be damaged in cutting process will be over packed into cartridges. Up to 105 damaged SFA which require to be processed using the DFHS are anticipated after the INPP shutdown. According to Tables A9.5 and A9.6 of the TS [1] there will be 28 SFA with heavy damage, 30 SFA with cladding which is likely to be damaged in cutting process and 47 untight SFA with mechanical damages (10 % from 467 untight SFA). In addition to the mechanically damaged fuel up to 33 experimental SFA (they are approximately ~10 m, ~16.3 m and ~17 m in length) require also to be processed using the DFHS. For canned damaged fuel assemblies a special ring basket will be used with a capacity of 15 SFA (30 canned fuel rod bundles).

Damaged and experimental spent fuel assemblies will be processed after all undamaged fuel assemblies are emptied from the storage pool which will be used for damaged fuel processing.

Doses to personnel during handling of damaged and experimental fuel including collection of SFA pellets depend on actual design solutions and organization of working activity. Potential exposure of personnel can be planned in advance, handled during working activity and mitigated if necessary. Doses to personnel will be optimised according to the ALARA principle using remote-controlled equipment, appropriate shielding and operational procedures and in any case will not exceed the limit for annual effective dose. Estimation of doses to personnel during handling of damaged and experimental fuel including collection of SFA pellets will be presented in the SAR.

Modification of existing equipment and installation of new equipment

Doses to personnel in case of modification of the existing equipment and installation of the new equipment at the Reactor Units depend on actual design solutions and organization of working activities. Potential exposure of personnel can be planned in advance, handled during working activity and optimised. Doses to personnel in any case will not exceed the limit for annual effective dose. Estimation of doses to personnel during modification of the existing equipment and installation of the new equipment will be presented in the SAR.

5.2.1.2. Potential exposure from building of Reactor Units

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

Storage Pools Halls at the Reactor Units have sufficient shielding for already licensed spent nuclear fuel retrieval, handling and loading operations. All new spent fuel retrieval, processing, handling and loading operations will be performed in under water position with assuring of necessary shielding requirements within SPH working premises. Increase of radiation dose rate outside the Reactor Units due to proposed economic activity is not expected. Therefore impact due to irradiation from structures of reactor buildings is not further addressed in EIA Report. Existing impact from INPP site is described in chapter 5.3.2.

5.2.2. Potential Impact during Cask Transfer from the Reactor Units to the ISFSF

A member of general public can be irradiated during cask transfer from INPP site to ISFSF facility. The spent nuclear fuel transfer from INPP to ISFSF is scheduled to start in the middle of 2008 and has to be finished by the end of 2015. In total 201 casks has to be transferred to ISFSF. Up to 40 casks can be transferred within 12 month period.

The railroad transport will be used for the transfer of casks. A new railway line up to 1000 m length from INPP to ISFSF site will be constructed and connected to the existing railway system at INPP. The part of railway line which connects INPP and ISFSF sites (up to 600 m length) will be fenced. The width of fenced railroad connection will be at least 10 m [22]. The distance from cask to potential exposure position where member of population could be located will vary during cask transfer. The minimal distance from passing by external surface of the cask to the member of population located just outside the railroad connection fence is about 3.7 m.

The casks from INPP site to ISFSF facility will be transferred loaded on a rail transporter in vertical position. Cask will not be shielded additionally. The rail transporter will be drawn/pushed by the existing locomotive. The locomotive safe speed is limited to 5 km/h.

5.2.2.1. Expected dose rate from CONSTOR® RBMK1500/M2 cask

The calculations were performed with the Monte Carlo Code MCNP 4c2 [23]. The spectral neutron and photon fluences tallied with MCNP were converted to an ambient dose equivalent H*(10) (ICRP Publication 60) with the fluence-to-dose conversion factors according to ICRP Publication 74. Besides the total dose rate from the whole system, dose rates originating from the cask shell and the lid-surface were calculated by cell flagging.

The applied shielding model of the cask is described in [24]. The cask inventory consists of 182 fuel bundles with the respective nominal radiation sources. Activity and radiation sources of the reference fuel bundle in 32M basket consist of the maximal values from the spent 2.0% and 2.1% fuel. Activity and radiation sources for the ring basket consist of the maximum values from experimental, 2.4%, 2.6% and 2.8% fuel. The lid system consists of the primary lid (27.5 cm thickness) and the protection plate (4 cm thickness). All components were applied with their nominal thickness (Figure 5.2.2-1).

To simulate the transport situation, the transport wagon was neglected and instead, the bottom of the vertical cask was located 30 cm above a ground floor (30 cm concrete of 2.2 g/cm^3). The detectors were positioned vertically from 50 cm to 200 cm above the ground floor in the respective distance from the cask side wall. Depending on the distance from the shell, the volume of the detectors becomes larger in order to assure adequate low statistical errors of the results.

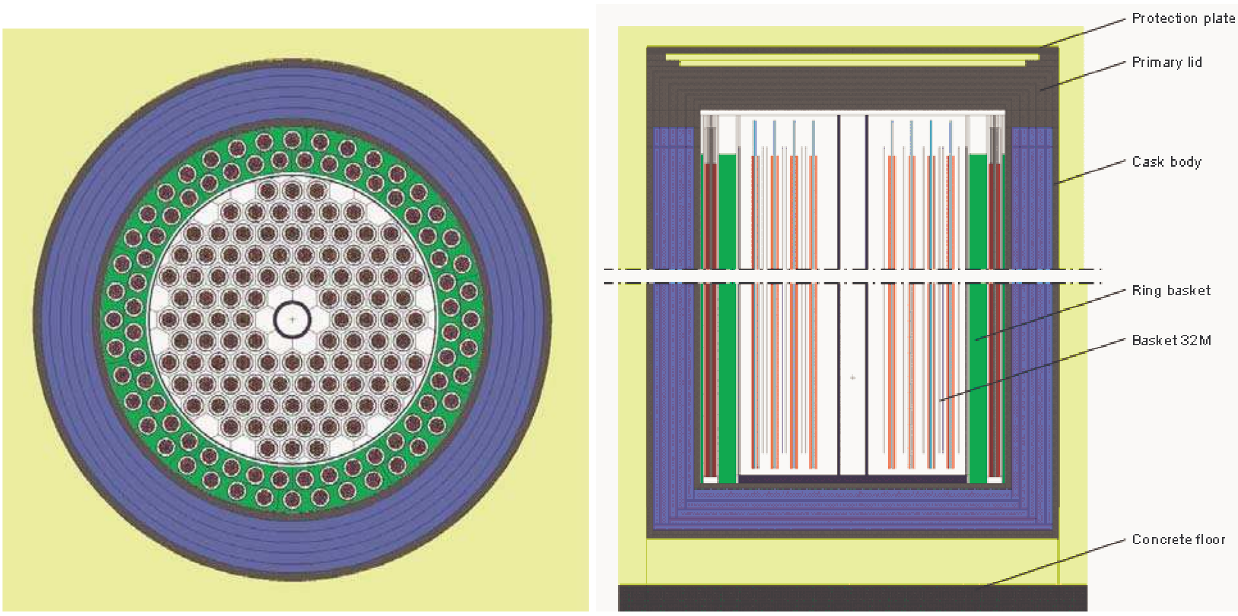


Figure 5.2.2-1. Horizontal and vertical cross sections of the CONSTOR® RBMK1500/M2-shielding model

The calculated dose rates include contributions from:

- Neutrons due to spontaneous fission and (α,n)-reactions;
- Secondary gammas from neutron capture;
- Primary gammas from fission products;
- Gammas from the activation product Co-60 in structural materials.

The results of the shielding calculations are presented in Figure 5.2.2-2 and Table 5.2.2-1. The statistical uncertainties of the calculation were less than 1 % up to 10 m distance and less than 7 % up to 1000 m distance. Dose rates at distances beyond 600 m are irrelevant (they are less than 0.001 µSv/h).

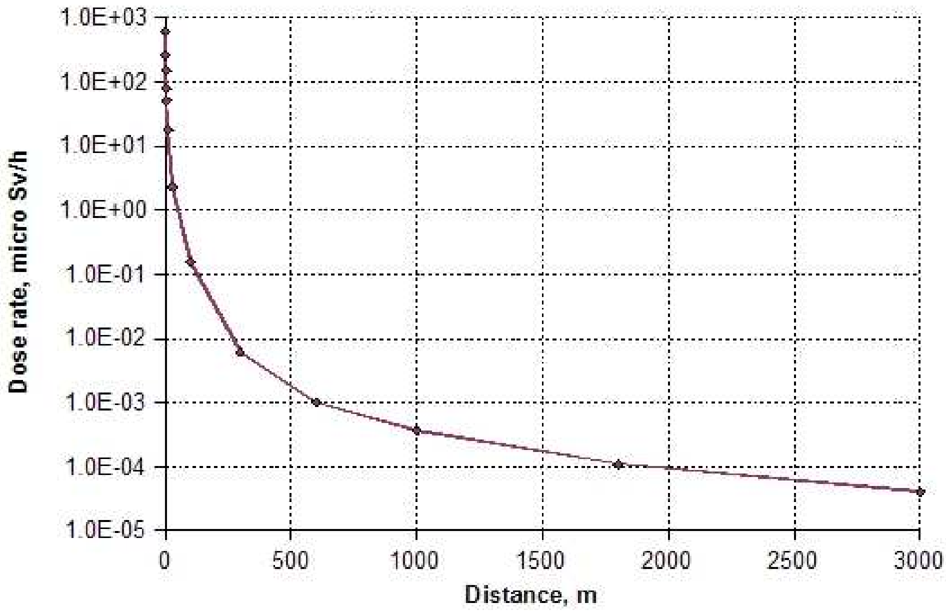


Figure 5.2.2-2. Equivalent dose rate values at various distances from cask CONSTOR® RBMK1500/M2 side wall

Table 5.2.2-1. Equivalent dose rate values from the cask at the distance of 0-3000 meters

Distance, m	Dose rate, µSv/h
0	616.3
1	259.2
2	151
3.7	77.6
5	52.2
10	17.7
30	2.228
100	0.155
300	0.006
600	0.001 *)
1000	3.60E-04 **)
1800	1.11E-04 **)
3000	4.00E-05 **)

*) Report [24] specifies that dose rate values starting from the distance of 600 m are below 0.001 µSv/h. It is conservatively assumed that dose rate value at the distance of 600 m is 0.001 µSv/h.
**) Dose rate values are extrapolated assuming dose rate decrease be inversely proportional to the square of the distance (i.e. cask is considered as point source).

5.2.2.2. Effective dose to the member of population due to SNF transfer from Reactor Units to ISFSF

The annual effective dose to the member of population due to external exposure from the cask is calculated by equation:

$$D = N \times \int_0^t E(r)dt ;$$

where:

$N = 40$, the number of casks transferred annually from INPP to ISFSF;

$E(r)$ – the external exposure effective dose rate at a distance r from cask surface, mSv/h. Equivalent dose rate values at determined distances from cask side wall are presented in Figure 5.2.2-2. The body tissue weighting factor $\sum_T W_T = 1$;

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

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

where:

$L = 1$ km, the railroad connection length;

$v = 3$ km/h, the assumed average cask transfer (i.e. locomotive) speed.

The highest doses are expected when exposure location is selected to be just outside the fence of railway connection. The doses are calculated also for exposure locations at the distance of 500 m from the fence of railway connection and on the border of INPP sanitary protection zone. The results of calculation of annual effective dose to a member of population due to casks transfer are summarized in Table 5.2.2-2.

Table 5.2.2-2. Annual effective dose to the member of population at the cask transfer railroad due to casks transfer from INPP site to ISFSF

Exposure distance from the cask transfer railroad fence, m	Annual effective dose, Sv
3.7	2.03E-05
500	2.25E-08
2000	1.31E-09

Annual exposure of the member of population is also calculated for the specific locations (cf. chapter 5.2.3.2) along the ISFSF site. Effect of radiation shielding by structures located at the ISFSF site is conservatively not taken into account. The results of calculation are summarized in Table 5.2.2-3.

Table 5.2.2-3. Annual effective dose to a member of population due to transfer of casks from INPP to ISFSF sites

Distance from security fence, m	Annual effective dose for direction, Sv				Remark
	North	East	South	West	
0	1.53E-05	8.87E-08	3.01E-08	2.02E-08	At the security fence of the site
50	1.96E-05	7.22E-08	1.81E-08	1.75E-08	At the border of the site
500	2.03E-05	7.96E-09	4.20E-09	5.36E-09	At the border of proposed SPZ

5.2.2.3. Estimated collective doses to personnel due to SNF transfer from Reactor Units to ISFSF

The spent nuclear fuel transfer from INPP to ISFSF is scheduled to start in the middle of 2008 and has to be finished by the end of 2015. In total 201 casks has to be transferred to ISFSF. Up to 40 casks can be transferred within 12 month period.

The railroad transport will be used for the transfer of casks. A new railway line up to 1000 m length from INPP to ISFSF site will be constructed and connected to the existing railway system at INPP.

The casks from INPP site to the ISFSF will be transferred loaded on a rail transporter in vertical position. Cask will not be shielded additionally. The rail transporter will be drawn/pushed by the existing locomotive. The locomotive safe speed is limited to 5 km/h.

The exposure duration due to transfer of one cask is 20 minutes (1/3 hour) assuming 3 km/h average cask transfer (i.e. locomotive) speed. For 40 cask transfer to the ISFSF the total collective dose for personnel is preliminary estimated to be: 3 workers × 1/3 h × 0.1 mSv/h × 40 casks = 4 man-mSv/year.

5.2.3. Potential Impact from Activities at the ISFSF Site

5.2.3.1. Estimated collective doses to personnel due to cask handling, storage and repacking

The EIA Report presents preliminary assessment of collective exposure of the personnel during SNF and casks handling at the ISFSF. Assessment is based on the INPP handling experience of the existing type CONSTOR and CASTOR casks, taking into consideration key features of the new CONSTOR® RBMK1500/M2 casks and additionally planned operations of casks and SNF handling. Such analogy is partly possible as the design limit values for the external radiation fields of the new type CONSTOR® RBMK1500/M2 casks do not differs from the design limit values of the existing casks (e.g. surface dose rate of the cask should not exceed 1 mSv/h).

Since EIA is performed before the Technical Design of the proposed economic activity is available, the main purpose of such assessment is to show that personnel exposure resulting from existing and additional operations of the proposed economic activity will not exceptionally increase, and, therefore, can be limited using necessary shielding, remote-controlled equipment, appropriate operational procedures etc.

The detailed personnel exposure (individual and collective doses) due to handling of new type CONSTOR® RBMK1500/M2 casks and due to other operations introduced by proposed economic activity can be assessed only in Safety Analysis Report considering Technical Design issues.

Exposure of the supporting personnel (such as security guards, maintenance staff) is not additionally assessed in the EIA report, as the existing Ignalina NPP practice shows that (in case of proper organization of working activity) exposure of the supporting personnel is always lower than that of the operating personnel, directly handling casks. According to the requirements of Technical Specification [1], the design of ISFSF shall ensure conditions at the work places that shall be in conformance with radiation protection requirements (rooms of controlled areas have to be categorized as prescribed by HN 87:2002 [30], according to the category of the room appropriate and controlled conditions of radiological exposure and contamination have to be assured, monitoring has to be performed, permissible work time has to be foreseen, protections measures have to be taken, if necessary etc.).

The conservatively evaluated maximal effective dose rate at the ISFSF site does not exceed 0.23 μSv/h, c.f. chapter 5.2.3.2. Conservatively evaluating (assuming exposure time 2000 h per year), such dose rate may cause annual exposure of 0.46 mSv. Therefore, exposure of the supporting personnel at the ISFSF site will not exceed limiting doses. The exposure of supporting personnel may be evaluated in more details in the Safety Analysis Report considering Technical Design issues.

Cask handling at the ISFSF

Cask handling at the ISFSF [25] consists of the following operations:

- Transfer of the cask from the rail transporter to the Cask Service Station (3 workers × 8 hours × 5 μSv/h = 0.12 man-mSv/cask);
- Final cask preparation for storage in deconservation area (3 workers × 5 hours × 1 μSv/h = 0.015 man-mSv/cask);
- Final cask preparation for storage in the Cask Service Station (3 workers × 14 hours × 40 μSv/h = 1.68 man-mSv/cask);
- Transfer of the cask to the storage position (3 workers × 5 h × 5 μSv/h = 0.075 man-mSv/cask).

The total sum for all cask handling operations at the ISFSF is 1.89 man-mSv/cask. Conservatively it is assumed 2 man-mSv/cask. For handling of 40 casks per year from both Reactor Units the total collective dose for ISFSF personnel is conservatively estimated to be: 2 man-mSv/cask × 40 casks/y = 80 man-mSv/y.

Storage in the Storage Hall of the ISFSF

During storage period it is conservatively assumed that the following activities are performed:

- Inspection of the cask at the Cask Service Station (3 workers × 40 μSv/h × 5 h/cask × 5 cask/y = 3 man-mSv/y);
- Cleaning activities in the Storage Hall (2 workers × 130 μSv/h × 20 h/year = 5.2 man-mSv/y).

At the Control Room and social area of the completely filled ISFSF dose rates are preliminary estimated to be very low – 0.0005 and 0.0008 μSv/h, respectively. It is conservatively estimated that the total collective dose for ISFSF personnel during storage period is 15 man-mSv/y.

Fuel repackaging at FIHC

If the cask is found to be defective during the long-term storage period the spent fuel will be reloaded into the new cask. Preliminary estimation has shown that duration to transfer all fuel from defective cask to new cask in the FIHC for typical fuel only (worst case) is approximately 450 hours. Reloading of damaged fuel canned in cartridges requires less time due to less amount of cartridges to be reloaded in special ring basket in comparison with ring basket for positioning of typical SNF bundles. It is conservatively estimated that for fuel repackaging at FIHC the total collective dose for ISFSF personnel is 20 man-mSv per cask.

5.2.3.2. Dose to population from ISFSF building structure

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

The external irradiation dose rate values (due to gamma and neutron fluxes) from ISFSF building structure under normal operation conditions are evaluated in [26]. Calculations are performed on the base of the drawings of the ISFSF building with additional structures for a Hot Cell, the social area and Cask Service Station area. The computer model is created with the following grade of detail:

- The ISFSF is modelled in detail as a concrete structure. The wall thickness is considered with 0.6 m (0.7 m southern wall). The roof is modelled as a 0.2 m thick concrete plate with 0.12 m insulating material on top;
- The air inlets in the side walls of the ISFSF as well as the air outlets in the roof are modelled 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 modelled to take the scattering, especially of the neutrons on air (sky-shine), into account;
- The buildings for LLW, SLW and waste treatment are modelled as concrete hulls at their positions on site with 0.3 m wall thickness;
- The casks in the Storage Hall are arranged in rows of 2 x 3. The modelled 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. The mid-to-mid distance between two casks in a row is 3.45 m, between two rows 3.35 m (3.65 m in front of the emergency exits);
- The surface source will be applied on the 202 casks, which are modelled simplified as massive CONSTORIT cylinders with steel liner and a 0.25 m concrete plate on top. The source is normalised to 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 concrete plate (8 µSv/h from neutrons) [27]. The outer dimensions of the cask model are 2.63 m diameter and 4.77 m height.

Version 4C of the program MCNP [23] is used for the shielding and skyshine calculations. MCNP is a program describing the coupled transport of neutrons and photons and is the international standard in the field of nuclear applications. MCNP uses the Monte-Carlo method for simulating the life history of individual particles from the place of their creation to the place of their absorption or until departure out of the considered volume.

Conversion of the expectation values for the spectral neutron and gamma flux densities calculated with MCNP to radiological dose rates is made with the flux to dose conversion factors for the ambient dose rate equivalent H*(10) contained in ICRP publication 74 [28], in compliance with ICRP Publication 60 [29]. Thus all dose rates calculated in this report are qualified as ambient dose rates equivalent.

More details on modelling approach can be finding in [26] and [27]. Calculation results are summarized in Figure 5.2.3-1.

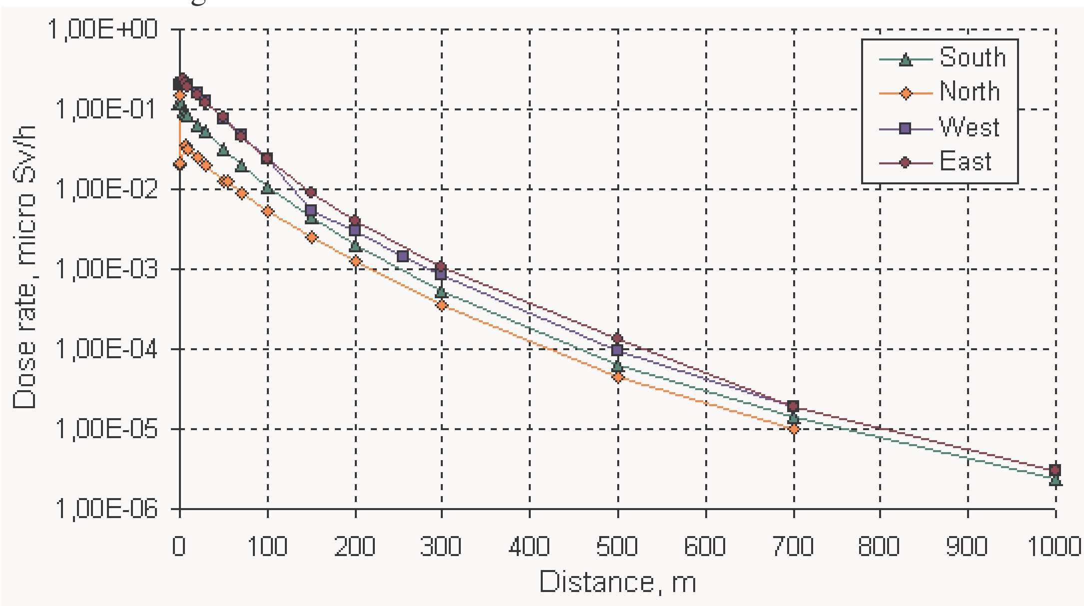


Figure 5.2.3-1. Dose rates outside the ISFSF in case of completely filled ISFSF

The dose rate maximum in eastern direction of 0.23 µSv/h lies at a distance of 5 m immediately behind the shielding wall of the emergency exit. The maximum dose rate in western direction of 0.23 µSv/h is reached at a distance of 2 m. The dose rate maximum in southern (0.13 µSv/h) and northern direction (0.15 µSv/h) can be found immediately behind the wall or in front of the outer gate. The maximum of dose rates occur inside the perimeter of permanent security fence of the ISFSF protective zone. Dose rates outside this fence decline by increasing distance from the ISFSF building.

The external irradiation dose rate values (due to gamma radiation) from SWSF (Solid Waste Storage Facility) buildings structures under normal operation conditions are evaluated in [34]. The total dose rates from ISFSF and SWTSF (Solid Waste Treatment and Storage Facility) buildings structures are summarized from the results of the Interim Spent Fuel Storage Facility (B1), the Solid Waste Treatment Facility (B3) and the Solid Waste Storage Facilities (B4) and are given in [35].

The computational methods and the models used for the calculations of the dose rates resulting from the B1 and B4 buildings are described in detail in [26] and [34].

Compared to the much larger dose rate values on the ISFSF/SWTSF territory coming from the B1 and B4 buildings, the contribution from the B3 building was neglected in the summarization report [35]. The source of radiation of the B3 building is coming from 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 B4 short lived waste storage facility 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 ISFSF/SWTSF site from the B3 building is about 1 % of the contribution from the roof of B4 short lived waste storage facility. Therefore the B3 dose rate contribution is neglected [35].

Summarized doses to a member of population from ISFSF and SWTSF buildings are presented in Table 5.2.3-1. The annual exposure time is set to 2000 h within sanitary protection zone and 8760 h outside the border of sanitary protection zone.

Table 5.2.3-1. Annual effective dose to a member of population from the SWTSF and ISFSF site

Distance from security fence, m	Annual exposure duration, h	Annual effective dose for direction, Sv				Remark
		North	East	South	West	
0	2000	5.00E-05	1.66E-04	1.48E-04	8.80E-05	At the security fence of the site
50	2000	4.00E-05	1.00E-04	8.00E-05	6.40E-05	At the border of the site
500	2000	1.80E-07	2.00E-07	2.20E-07	1.04E-07	At 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	

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

Potential exposure of the member of population sharply decreases with the increase of distance from the permanent security fence. At the boundary of ISFSF/SWTSF site, which is distant in approximately 50 m apart from permanent security fence of the ISFSF/SWTSF protection zone, exposure from ISFSF/SWTSF decreases (depending on exposure direction) approximately by factor of 1.5 compared to the exposure at the security fence.

Basing on dose assessment results an approximately 500 m wide sanitary protected zone could be recommended for ISFSF/SWTSF site where exposure of member of population could be considered as insignificant (effective dose is close to or below 1 µSv). The actual boundaries for sanitary protection zone of ISFSF/SWTSF site will be specified during the Technical Design.

5.3. Summary of Potential Impact on the Environment due to Normal Operation of Proposed Economic Activity

5.3.1. Radiation Protection Requirements

An overview of regulatory requirements for radiation protection necessary for demonstration that proposed economic activity by virtue of its nature and environmental impacts may be carried out in the chosen sites is presented in this chapter. This chapter does not addresses all specific radiation safety requirements considering safety of operating personnel such as admissible dose rates and radionuclide concentrations in the air of premises of controlled zone, radioactive contamination of surfaces, etc. Assurance of these safety requirements is a task of Technical Design. If necessary, mitigation measures shall be proposed. Conformance to all radiation protection requirements applicable for personnel and demonstration of ALARA will be presented in Safety Analysis Report considering Technical Design solutions.

5.3.1.1. Radiation protection requirements for members of personnel

The Republic of Lithuania normative document [15] defines dose limits for workers:

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

5.3.1.2. Radiation protection requirements for members of public

The Republic of Lithuania normative document [15] defines dose limits for members of the public:

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

In optimization of radiation protection the source related individual dose is bounded by a dose constraint. The dose constraint for each source is intended to ensure that the sum of doses to critical group members from all controlled sources remains within dose limit [15]. The dose constraint for the members of public due to operation and decommissioning of nuclear facilities is 0.2 mSv/year [30]. 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/year [18].

5.3.1.3. Radiation protection requirements for other environment components

The Republic of Lithuania normative document [18] 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.

5.3.2. Existing and Planned Radiological Impact from INPP Site

The new ISFSF will be constructed inside the existing INPP sanitary protection zone of 3 km radius. For purposes of dose assessment with regard to the dose constraint, cf. chapter above, the impact from the other existing and planned nuclear facilities located in the INPP sanitary protection zone must be considered as well.

The construction of ISFSF is one of separate Ignalina NPP decommissioning projects.

According to Ignalina NPP Final Decommissioning Plan [37] 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, EIA Program of INPP decommissioning [38] provides to develop EIA reports separately for each DP. Every EIA report of a subsequent DP shall take into account the 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.

5.3.2.1. Existing and planned nuclear facilities in the SPZ of INPP

During INPP decommissioning it is foreseen to construct a new Solid Radioactive Waste Management and Storage Facility (SWMSF), very low level radioactive waste disposal facility (Landfill repository), low and intermediate level radioactive waste near-surface disposal facility. It is foreseen to convert presently operated Bituminized Waste Storage Facility into a disposal facility in future. Liquid radioactive waste Cement Solidification Facility (i.e., 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 the 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 5.3.2-1. Activity phases (operation, decommissioning, institutional surveillance, etc.) of the nuclear facilities are summarized in Figure 5.3.2-2.

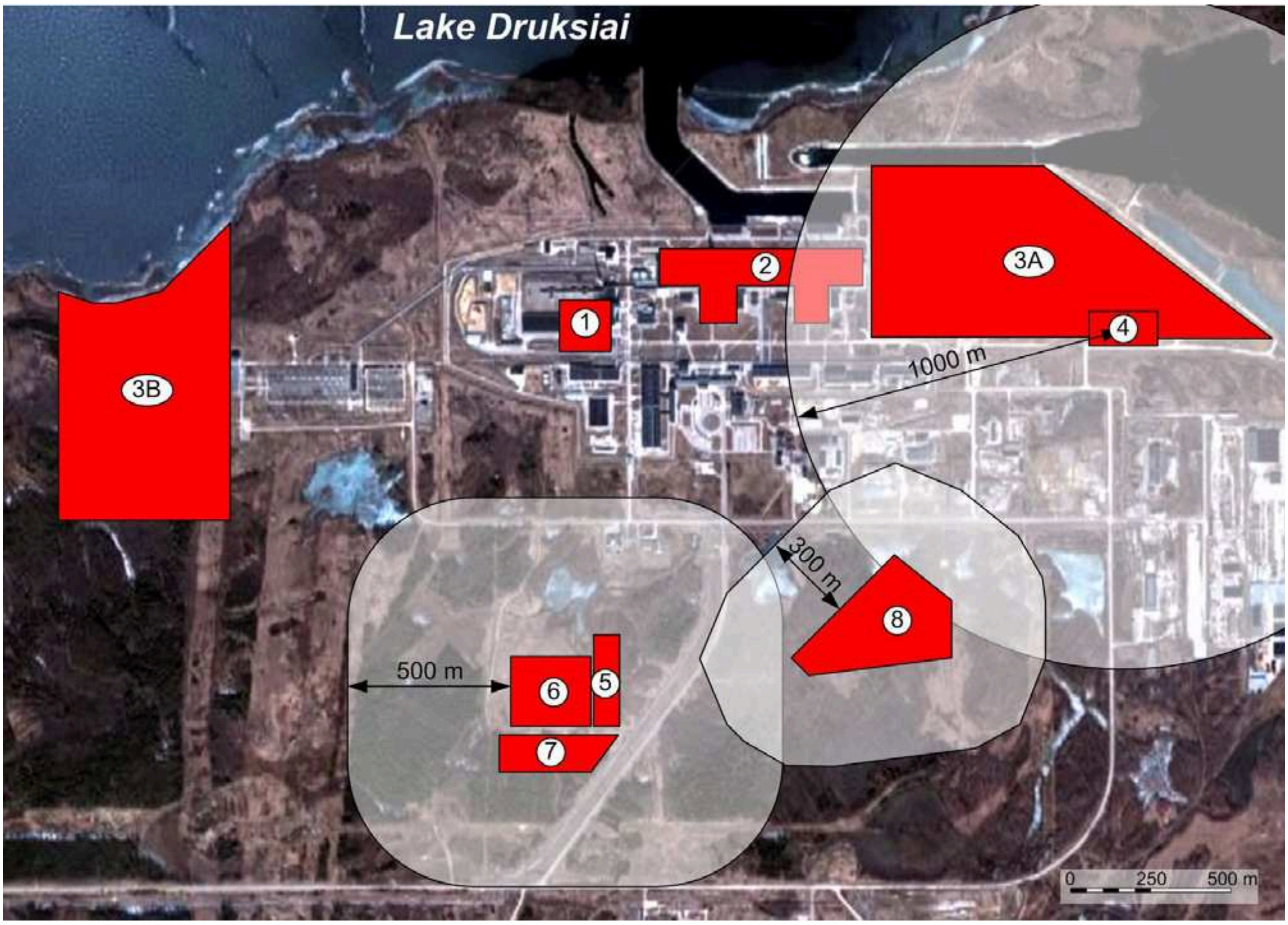


Figure 5.3.2-1. Existing and planned nuclear facilities, located in the Ignalina NPP sanitary protection zone of 3 km radius:

(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.

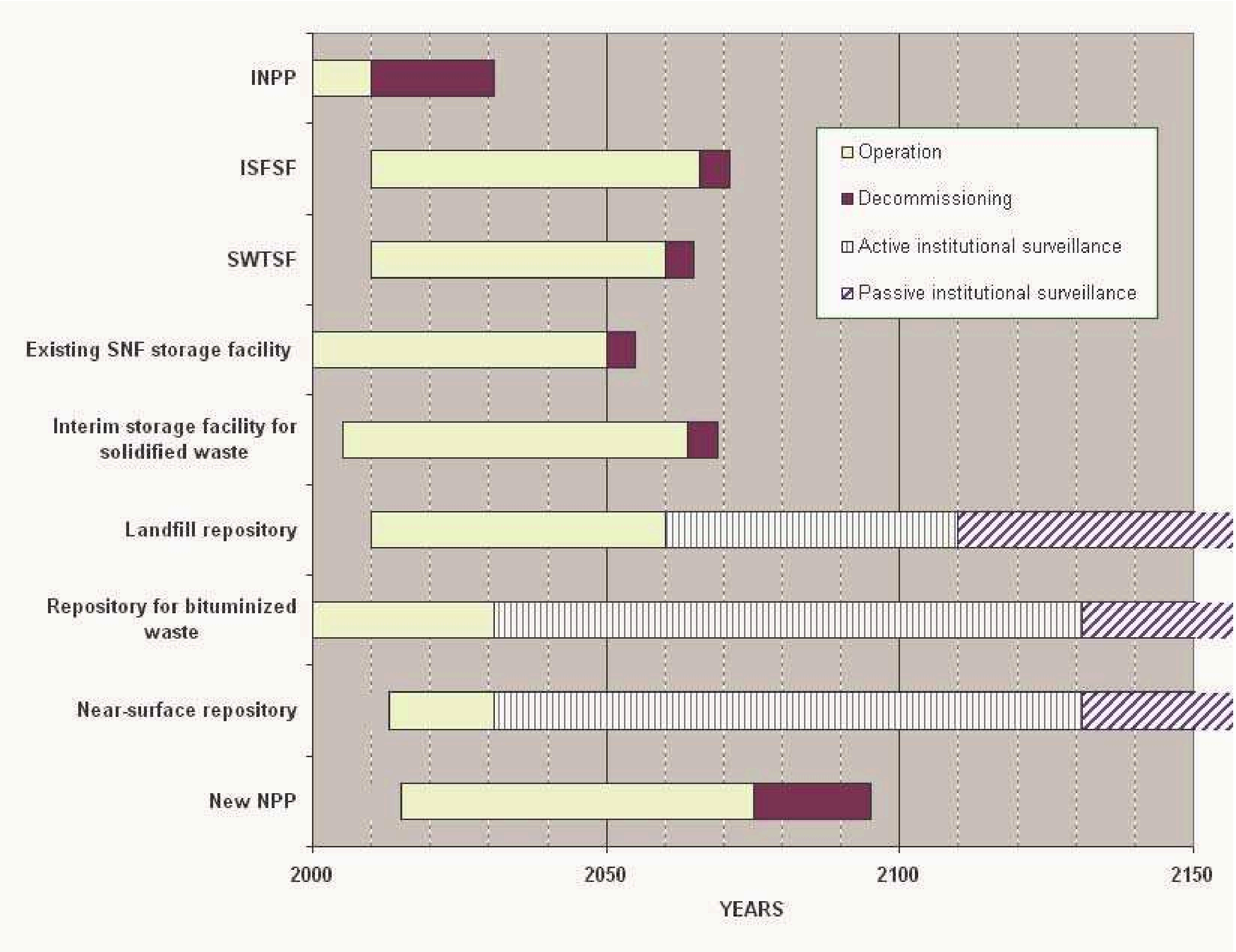


Figure 5.3.2-2. Main activity phases of the existing and planned nuclear facilities, located in Ignalina NPP existing sanitary protection zone of 3 km radius

The interim storage facility stored solidified radioactive waste packages are planned to be disposed in the near-surface disposal facility for low and intermediate level radioactive waste. Therefore the operation period of this facility may be shorter than indicated in Figure 5.3.2-2.

The new solid radioactive waste treatment facility 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 disposal facility for low and intermediate level radioactive waste. Therefore the operation period of these facilities may be shorter than indicated in Figure 5.3.2-2.

Operator of repository (RATA) during the active control period (not shorter 100 years) will assure physical protection, will perform surveillance and monitoring of the repository, will kept records and, if needed, will perform corrective actions. The passive control period (at least 200 years) will start after the active control period. The land use activities will be limited during the passive control period.

It is planned that active institutional surveillance period for the near-surface disposal facility for low and intermediate level radioactive waste will last not shorter than 100 years. The passive institutional surveillance period (at least of 200 years) will start afterwards. 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.

5.3.2.2. The impact due to radioactive releases

Radioactive releases from the existing nuclear facilities located in the SPZ of INPP

Present doses due to radioactive releases (airborne emission into the atmosphere and liquid discharges into Lake Druksiai) from the nuclear facilities, located in the SPZ of INPP, are summarized in Figure 5.3.2-3 [31].

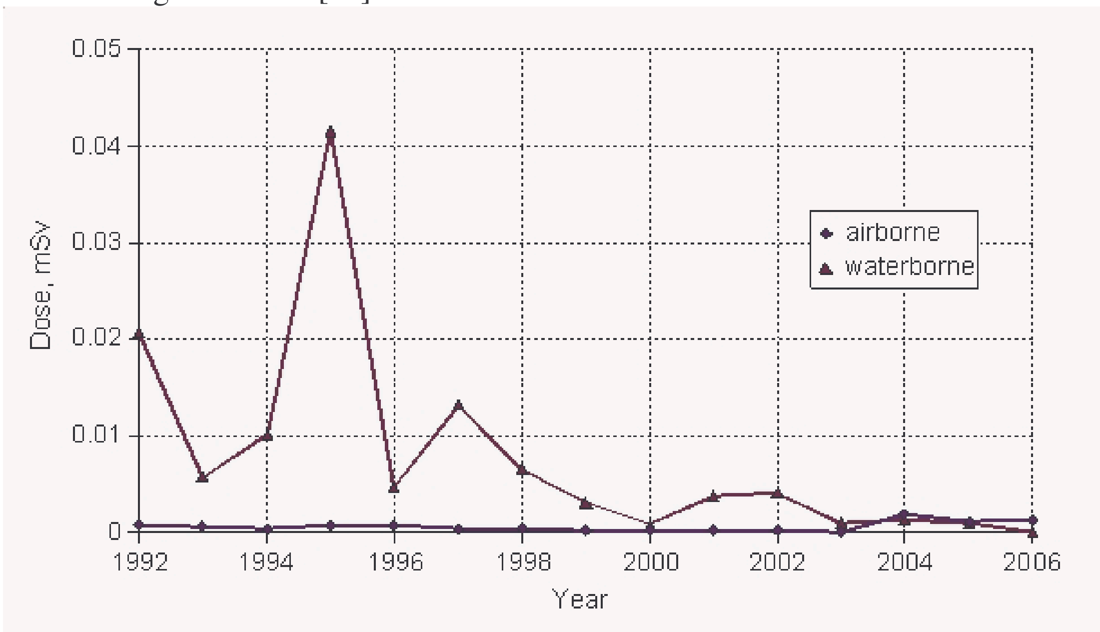


Figure 5.3.2-3. Annual effective dose to the critical group member of population due to radioactive releases (airborne emissions and liquid discharges) from the nuclear facilities located in the SPZ of INPP for time period 1992 – 2006 [31]

It can be concluded that the doses due to the actual radioactive releases from the existing nuclear facilities are far below the dose constraint (0.2 mSv per year). Starting from 1995 the dose due to waterborne releases into Lake Druksiai gradually decreases. The dose due to airborne releases in general is considerable 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. No evident dose increase can be associated with existing spent nuclear fuel handling and storage activity.

It is planned that INPP will be in operation till the end of 2009. By this time the existing SNF storage facility will be filled up. To forecast future doses the last seven years (1999–2006, when SNF transfer was performed) observed dose maximum is selected as conservative estimation of the impact due to the operation of INPP till the year 2010. The assumed annual effective dose to the critical group member of 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).

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) [32]. The U1DP0 activities are planned to be implemented in years from 2005 to 2012;
- Start-up of 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 [33]. 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 5.3.2-4.

Figure 5.3.2-4. Forecast for the dose to the critical group member of population due to radioactive releases (airborne emissions and liquid discharges) from the nuclear facilities, located in the SPZ of INPP

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 planned start up of the in-line decontamination activities at the Reactor Unit 1 (3.6×10^{-6} Sv) and the assumption that the conservatively assessed doses resulting from the operation of INPP Reactor Unit 2 are still relevant (6.0×10^{-6} Sv). The dose forecast as presented in Figure 5.3.2-4 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 INPP decommissioning projects are available at the moment. EIA Program of INPP decommissioning [38] provides that every subsequent environmental impact assessment shall take into account the results of previous reports. According to this proposed economic activity by the year 2016 the all spent nuclear fuel 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 proposed economic activity could be possible only in the case of fuel reloading in the Fuel Inspection Hot Cell (FIHC) of ISFSF. 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 expected dose due to the radioactive airborne emissions is low (1.67×10^{-7} Sv) and makes less than 0.1% from the dose constraint (0.2 mSv). Therefore impacts due to radioactive airborne emissions resulting from this proposed economical activity will have no significant influence on the technical solutions of further INPP decommissioning projects.

Radioactive releases from the newly planned nuclear 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 (ISFSF), the new Solid Waste Management and Storage Facilities at Ignalina NPP (SWMSF) and the newly planned nuclear power plant.

The estimation of doses resulting from airborne emissions from ISFSF is presented in chapter 5.1.1. 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. In case of SNF reloading in the FIHC of ISFSF (what is a low probable event) additional exposure of up to 1.67×10^{-7} Sv is possible.

The impact from SWMSF is assessed in the EIA Report for SWMSF [39] The conservatively estimated annual effective dose to the critical group member of population due to radioactive airborne emissions during the waste retrieval (from the existing INPP radioactive waste storage facilities) and treatment phase (i.e. in the period 2010-2020) is equal to 7.26×10^{-6} Sv. With finishing of waste retrieval the radioactive airborne emissions and subsequently the exposure of the population will decrease.

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.

As it was indicated before, according to this proposed economic activity by the year 2016 (i.e., almost until the beginning of the operation of the new NPP) the all spent fuel will be loaded into leak-tight storage casks and will be isolated from the environment. Later on potential radioactive airborne emissions due to the proposed economic activity are low probable and their impact is insignificant. Therefore impacts due to radioactive airborne emissions resulting from this proposed economical activity will have no significant influence on design solutions of the new nuclear power plant.

Forecast of the impact 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 5.3.2-5.

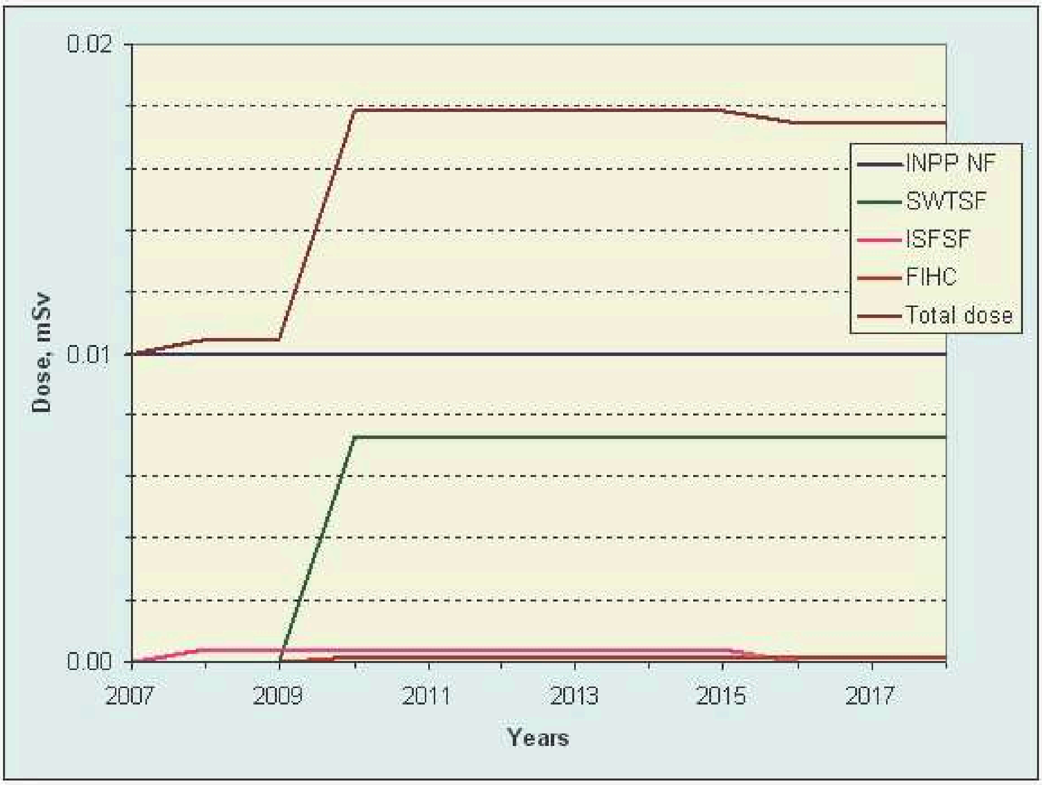


Figure 5.3.2-5. Forecast of the maximal annual effective dose to the critical group member of population due to radioactive releases (airborne emissions and liquid discharges) from the existing and planned nuclear facilities located in the SPZ of INPP

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

Only solid and solidified radioactive waste packages will be disposed of in the near-surface disposal facility for low and intermediate level waste [40]. 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 at least for 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 ISFSF are foreseen.

Environmental impact assessment for very low level radioactive waste near-surface disposal facility (Landfill) has not been performed yet. The INPP Final Decommissioning Plan [37], the Concept of the Disposal Facility [41] and study of Derivation of Preliminary Waste Acceptance Criteria for Landfill Facility [42] 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 ISFSF 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 ISFSF operation time will occur from Bituminized Waste Disposal Facility.

5.3.2.3. The 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 ISFSF and SWTSF sites demonstrates (c.f. chapter 8) 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 [31]. Therefore assessment of impact due to direct irradiation in the surroundings of the ISFSF / SWTSF site assumes that INPP presently existing nuclear facilities do not create exceptional impact in the environment of ISFSF / SWTSF site 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 (spent ion-exchange resins and filter aid (Perlite) deposits)

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 5.3.2-1. 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 ISFSF / SWTSF site and the interim storage facility is summarized in Figure 5.3.2-6. The calculations consider maximally loaded facilities and assume annual exposure duration of 2000 hours.

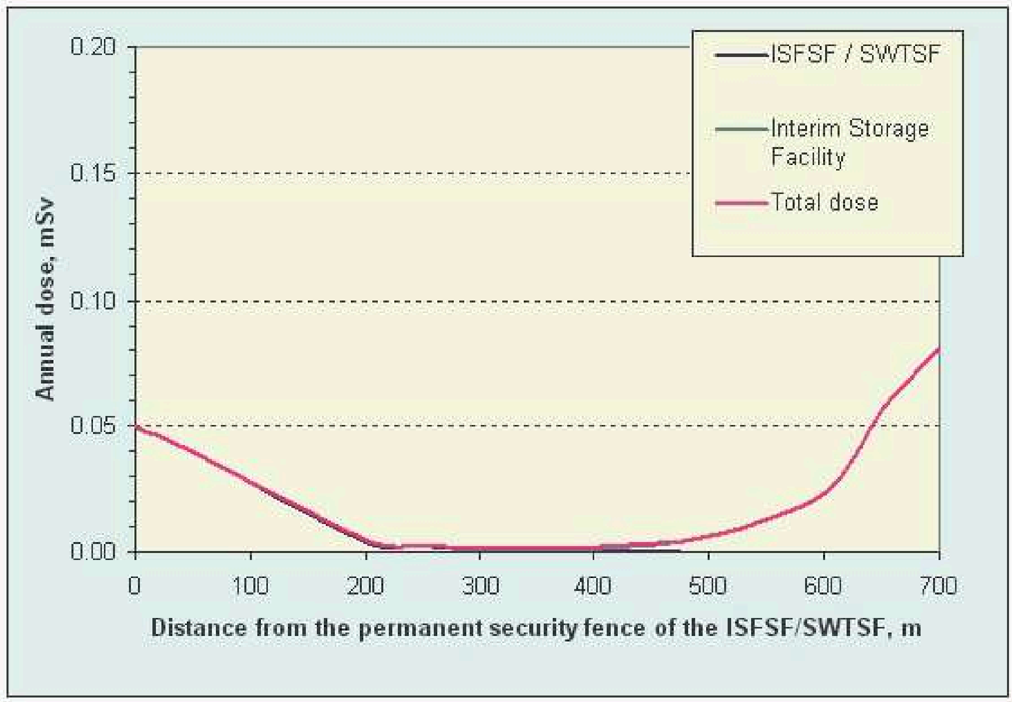


Figure 5.3.2-6. Potential annual dose to the member of population due to direct ionizing irradiation from the ISFSF / SWTSF and the Interim Storage Facility. Calculations consider maximally loaded facilities and assume annual exposure duration of 2000 hours

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 ISFSF / SWTSF.

New Solid Waste Treatment and Storage Facilities

The new Solid Waste Treatment and Storage Facilities (SWTSF) will be constructed close to the ISFSF. 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 ISFSF / SWTSF site is presented in chapter 5.2.3.2.

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 [43] 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 ISFSF site. The designed sanitary protection zone of the existing SNF storage facility and the proposed sanitary protection zone for the ISFSF do not overlap. These nuclear facilities do not have a common SPZ, c.f. Figure 5.3.2-1.

Considering trends in changes of radiation fields monitored in the recent years and taking into account significant distance in between the ISFSF 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 ISFSF, outside borders of which the impact of direct ionizing radiation stipulated by ISFSF / SWTSF 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 ISFSF / SWTSF, c.f. Figure 5.3.2-1. 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 [40]. According to preliminary estimation the nearest vault of the disposal facility could be 600 m away from the permanent security fence of ISFSF / SWTSF site.

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 [40]. 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 ISFSF / SWTSF site and the near-surface disposal facility site is summarized in Figure 5.3.2-7. The calculations assume annual exposure duration of 2000 hours.

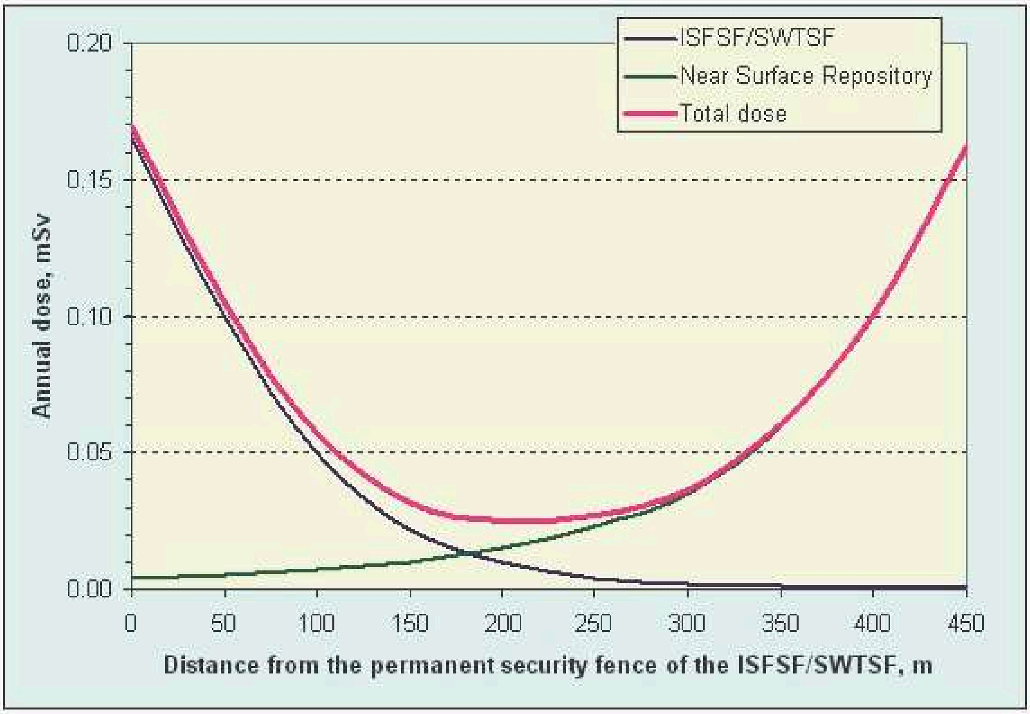


Figure 5.3.2-7. Potential annual dose to the member of population due to direct ionizing irradiation from the ISFSF / SWTSF site and the near-surface disposal facility in Stabatiskes site. Calculations assume annual exposure duration of 2000 hours

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 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 5.3.2-1. The disposal facility site is in the proposed sanitary protection zone of ISFSF. 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 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 ISFSF is expected at the permanent security fence of this facility. The impact rapidly decreases with increasing distance from ISFSF / SWTSF security fence. At the southern border of the ISFSF / SWTSF site (at the distance of 50 m from the ISFSF / SWTSF 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 ISFSF / SWTSF project 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 ISFSF and the disposal facility sites. A common security zone might be foreseen for these two nearby located nuclear 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.

5.3.3. Summary of potential radiological impacts and conclusions

This chapter summarizes all assessed radiological impacts resulting from the normal operation of proposed economical activity, considers their total effect and demonstrates the compliance of the radiological impact with the radiation protection requirements. The results and conclusions are presented separately for personnel and population.

5.3.3.1. Potential radiological impact to personnel due to normal operation of proposed economic activity

Potential radiological impact to personnel from airborne radioactive releases due to normal operation of proposed economic activity is summarized in Table 5.3.3-1.

Table 5.3.3-1. Annual effective dose to the members of personnel from airborne releases due to normal operation of proposed economic activity

Activities	Annual effective dose, Sv	Remarks and reference
Leaking fuel handling (at Reactor Units)	2.75E-04	One year maximal dose increase, Chapter 5.1.5.1
Damaged and experimental fuel handling and fuel debris collection (at Reactor Units)	3.47E-03	One year maximal dose increase, Chapter 5.1.5.1
Cask handling (at ISFSF)	No dose	No airborne releases into environment of working premises under normal operation, Chapter 5.1.3
Spent fuel repackaging (at FIHC of ISFSF)	No dose	No airborne releases into environment of working premises under normal operation, Chapter 5.1.4

The potential annual exposure of operating personnel due to release of airborne activity into environment of working premises is low. During the most of spent fuel handling operations, associated with proposed economic activity, the expected effective annual dose for member of operating personnel would be below 1 mSv. Higher annual doses can be expected during operation of defective fuel handling system. The expected maximal one year effective dose for member of operating personnel could be below 4 mSv.

The operator exposure will be governed by external irradiation. During preparation of the Technical Design and Safety Analysis Report application of radiation protection measures will be optimised according to the principle ALARA. Means of radiological impact reduction are implemented both during design and operation stages.

During design stage:

- The principle of "protection in depth" is implemented foreseeing the complex system of barriers that restrict spread out of radioactive substances into premises and environment;
- Safety SSC preferred over Administrative Controls;
- Passive SSC preferred over active SSC;
- Preventive controls preferred over mitigate controls;
- Adequate facility physical design to potential hazards, alternatives are considered, ALARA principle is applied (e.g. area layout, equipment layout, shielding, confinement and ventilation etc.).

Means of radiological impact reduction during operation:

- Implementation of preventive maintenance and repair concept;
- Implementation of preventive cleaning / decontamination concept;
- Application of ALARA principle (planning of the operations and personnel exposure; planning and preparation of operations which may cause significant exposure; personnel training, considering of gained experience, improvement of operation and etc.);
- Monitoring of casks surface dose rate and contamination (and decontamination if necessary);
- On-line monitoring of airborne releases to the environment;
- Monitoring of radiological contamination of environment air, soil, ground and underground water; monitoring of ionizing radiation dose rate at the Ignalina NPP and ISFSF sites.

Personnel exposure during normal operation will not exceed dose limits. This will be justified in the Safety Analysis Report.

5.3.3.2. Potential radiological impact to population due to normal operation of proposed economic activity

Potential radiological impact to the critical group member of population due to normal operation of proposed economic activity is summarized in the tables below. Results are presented for the phase of SNF handling in the Reactor Units and transfer to the ISFSF (for the period of 2008-2015). At this stage the proposed economic activity potentially will stipulate the maximal radiological impact on environment. During the SNF interim storage at the ISFSF (years 2016-2065) no airborne radioactive emissions (associated with handling of SNF) from the Reactor Units could be expected, no operations of SNF transfer to the ISFSF will be performed. A significantly lower impact on environment would be expected at this stage of the proposed economic activity.

Table 5.3.3-2. Annual effective doses to the critical group member of population at the permanent security fence of SWTSF / ISFSF site during SNF handling at the Reactor Units and transfer to the ISFSF phase (years 2008 – 2015)

Impacts and activities	**Annual effective dose for direction, Sv**			
	North	**East**	**South**	**West**
External and internal irradiation due release of airborne activity from SNF handing at INPP, 1)	4.15E-07	4.15E-07	4.15E-07	4.15E-07
External irradiation due to SNF transfer from INPP to ISFSF site, 2)	1.53E-05	8.87E-08	3.01E-08	2.02E-08
External irradiation from SWTSF and ISFSF structures, 3)	5.00E-05	1.66E-04	1.48E-04	8.80E-05
External and internal irradiation due to release of airborne activity from SNF reloading at FIHC, 4)	1.46E-07	1.46E-07	1.46E-07	1.46E-07
Total dose from proposed economic activity (ISFSF)	**6.59E-05**	**1.67E-04**	**1.49E-04**	**8.86E-05**
External and internal irradiation due to release of airborne activity from SWRF and SWTSF sites, 5)	7.29E-06	7.29E-06	7.29E-06	7.29E-06
External irradiation due to waste transfer from INPP to SWTSF site, 6)	6.87E-05	6.28E-06	1.03E-06	9.74E-07
External and internal irradiation due to radioactive releases from existing nuclear facilities of INPP, 5)	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 7)	1.80E-08			
External irradiation from near-surface repository of low and intermediate level short-lived radioactive waste in Stabatiskes site 7)		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 conservative scenario – "One year maximal increase of radioactive releases due to handling of all leaking fuel"; assessment is presented in chapter 5.1.5.2.

2) Assessment presented in chapter 5.2.2.2.

3) Assessment presented in chapter 5.2.3.2.

4) Assessment presented in chapter 5.1.5.3.

5) Assessment presented in chapter 5.3.2.2.

6) Data are taken from [39]

7) Assessment presented in chapter 5.3.2.3.

Table 5.3.3-3. Annual effective doses 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 SNF handling at the Reactor Units and transfer to the ISFSF phase (years 2008 – 2015)

Impacts and activities	**Annual effective dose for direction, Sv**			
	North	**East**	**South**	**West**
External and internal irradiation due release of airborne activity from SNF handing at INPP, 1)	4.15E-07	4.15E-07	4.15E-07	4.15E-07
External irradiation due to SNF transfer from INPP to ISFSF site, 2)	1.96E-05	7.22E-08	1.81E-08	1.75E-08
External irradiation from SWTSF and ISFSF structures, 3)	4.00E-05	1.00E-04	8.00E-05	6.40E-05
External and internal irradiation due to release of airborne activity from SNF reloading at FIHC, 4)	1.46E-07	1.46E-07	1.46E-07	1.46E-07
Total dose from proposed economic activity (ISFSF)	**6.02E-05**	**1.01E-04**	**8.06E-05**	**6.46E-05**
External and internal irradiation due to release of airborne activity from SWRF and SWTSF sites, 5)	7.29E-06	7.29E-06	7.29E-06	7.29E-06
External irradiation due to waste transfer from INPP to SWTSF site, 6)	1.07E-04	5.21E-06	6.18E-07	7.87E-07
External and internal irradiation due to radioactive releases from existing nuclear facilities of INPP, 5)	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 7)	3.00E-08			
External irradiation from near-surface repository of low and intermediate level short-lived radioactive waste in Stabatiskes site 7)		5.00E-06		
Total dose from proposed economic activity together with other existing and planned activities	**1.84E-04**	**1.28E-04**	**9.85E-05**	**8.27E-05**

Remarks 1), 2), 3), 4), 5), 6), 7) are explained below the Table 5.3.3-2.

Table 5.3.3-4. Annual effective doses 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 SNF handling at the Reactor Units and transfer to the ISFSF phase (years 2008 – 2015)

Impacts and activities	**Annual effective dose for direction, Sv**			
	North	**East**	**South**	**West**
External and internal irradiation due release of airborne activity from SNF handing at INPP, 1)	4.15E-07	4.15E-07	4.15E-07	4.15E-07
External irradiation due to SNF transfer from INPP to ISFSF site, 2)	2.03E-05	7.96E-09	4.20E-09	5.36E-09
External irradiation from SWTSF and ISFSF structures, 3)	1.80E-07	2.00E-07	2.20E-07	1.04E-07
External and internal irradiation due to release of airborne activity from SNF reloading at FIHC, 4)	2.25E-08	2.25E-08	2.25E-08	2.25E-08
Total dose from proposed economic activity (ISFSF)	**2.09E-05**	**6.45E-07**	**6.62E-07**	**5.47E-07**
External and internal irradiation due to release of airborne activity from SWRF and SWTSF sites, 5)	7.29E-06	7.29E-06	7.29E-06	7.29E-06
External irradiation due to waste transfer from INPP to SWTSF site, 6)	1.28E-04	1.19E-07	1.81E-08	3.63E-08
External and internal irradiation due to radioactive releases from existing nuclear facilities of INPP, 5)	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 7)	6.30E-06			
External irradiation from near-surface repository of low and intermediate level short-lived radioactive waste in Stabatiskes site 7), 8)		1.62E-04		
Total dose from proposed economic activity together with other existing and planned activities	**1.73E-04**	**1.80E-04**	**1.80E-05**	**1.79E-05**

Remarks 1), 2), 3), 4), 5), 6), 7) are explained below the Table 5.3.3-2.

8) 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.

Potential radiological impact to population due to radioactive airborne emissions from the proposed economic activity is very low. Highest radioactive releases could be expected during spent nuclear fuel handling at the Reactor Units and transfer to the ISFSF phase (years 2008–2015). The estimated annual effective dose to the critical group member of population is below 0.001 mSv (5.61×10^{-7} Sv) and from radiological point of view can be considered as insignificant.

The highest annual dose to the population may be expected only in the close vicinity of the SWTSF / ISFSF permanent security fence, Figure 5.3.3-1. The dose to the member of population is governed by external exposure from the radioactive waste and spent nuclear fuel stored within 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 0.17 mSv (1.67×10^{-4} Sv), c.f. Table 5.3.3-2.

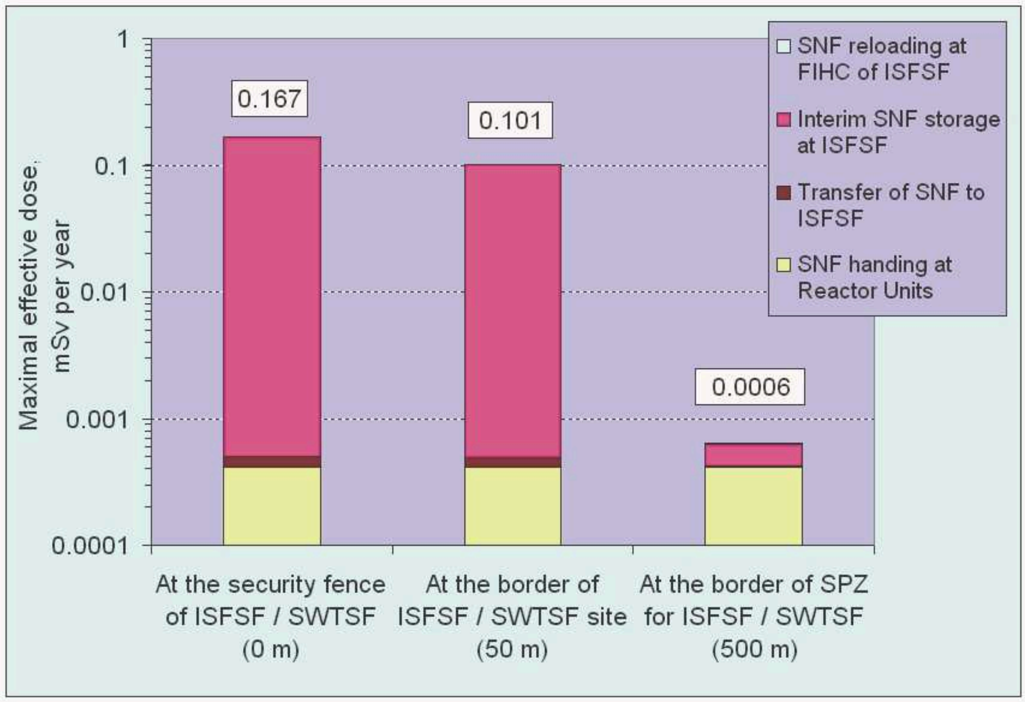


Figure 5.3.3-1. Annual exposure of the critical group member of population in the eastern direction from the ISFSF / SWTSF site due to the proposed economical activity (based on data from Table 5.3.3-2, Table 5.3.3-3, Table 5.3.3-4)

Under the same conservative approach calculated the highest annual effective dose to the population at the ISFSF / SWTSF permanent security fence due to proposed economical activity together with exposure from other existing and planned nuclear facilities, located in the SPZ of INPP equals to 0.19 mSv (1.94×10^{-4} Sv), c.f. Table 5.3.3-2. The annual effective dose is below dose constraint of 0.2 mSv (cf. Chapter 5.3.1.2) therefore the radiological protection requirements are not being violated and proposed economic activity is possible.

It should be indicated, that permanent activity of the population in the vicinity of SWTSF / ISFSF permanent security fence is normally not expected. According to the requirements for physical protection of nuclear facilities [36], presence of the population in the vicinity of the SWTSF / ISFSF site must be controlled (and limited). Moreover, the calculations of SWTSF and

ISFSF radiation fields are based on conservative source term and assuming completely filled ISFSF and SWTSF. The sensitivity analysis of conservative assumptions used in ISFSF shielding calculations [26] shows, that consideration of realistic fuel data, cooling time in storage pools and ISFSF filling schedule leads to 45% lower exposure (in the vicinity of ISFSF) due to neutron flux in comparison with evaluations, currently presented in the EIA Report. Therefore, the actually expected exposure of the population will be lower than it is evaluated in this EIA Report.

With increasing distance from the ISFSF / SWTSF site, the potential exposure to the population rapidly decreases (see Figure 5.3.3-1). At the distance of 500 m from ISFSF / SWTSF permanent security fence and railroad connection fence (i.e. at the border of proposed sanitary protection zone of ISFSF / SWTSF) the radiological impact to the member of population due to proposed economic activity can be considered as insignificant. The calculated annual effective dose due to proposed economic activity is below 0.002 mSv (1.55×10^{-6} Sv).

The calculated exposure of a critical group member of the 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, c.f. Table 5.3.3-2, Table 5.3.3-3 and Table 5.3.3-4. Therefore it can be stated that the radiological protection requirements are not being violated and 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.

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

The highest radiological impact on environment could be expected during spent nuclear fuel handling and transfer to the ISFSF phase. When the fuel will be removed from the power units and safely stored in the ISFSF, the impact on environment will become decreasing. The nuclear fuel will be confined into long-term stable, steel-welded and double-barrier casks. The hazardous radionuclides will become isolated from environment. There will be no radioactive releases into the environment (the cask repacking in the new FIHC is normally not expected). There will be no off-site cask transfer operations. Due to the natural radioactive decay the radioactive fields around the ISFSF will become gradually decreasing.

When the interim storage is finished, it will be possible to transport the spent fuel away from the ISFSF site without repackaging the fuel. The CONSTOR® RBMK1500/M2 type casks will be designed to meet requirements of IAEA Regulations for the Safe Transport of Radioactive Material.

6. NON RADIOLOGICAL IMPACTS ON THE ENVIRONMENT AND IMPACT MITIGATION MEASURES

The construction of the new ISFSF will occur within the boundaries of the existing industrial site and is anticipated to have little to no impact on terrestrial ecology. No significant impacts will occur to the soils and the vegetation outside of the footprint of this previously disturbed area. No rare and endangered species of plants and animals have been identified in the vegetation communities occurring within the proposed construction site.

The main environmental, social and economic impacts during the construction period are those typical of any construction project. These include intensification of traffic due to the transportation of workers and materials, noise resulting from the operation of machinery, the temporary accumulation of soil and equipment, generation of dust from the movement of heavy vehicles and also from earth movements (dust clouds during dry periods), and air pollution from the diesel exhausts of heavy vehicles. These impacts will be temporary and are expected to be low due to the site location and favourable conditions of the existing infrastructure in the region. It needs to be mentioned that all impacts will be reversible.

Since the new ISFSF will be built in an existing industrial area, birds can get used to the activities on the INPP site or they may go to other, calmer parts of the lake Druksiai which is proposed as NATURA 2000 area. However birds could be affected by sudden, heavy noises. It is anticipated that the area around the ISFSF may be slightly devaluated as bird habitat. The main impact mitigation measure is that noisy activities will be carried out during daytime only. More detail analysis of possible impact on biodiversity and other impact mitigation measures are presented in Subchapter 6.5. As regards population, the closest premises are too far from the site being significantly affected by noise (see Subchapter 6.8.2).

6.1. Water

It is considered that construction and operating of the ISFSF will not have any significant effect on surface water and groundwater hydrology and quality. Due to low forecasted traffic levels the impact on surface water and groundwater by traffic-related substances is also considered insignificant. The ISFSF surface drain water system shall be routed outside the territory of the ISFSF and connected to the existing industrial-storm drain system. Oil removers (mechanical) are installed just at the outlet of industrial-storm water to the lake Druksiai.

The ISFSF sewage water system shall follow the requirements of normative document [1]. The ISFSF site surface drain water collection system shall follow the requirements of normative document [2].

6.1.1. Construction water supply

Bottled water will be provided as drinking water during the construction of the project. Water in support of construction activities will be obtained by way of a connection to the INPP water supply line.

6.1.2. Construction waste water management

A construction workforce of as many as 50 people could generate as much as 5 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.

6.1.3. Construction storm water

Construction techniques will be implemented that will minimize soil erosion and the quantities of sediment in storm water runoff from the construction area. Site grading and materials stockpiling will be performed using techniques designed to minimize potential erosion of topsoil. Where appropriate, hay bales and/or silt fencing will be installed in areas down gradient of construction activities to minimize sediment loading in storm water runoff. If necessary, and where appropriate, a temporary storm water sedimentation basin will be constructed that will control peak flows of storm water runoff and allow for the settling of suspended sediment. Storm water runoff will be routed to the INPP storm drainage system.

6.1.4. Dewatering of foundation excavations

Minor short-term lowering of the groundwater table may occur in the vicinity of the ISFSF site during dewatering of foundation excavations. Water from dewatering activities could contain suspended solids. Measures could 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 dewatering activity is not expected to have a significant impact.

6.1.5. Accidental spills

Accidental spills of combustive-lubricating materials, paints or other materials during construction phase could contaminate coastal or inland waters. Workers must be trained in the proper handling, storage and disposal of hazardous materials. A written emergency response plan will be prepared and retained on site and the workers will be trained to follow specific procedures in the event of a spill. The mitigation measures include:

- Segregating all waste oils and lubricants from maintenance of construction equipment and disposing of them according to regulatory procedures;
- Constructing secondary containment areas and other sumps;
- Inspecting secondary containment areas and other sumps regularly;
- Constructing and maintaining facilities to remove rainwater from the secondary containment structures, removing oil from the surface of the accumulated material and disposing of according to regulatory procedures.

6.2. Environmental Air

The ISFSF in itself does not cause perceptible atmospheric emissions. The backup power will be provided by an emergency diesel (approx. 80 kW) and limited to 24 hours. Calculated amounts of pollutants and tax for pollution of environment are presented in Section 3.1.3.

Mobile sources, such as the existing locomotive Type TM-2, which will draw or push the rail transporter, vehicles during the construction of the ISFSF and personnel transport (private cars, public minivans) will not cause significant atmospheric emissions. EU standards for combustive-lubricating materials (among which sulphur content) and old cars replacement will help in the relative reduction of pollutant emissions from each individual vehicle.

The planned new 400 m long technological road connecting already existing road No. 6 with the new ISFSF and the main exit to the existing road No. 3 are in INPP sanitary protective area and does not cross residential areas. The ambient air quality will be directly affected by NO_x, SO_2 and dust emissions generated by the road transfer of construction materials 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. Due to low forecasted traffic levels the impact level of the emissions of the 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 avoid the accumulation of significant concentrations of such substances.

In summary, no significantly adverse effect on the environment is to be expected from air pollutant emissions.

The most important potential source of atmospheric emissions would be a fire. The INPP Fire Protection Plan will be adapted to the proposed economic activity. The means required for both rapid detection and extinguishing of fires are described below.

6.2.1. Fire Protection Systems

6.2.1.1. System coverage, location and number of detectors

The fire detection shall cover all rooms in the Security and Administration Building and the rooms in the Reception Hall of the Storage Hall (except the Cask Service Station). The Control Room will get supplementary detection for the fire fighting system with Argon [3].

As a first estimate, 17 detectors will be foreseen in the Security and Administration Building and 12 in the Reception Hall of the Storage Hall. The exact numbers will be finalised in the Technical Design.

6.2.1.2. Alarm system and possible interface with existing systems

The alarm system will be the combination of horning facility and forwarding to the fire brigade. Possible interfaces to be considered are:

- interface with data system;
- connection to fire brigade;
- BUS System–interface coupler.

6.2.1.3. Actuating mechanism for fixed fire suppression system

The only actuating fixed fire fighting suppression system is proposed to be installed in the Control Room (Security and Administration Building) and in the high/low voltage rooms (Reception Hall of the main building).

It will be an argon-based suppression system. The detection for the suppression system will be released at first and later the central alarm system.

The activation of fire hydrants will occur only with the approval of the fire brigade.

6.2.1.4. Fire suppression medium

The suppression installations will be:

- hand-held or movable fire extinguishers;
- installed Argon fire extinguishing system (Control Room and high/low voltage rooms; the installed system will include a means of preventing the system activation in the event of personnel being in the affected area);
- loop fire water mains with hydrants around the buildings.

The loop fire water system will be installed around the site, with hydrants positioned each 80 m. The necessary water pressure is at least 3 bars (0.3 MPa) flowing pressure, with the capacity of 1800 l/min for 2 hydrants in use at the same time (900 l/min or 15 l/s for each).

The pipes shall be submitted to a continuous rinsing, which occurs if the same piping system is used for supply of cold water for the buildings.

The testing procedure for the fire extinguishing systems is “self testing”.

6.2.1.5. Use of non combustible materials

All materials to be used in construction will be specified as non combustible, where possible. For a few parts such as earth-side insulation of floors or cables for crane-energy supply, materials with an acceptable fire resistance qualification will be proposed.

6.2.1.6. Provision of hand-held fire extinguishers

Hand-held fire extinguishers as well as movable extinguishers will be positioned in the rooms of the Reception Hall of the main building. The same devices are foreseen for the inspection areas for the vehicles and Rail Transporter.

In the Reception Hall of the main building, where the casks are handled and the arrival of the Rail Transporter takes place, movable fire extinguishers will be located.

6.3. Soil

Excavations of 8500 m^3, soils improvement of 6200 m^3 and re-fillment of 2400 m^3 are foreseen in the ISFSF site. New roads’ surface is expected to be 6900 m^2. Existing sand and gravel quarrying operations close to the site will provide sufficient resources for construction requirements without depleting local resources. Existing sources of aggregate will be used and no new sources will be developed.

Approximately 6000 m^3 of earth will be removed and stored outside of the construction area. The final site grade will facilitate drainage and avoid flooding and pooling. A site drainage plan will be developed to protect against erosion. Protecting stockpiles through the use of silt fencing and reduced slope angles will also minimize soil erosion during construction.

All slopes and working surfaces will be returned to a stable condition. Topsoil on the final site will be graded and planted as appropriate. Re-vegetation will be performed using local plants.

In the future winter maintenance process of roads, the authors of the EIA Report recommend to replace NaCl based de-icing agents by alternative materials such as plant protective based agents (e.g. TRANSHEAT) in order to reduce soil pollution along the roadside.

There will be no consumption of hazardous substances that will become waste during the construction and operation of the ISFSF. The proposed economic activity does not also involve the use of chemical reagents that, in case of accidental releases, could contaminate the soil and groundwater.

6.4. Underground

In itself, the proposed economic activity does not include activities that can have a non-radioactive impact on the 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 land use in the area and the relatively small surface used by the project, this effect is not significant.

6.5. Biodiversity

The main objective of land protection initiatives in Lithuania is to preserve both ecosystem biological diversity and the natural processes that occur in them. Since the proposed economic activity is in the INPP territory there will be no loss of agricultural land, forest or parts of village areas. The proposed economic activity is not in conflict with nature reserves or protected areas. No rare or endangered plant communities and invertebrates are known to occur at or near the new ISFSF site. There is no loss of vegetation communities with ecological value and conservation significance. The new ISFSF will not affect the migration of animals (e.g. birds, amphibia and flying insects).

No unique bird ecosystems or mapped critical habitats occur at the ISFSF site. An impact during the construction phase is the nuisance of breeding birds by the construction machines due to exhaust fumes, noise and visual irritations. It is anticipated that due to disturbance the area around the ISFSF may be slightly devaluated as bird habitat.

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 ISFSF will be fenced off.

The railroad will be fenced for traffic safety reasons. This constitutes a barrier for passage of large animals. However, there are no large animals like elk or hind in the area. Landscape, terrain and habitat structures indicate that elk or hind crossing is not expected. Although several of mammal species could potentially occur in the site vicinity, it is likely that several of these taxa would require more remote habitats than the territory of INPP provides.

To mitigate impacts and to compensate for deterioration of vegetation communities and habitat functions some measures need to be realised. Main compensation measures include the ecological improvement of surrounding area and planting of trees and hedges. Trees should be local species preferably with large crown habitus.

If the afforestation of areas surrounding the ISFSF is foreseen, it should take place in the same regional natural landscape context and only in areas which have been identified by the forest authorities.

Construction activities may have a potential impact on flora and fauna. To avoid unnecessary deterioration of vegetation communities and habitat functions the construction site will be limited to the minimum area needed for the ISFSF works and materials will be handled within the construction site. Removed vegetation at the construction site and local borrow areas will be replanted after finalisation of the ISFSF works.

6.6. Landscape

The landscape in the lake Druksiai watershed has degraded because of the building and operation of INPP, Visaginas town and related infrastructure. According to the State Research [4], it was determined that 1.43 % of the watershed (not taking the lake into account) was damaged irreversibly. There are abandoned farming lands (1.56 %) and a reduction of the forest area (3.83 %).

Today, the landscape can be characterized as industrial near the INPP: power production units, ancillary facilities, partly build third unit (industrial ruin), operative spent fuel storage facility, domestic wastewater treatment plant, ducts for the urban warming system of Visaginas and the electricity transmission lines. Figure 6.6-1 illustrates damages to the initial landscape in the lake Druksiai watershed.

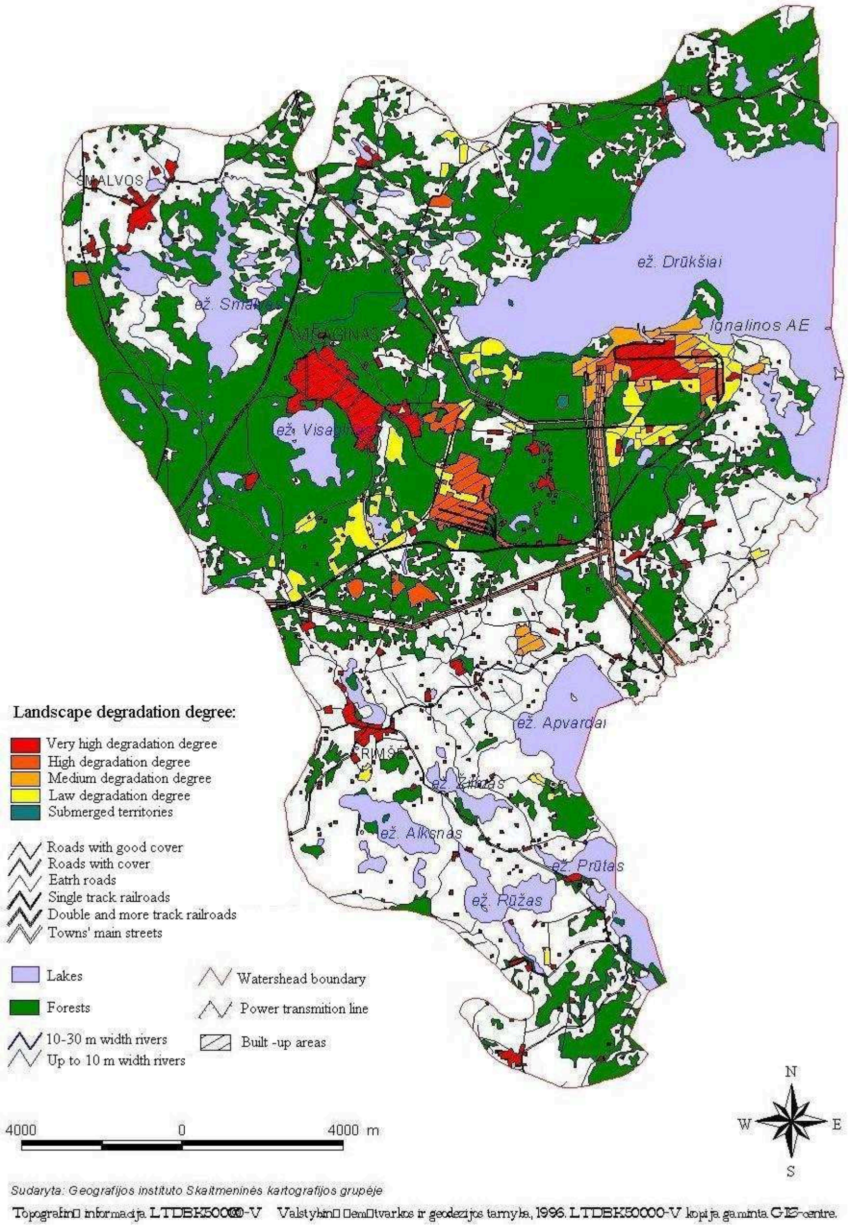


Figure 6.6-1. Deteriorated landscape in the lake Druksiai watershed [5]

The ratio between the natural and comparatively natural territories and technogenic-urbanized areas in the Druksiai lake watershed is 21.4. This value for the whole 30 km area around the INPP is slightly smaller but still positive (from the ecological point of view). Though the building of INPP and Visaginas town has considerably (twice) reduced this ratio, it remains by a few times higher than elsewhere in Lithuania (7.9) (Utena county – 10.6, Ignalina district – 10.9). Thus, we may conclude that the Druksiai lake watershed is predominated by comparatively natural and poorly culturalized landscape with hotbed of intensive technogenization. The mentioned ratio is improving (in the territory of Visaginas and INPP) due to deserted farmlands and renaturalization of recultivated areas.

The following conclusion can be made: construction of ISFSF near the INPP will produce no greater effect of landscape degradation and will not disrupt the equilibrium between the natural and anthropogenic territories. Considering its location and general layout visual impact of the new ISFSF will be insignificant. The visibility of the buildings of the ISFSF will be mainly limited to the closest roads and INPP sanitary protective area.

Landscaping, selection of proper design, materials and construction types (Figures 6.6-2 and 6.6-3) and planting of greenery will be used to enhance the appearance of the ISFSF.

Figure 6.6-2. Concept of the main storage building

Figure 6.6-3. Concept of the security and administration building (the gate-house) and the vehicle and rail transport inspection area

6.7. Cultural Heritage

Cultural heritage objects in the vicinity of the INPP (see Chapter 4.9) will not be affected by the construction of new ISFSF while they are distant from the foreseen ISFSF site. ISFSF construction site is now recultivated (planted with pine seedlings) former soil buffer dump. The geologic/lithologic structure of the ISFSF site has been investigated by drilling a lot of bores. The main bores reached the depth of 40 m (see Subchapter 4.1.3). No traces of archaeological objects have been found.

6.8. Social and Economic Environment

Construction of new ISFSF was dictated by the Radioactive Waste Management Strategy [6] "… to store the spent nuclear fuel in the dual-purpose storage systems applicable for both the long-term storage and transport. Ready for storage spent nuclear fuel shall be removed to the dry storage facility in order that the Ignalina NPP decommissioning activities would be performed effectively".

Benefits associated with the proposed ISFSF site include:

- Already existing INPP infrastructure suitable for ISFSF operation;
- Short distance to the Storage Pools Halls reducing the need for transportation of spent nuclear fuel over long distances;
- Nearby sources of hot and potable water, electricity, telecommunications, alarms etc.;
- A local work force with a high skill level associated with work in the nuclear industry;
- A brown field site that would not require the disturbance of any ecologically sensitive land with less work being required with regards to site preparation prior to construction.

6.8.1. Social, Economic and Environmental Benefits

In addition, the proposed economic activity will have other social, economic and environmental benefits, which are summarized below.

6.8.1.1. Nuclear safety

Since all spent nuclear fuel is transferred from reactors and Storage Pools Hall to the ISFSF the nuclear safety will be guaranteed for long-term period.

6.8.1.2. Reduced radioactive releases and discharges

CONSTOR® RBMK1500/M2 cask containment system guarantees "zero"–activity release during long-term storage without active continuous monitoring of the leak-tightness of the cask lid system. The proposed ISFSF will have also zero discharge of radioactive liquids. Since all spent nuclear fuel is transferred from Reactor Units to the ISFSF the radioactive releases and discharges from the INPP will reduce significantly. This will lead to a long-term improvement in regional air and surface water quality. Improved regional air and surface water quality will lead to long-term human health benefits, as well as reduced ecological impacts resulting from INPP operation.

6.8.1.3. Regional development

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 investor confidence in the domestic and international markets. With contract for Stage 1 (with delivery of 39 casks) value of approximately €93 million, millions could be earned by local companies.

6.8.1.4. Employment

Local construction companies, among others, will be involved in construction of the new ISFSF. The project will employ up to 50 people during the 1.5–2 year construction period.

During operation, the new ISFSF will provide direct employment for up to 30 people as well as indirect employment for the service workers.

The INPP personnel that will be released from INPP operation and maintenance (including post-shutdown activities) will be used, to the largest reasonable extent, to perform tasks associated to the defuelling of the Reactor Units and new ISFSF operations.

6.8.1.5. Related industries

The project's secondary economic effects will result in a possible increase in new business opportunities associated with the ISFSF construction and possible CONSTOR® RBMK1500/M2 casks production in Lithuania. The need for services and products to support the construction of new facility will create additional business opportunities in Lithuania.

6.8.1.6. Technology transfer

The project will stimulate the transfer of technologies and operating know-how in Lithuania.

6.8.2. Noise

The construction of the ISFSF 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 construction will be highly variable. However, since the nearest residential properties are located approximately 2 km from the ISFSF site, it is estimated that construction noise will rarely exceed existing levels. Consequently, construction activities are expected to have minimal and temporary impacts on the noise environment in the communities south and west of the ISFSF site.

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.

Once operational the proposed ISFSF will produce no noise that will be perceptible at the nearest residential receptors. For example, if an ambient noise at the ISFSF site reaches 85 dB (A) (which is typical of an automobile passing at a few meters), than 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.

6.8.3. Employee Training

Employee training will be an important component of proposed economic activity development. The project anticipates training relative to all aspects of Lithuanian regulations (environmental as well as occupational health and safety) with which many employees may already be familiar. Just as important it anticipates training relative to its own health and safety standards as well as those of the EU and EBRD. Consortium corporate goals on health and safety and environmental improvement will be part of the orientation programme conducted for all people employed during ISFSF construction. As construction progresses, additional health and safety or environmental management training may be required to address specific issues that arise.

6.8.4. Possible Public Discontent with Proposed Activity

No public discontent with the proposed activity is expected to take place for the following reasons:

- There are no alternatives for proposed economic activity as decommissioning of INPP is inevitable. Therefore, a safe and reliable facility for long-term storage of spent nuclear fuel, i.e. construction of a new ISFSF is required. There could be location alternatives but the performed analysis has clearly shown that the INPP area is the most appropriate place for the ISFSF (see developments in Subsection 7.1 Location Alternatives);
- The new ISFSF will be constructed in accordance with the modern environmental requirements using state-of-the-art technologies;
- The new ISFSF is to be financed under the EBRD managed International Ignalina Decommissioning Support Fund;
- The new ISFSF will be built in an existing industrial area;
- No soil pollution or erosion caused by the proposed activity is expected;
- No generation of physical or biological pollutants during operation of the ISFSF is expected;
- Impact of non radioactive kind on components of natural and social environment will be negligible and could be evident just at a close vicinity of the ISFSF site;
- Local construction companies will be involved in construction of the new ISFSF;
- During operation, the new ISFSF will provide direct and indirect long-term employment for local workers;
- The proposed economic activity will not have impact on the local demographic conditions;
- Calculations and assessments performed in this EIA Report have clearly shown, that the proposed economic activity will not produce significant impacts neither the radiological nature nor the non radiological nature, which could physically affect public health.

6.9. Public Health

At it is indicated in the EIA Programme, this EIA report contains data, which are mandatory for assessment of impact on the public health and other components of environment in accordance with the requirements of clause 1, article 9 of the Law on the Environment Impact Assessment of Proposed Economic Activity [7]. In accordance with the requirements of legal acts of the Republic of Lithuania, the public health impact assessment report shall be prepared by public health impact assessor as prescribed by the Recommendations on Assessment of Impact on the Public Health [8] and after EIA Programme and EIA Report have been assessed.

Following the Recommendations on Assessment of Impact on the Public Health [8] the main factors and impacts of proposed economic activity are identified and evaluated in this report. The direct and indirect impacts of the proposed economic activity on factors influencing the public health are summarized in Table 6.9-1. Possible impact of proposed economic activity on public groups is summarized in Table 6.9-2. Assessment of impact features is presented in Table 6.9-3.

Table 6.9-1. Direct and indirect impacts of the proposed economic activity on factors influencing the health

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
1. Factors of behavior and lifestyle (nutrition habits, alcohol consumption, smoking, consumption of narcotic and psychotropic drugs, safe sex and other)	ISFSF 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 ISFSF only. The INPP personnel will be used at the largest extent in the operation of ISFSF. 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 (see Chapter 6.2)	Generation of dust and local air pollution	(-)	The ambient air quality will be directly affected by NO_X, SO_2 and dust emissions generated by the road transfer of construction materials and by the operation of road construction equipment. All impacts will be reversible.	The affected area includes the construction route and their direct environment in a range of about 100 m. Due to low forecasted traffic levels the impact level of the emissions of the vehicles and construction equipment will be acceptable both in the construction and	The backup power will be provided by an emergency diesel (approx. 80 kW) and limited to 24 hours. Calculated amounts of pollutants and tax for pollution of environment presented in Chapter 3.1.3 are

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
					operation phases. Most of the works will be carried out in open air so that the natural air circulation will avoid the accumulation of significant concentrations of such substances (see Chapter 6.2).	negligible.
2.2. Water quality	ISFSF domestic sewerage system and surface drain water system (see Chapters 3.1.2 and 8.3.9)	Possible controlled slight pollution due to utilities type sewage release to environment (see Chapter 4.5.2).	(-)	The potable water will be supplied by "Visagino Energija". No new boreholes are foreseen (see Chapter 1.6.2). The aquifer complex D_{3+2}sv-up rich with underground water is exploited by the Visaginas town waterworks. The quality of underground water of exploited aquifer complex is good not only in the waterworks but also in all region and its changes happened in the waterworks are minimal (see Chapters 4.4.2 and 4.4.4). Changes are not forecasted.	The ISFSF sewage water system shall follow the requirements of normative document [1]. The ISFSF site surface drain water collection system shall follow the requirements of normative document [2] (see Chapter 6.1).	Survey boreholes (wells) for monitoring underground run-off water are foreseen around the ISFSF as part of required environmental monitoring. The underground water monitoring programme for boreholes to be arranged at ISFSF site will be developed in accordance with normative document [14] and presented to the Geological Survey of Lithuania for approval (see Chapter 8.3.8).
2.3. Food quality	ISFSF construction and operation	Not foreseen				
2.4. Soil	ISFSF construction and operation	Soil erosion (the land-tenure of the region – see Chapter 4.5.3, soil of ISFSF site – see	(-)	Excavations of 8500 m^3, soils improvement of 6200 m^3 and re-fillment of 2400 m^3 are foreseen in the ISFSF site. New roads' surface is	Approximately 6000 m^3 of earth will be removed and stored outside of the construction area. The final site grade will facilitate	All slopes and working surfaces will be returned to a stable condition. Topsoil on the final site will be graded and

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
		Chapter 4.6)		expected to be 6900 m^2. Existing sources of aggregate will be used and no new sources will be developed.	drainage and avoid flooding and pooling. A site drainage plan will be developed to protect against erosion. Protecting stockpiles through the use of silt fencing and reduced slope angles will also minimize soil erosion during construction (see Chapter 6.3)	planted as appropriate. Re-vegetation will be performed using local plants.
2.5. Nonionizing radiation	ISFSF construction and operation	Not foreseen				
2.6. Ionizing radiation	1. SNF retrieval, packaging, loading at Reactor Units. 2. Transfer of SNF from Reactor Units to the ISFSF. 3. Handling, preparation and interim storage of SNF in the ISFSF. 4. Decommissioning of the ISFSF.	Possible local impact to the environment	(-)	Possible local increase of exposure by ionizing radiation near the ISFSF (see Chapter 5.3.3).	Around the ISFSF site, the sanitary protection zone will be established, in which there is no permanent inhabitants and economic activities are limited. Monitoring of the ionizing radiation impact and possible changes in the environment will be performed (see Chapter 8).	Possible exposure under normal operation conditions will not exceed the limits prescribed by radiation protection requirements (see Chapter 5.3.3). Possible exposure of the public under emergency conditions will be negligible (see Chapter 9.4).
2.7. Noise	ISFSF construction and operation	Possible local impact to the environment	(-)	The area around the ISFSF may be slightly devaluated as bird habitat (see the beginning of Chapter 6). Since the nearest residential properties are located approximately 2 km from the ISFSF site, it is	The noisy activities will be carried out during daytime only.	

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
				estimated that construction noise will rarely exceed existing levels. Once operational the ISFSF will produce no noise that will be perceptible at the nearest residential receptors (see Chapter 6.8.2).		
2.8. Home conditions	ISFSF construction and operation	Not foreseen				
2.9. Safety	SNF retrieval from INPP pools, packaging, transfer and storage at ISFSF	Increase of the nuclear and radiation safety	(+)	The proposed economic activity, which intends to introduce an advanced spent nuclear fuel storage technology, will increase nuclear safety and significantly reduce risk of possible accidents compared with the existing technology of spent nuclear fuel storage in Ignalina NPP spent nuclear fuel storage pools (see Chapter 6.8.1).		All nuclear materials will be managed according to management principles of IAEA and in compliance with good practices in other European Union Member States (see Chapter 10.3.8).
2.10. Means of communication	ISFSF construction	Controlled slight impact on the environment	(-)	Possible temporary traffic increase.		New fenced blacktop road connecting INPP and ISFSF sites (the length about 1 km, see Chapters 2.4 and 6.2) will be used for transfer of SNF.
2.11. Territory planning	ISFSF construction	Not foreseen				ISFSF will be constructed in the INPP sanitary protection zone

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
2.12. Waste management	ISFSF constructional and operational waste management	Controlled slight impact on the environment	(-)	Waste amounts generated by ISFSF are very small (see Chapter 3), furthermore, the waste amounts generated now at INPP Reactor Units will reduce accordingly. So only small changes are forecasted.	Waste will be managed in accordance with the requirements of waste management legislation and regulations in force and Permission on integrated prevention and control of pollution (see Chapters 3, 5 and 6).	CONSTOR® RBMK1500/M2 cask containment system guarantees “zero”–activity release during long-term storage without active continuous monitoring of the leak-tightness of the cask lid system. The ISFSF will have also zero discharge of radioactive liquids. Since all SNF is transferred from Reactor Units to the ISFSF the radioactive releases and discharges from the INPP will reduce significantly. This will lead to a long-term improvement in regional air and water quality. Improved regional air and water quality will lead to long-term human health benefits, as well as reduced ecological impacts resulting from INPP operation (see Section 6.8.1.2).
2.13. Power appliance	ISFSF 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: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
2.14. Risk of misadventures	ISFSF construction and operation	Not foreseen				
2. 15. Passive smoking	ISFSF construction and operation	Not foreseen				
2.16. Other	ISFSF construction and operation	Not foreseen				
3. Social and economic factors						
3.1. Culture	ISFSF construction and operation	Not foreseen				
3.2. Discrimination	ISFSF construction and operation	Not foreseen				
3.3. Property	ISFSF construction and operation	Not foreseen				
3.4. Income	Large infusion of new capital into the region economy	Increase of population income	(+)	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 investor confidence in the domestic and international markets. With contract for Stage 1 (with delivery of 39 casks) value of approximately € 93 million, millions could be earned by local companies (see Section 6.8.1.3).		
3.5. Education possibilities	ISFSF construction and operation	Not foreseen				
3.6. Employment, labour	ISFSF construction and	Workplace creation	(+)	Local construction		The project's secondary

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
market, business opportunities	operation			companies, among others, will be involved in construction of the new ISFSF. The project will employ up to 50 people during the 1.5–2 year construction period. During operation, the new ISFSF will provide direct employment for up to 30 people as well as indirect employment for the service workers. The INPP personnel that will be released from INPP operation and maintenance (including post-shutdown activities) will be used, to the largest reasonable extent, to perform tasks associated to the defuelling of the Reactor Units and new ISFSF operations (see section 6.8.1.4j).		economic effects will result in a possible increase in new business opportunities associated with the ISFSF construction and possible CONSTOR® RBMK1500/M2 casks production in Lithuania. The need for services and products to support the construction of new facility will create additional business opportunities in Lithuania (see Section 6.8.1.5).
3.7. Criminality	ISFSF construction and operation	Not foreseen				
3.8. Leisure, recreation	ISFSF construction and operation	Not foreseen				
3.9. Movement	ISFSF construction and operation	Not foreseen				
3.10. Social security (social contact and welfare)	ISFSF 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: positive (+) negative (-)**	**Forecasted changes of the analyzed indicators**	**Possibilities to mitigate (to eliminate) the negative impact**	**Comments and remarks**
3.11. Sociality, sociability, cultural contact	ISFSF construction and operation	Not foreseen				
3.12. Migration	ISFSF construction and operation	Employment reduces migration	(+)	Small changes (see Section 6.8.1.4).		
3.13. Family constitution	ISFSF construction and operation	Not foreseen				
3.14. Other	ISFSF construction and operation	Not foreseen				
4. Professional risk factors						
4.1 Chemical	ISFSF construction and operation	Not foreseen				
4.2. Physical	ISFSF construction and operation, emergency situations	Ionizing radiation	(-)	Risk analysis of possible emergency situations during the proposed economic activity is presented in Chapter 9.	Risk of the majority emergency situations can be eliminated or reduced by appropriate technical solutions.	Possible personnel exposure during emergency situations can be controlled and limited.
4.3. Biological	ISFSF construction and operation	Not foreseen				
4.4. Ergonomic	ISFSF construction and operation	Not foreseen				
4.5. Psychosocial	ISFSF construction and operation	Not foreseen				
4.6. Manual work	ISFSF construction and operation	Not foreseen				
5. Psychological factors						
5.1. Aesthetical appearance	ISFSF construction and operation	Impact on landscape	(-)	Construction of ISFSF near the INPP will produce no greater effect of landscape degradation and will not disrupt the equilibrium	Landscaping, selection of proper design, materials and construction types (Figures 6.6-2 and 6.6-3) and planting of greenery will be used to	

Factors influencing the health	Kind of activity or means, contamination sources	Impact on factors influencing the health	Impact on health: positive (+) negative (-)	Forecasted changes of the analyzed indicators	Possibilities to mitigate (to eliminate) the negative impact	Comments and remarks
				between the natural and anthropogenic territories. Considering its location and general layout visual impact of the new ISFSF will be insignificant. The visibility of the buildings of the ISFSF will be mainly limited to the closest roads and INPP sanitary protective area (see Chapter 6.6).	enhance the appearance of the ISFSF.	
5.2. Comprehensibility	ISFSF construction and operation	Not foreseen				
5.3. Capability to hold the situation	ISFSF construction and operation	Not foreseen				
5.4. Significance	ISFSF construction and operation	Not foreseen				
5.5. Possible conflicts	ISFSF 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 construction of new nuclear objects such as ISFSF and others.	Psychological impact can be mitigated explaining necessity, goals and benefits from proposed economic activity (see Chapter 10.3.8).	
6. Social and health services (acceptability, suitability, succession, efficiency, protection, availability, quality, self-help technique)	ISFSF construction and operation	Not foreseen				

Table 6.9-2. Possible impact of proposed economic activity on public groups

Public groups	Kind of activity or means, contamination sources	Group size	Impact: positive (+) negative (-)	Comments and remarks
1. Public groups (local population) in the zone of activity impact	Ionizing radiation	There are no permanently living population in the sanitary protection zone and economical activity is limited as well.	(-)	Impact within the sanitary protection zone will be minimal and will not exceed the limits prescribed by radiation protection requirements (see Chapters 5 and 9). Outside the sanitary protection zone impact can be considered as insignificant.
2. Personnel	Ionizing radiation	Personnel of INPP Reactor Workshop, personnel of ISFSF	(-)	Personnel exposure due to existing and additional operations connected with proposed economic activity will not increase and can be controlled and limited using, where appropriate, shielding, remote-controlled equipment, proper operational procedures etc. Possible impact will be optimized during Technical Design and will not exceed the limits prescribed by radiation protection requirements (see Chapters 5, 8, 9).
3. Uses of activity products	Undiscriminated			
4. Persons with slender income	Undiscriminated			
5. The jobless	Undiscriminated			
6. Ethnical groups	Undiscriminated			
7. Persons sick with same diseases (dependence on drugs, alcohol etc.)	Undiscriminated			
8. Disables	Undiscriminated			
9. Single persons	Undiscriminated			
10. Refugees, emigrants and persons seeking political asylum	Undiscriminated			
11. The homeless	Undiscriminated			
12. Other population groups (arrestees, persons of special occupations, manual hard workers etc.)	Undiscriminated			
13. Other groups (single persons)	Undiscriminated			

Table 6.9-3. Assessment of features of impacts

Impact induced by factor	Impact features									Comments and remarks
	Number of persons under the impact			Evidence (possibility), strength of the evidentiary material			Duration			
	Up to 500 persons	501–1000 persons	More then 1001 persons	Clear	Probable	Possible	Short (up to 1 y)	Medium (1–3 y)	Long (more then 3 y)	
1. Ionizing radiation	X				X				X	Possible local impact near the ISFSF. Possible exposure not exceeds the limits prescribed by radiation protection requirements. The impact of proposed economic activity beyond of sanitary protection zone can be considered as insignificant.
2. Generation of dust and local air pollution	X				X			X		
3. Controlled slight pollution due to utilities type sewage release to environment			X		X				X	
4. Soil erosion	X					X		X		
5. Noise	X			X				X		
6. Waste management	X			X					X	
7. Impact on landscape			X	X					X	

7. ANALYSIS OF ALTERNATIVES

The alternatives considered are separated into three groups (location, spent nuclear fuel handling and storage system, and storage facility design concept) and are discussed below.

7.1. Location Alternatives

Transfer of spent nuclear fuel RBMK to other countries because of a number of technical and political reasons is not possible either now or in the near future. Therefore the Government of the Republic of Lithuania has decided to start the design of the spent nuclear fuel storage facility at the INPP region.

Four alternative locations have been considered in the Ignalina NPP region, namely in Zarasai and Dysnai areals, near Didziasalis and in the territory belonging to the INPP.

The Zarasai site is situated at the boundary of Zarasai and Turmantas municipalities (“seniunija”); the shortest distance from the INPP (country road with asphalt cover) is 27 km (through Visaginas bypass – 35 km). Alternative roads exist through Turmantas or Visaginas bypass. The main road is extending across two preserved areas. The site is not far from Zarasai town (5 km) and large suburban Marguciai settlement (3 km). There are no preserved territories in the immediate vicinity. There are a few sectors of ecological network. The state border is 4 km away.

The Dysnai site is at the boundary between Kazitiskis and Naujasis Daugeliskis municipalities (“seniunija”); the distance from the INPP (country and local roads) is 45 km. There are no alternative (including railway) roads. The main roads are extending through 2 large settlements. There are no preserved territories on way and in the immediate vicinity of the site. There are a few hill-forts. A necessity for archeological examination of the territory may arise.

Didziasalis site is located by the eastern edge of large settlement Didziasalis with the population of 2.4 thousand people; distance from the INPP (country road with asphalt cover) is 85 km (the shortest road – 70 km). No railway available. The main road crosses 6 large settlements. A short section of the road extends along the edge of the national park. Yet, the road crosses no preserved territories; there are also no preserved territories near the site. The state border is not far away (1 km).

Characteristics of the site in the territory belonging to the INPP are presented in Subsection 1.4 and Section 4.

For the determination of an appropriate area for the proposed economic activity the following criteria had been considered:

- Public acceptance: the use of an area within the territory belonging to the INPP is more favorable than the erection of a new controlled area for nuclear use outside of the INPP territory;
- Short transport distance between the Reactor Units and the ISFSF, avoiding transport in public areas;
- No interference with other facilities and relatively far from facilities, which potentially could affect safety of ISFSF;

- Availability and possibility to connect to the existing auxiliary systems for technological media (electrical power, cold and hot water, sewage, telephone, alarm, etc) supply;
- Availability of qualified personnel (personnel training will be required);
- Availability of other INPP structures and organizations (fire protection, emergency response, physical protection, maintenance, service, nuclear laundry, etc);
- Existing INPP environmental monitoring systems can be used after minor modification;
- Existing facilities for radioactive waste treatment and storage can be used without any necessity of expansion;
- Suitability of site geotechnical characteristics.

These criteria clearly led to the decision to erect the ISFSF within the INPP territory.

Other INPP facilities for spent nuclear fuel and radioactive waste storage are located in the INPP site or within the INPP territory. The capacities of existing facilities for supplying with resources and for radioactive waste treatment and storage are large enough to cover also the additional demand of the ISFSF. For delivery of building materials (non radioactive transports) the existing traffic infrastructure (road network in the vicinity of INPP) can be used. Its capacity is large enough to cover this additional demand.

The soil characteristics of the site are favourable for the construction of the ISFSF. Therefore excavation will not cause unexpected problems or impact to the environment.

Location alternatives outside the INPP territory would lead to usage of additional land resources, result in higher risk due to extended transportation of spent nuclear fuel and additional costs for establishing the required auxiliary, monitoring and maintenance systems. Furthermore, these systems are already available at INPP site. The negative impact on environment would be higher for all other possible alternative locations outside the INPP territory.

In addition, some extra exposure would be contributed and additional members of population would be subjected to radiation exposure due to spent nuclear fuel transportation from INPP to remote ISFSF location. According to the proposed economic activity it is intended to construct the ISFSF within the INPP sanitary protection zone. There are no villages, no farmland and no population. Comparison of the radiological impact to general public of the proposed economic activity with the radiological impact to general public of the alternative locations has clearly shown that the optimization principle would not be met unless the new ISFSF is built in close vicinity to INPP.

7.2. Spent Nuclear Fuel Handling and Storage System Alternatives

There is the possibility in the field of spent nuclear fuel management to choose between reprocessing and direct disposal.

Reprocessing is not foreseen by Lithuanian legislation. Also, presently there is no installations in the world concerning RBMK spent fuel reprocessing. Taking into account the fact that the first demonstrations of the direct disposal of spent fuel are expected only after the year 2020, long-term storage will be the primary option for the management of spent fuel all over the world at least until the middle of this century.

The storage of SNF in the ISFSF is a temporary solution before the final SNF route will be defined and necessary actions will be implemented. The national Strategy on Radioactive Waste Management [1] foresees several options to be investigated prior the final decision will be taken:

- Possibility to dispose off the SNF in the national deep geological repository;
- Possibility to dispose off the SNF in the regional deep geological repository;
- Possibility to transfer and dispose off the SNF in other countries;
- Possibility to safe store the SNF for 100 years and more.

The proven wet and dry long-term storage concepts are expected to continue to be used in the future. Three alternatives have been investigated which assume the wet and dry long-term storage of spent nuclear fuel.

7.2.1. Zero Alternative

Since the storage capacity of the existing spent nuclear fuel dry storage facility is finished, no further amount of spent nuclear fuel can be accepted by existing storage facility at INPP. The "zero" alternative stands for a spent nuclear fuel wet long-term storage in existing pools at Reactor Units without the construction of the new ISFSF. This alternative would block up the decommissioning of the INPP because the decommissioning of main systems can only start when spent nuclear fuel is fully removed from Reactor Units. Even Deferred Dismantling options consider removal of the fuel, removal of the operational waste and emptying of the circuits early in the decommissioning phase in order to obtain a significant reduction in the hazards associated with the installation.

In its resolution No. 1848, the Government of the Republic of Lithuania stated that: "… in order to prevent the heavy long-term social, economical, financial and environmental consequences… Decommissioning of Unit 1 of the State Enterprise Ignalina NPP shall be planned and implemented in accordance with the Immediate Dismantling Strategy". Immediate Dismantling implies the removal of all radioactivity inventories from the site as soon as possible. All equipment inside the controlled area and also inside the non-nuclear installations has to be dismantled. The radioactive material should be conditioned and packaged in a form which ensures safe conditions for the storage and/or disposal of this material.

7.2.2. First Alternative

In the Strategy on Radioactive Waste Management [1] it is foreseen to store the spent nuclear fuel in the dry storage facilities in order that the Ignalina NPP decommissioning activities would be performed effectively.

The first alternative was to expand the storage capacity of the presently existing spent fuel dry storage facility.

The advantage seems to be that there would be only one spent fuel long-term storage facility. But this first alternative was rejected because the site of the existing facility had no additional space enough for storage of about 16800 SFA.

7.2.3. Second Alternative

The second alternative is to construct the new spent nuclear fuel dry storage facility. This alternative was approved by the Government [2].

The ISFSF will be designed for safe and secure storage of the spent fuel from Ignalina NPP in full compliance with Lithuanian and international requirements, for a period at least of 50 years. Long-term storage is ensured by use of cask materials resistant to aging, by excluding of corrosion damage to fuel rods and casks and by limiting the cladding temperature below the threshold of relevant creeping.

It will be possible to transport the spent fuel away from the ISFSF site after interim storage without repackaging the fuel. The CONSTOR® RBMK1500/M2 type casks will be designed to meet requirements for B(U) packages according to IAEA Regulations for the Safe Transport of Radioactive Material [2] and therefore will be suitable for the off-site transport.

The prolongation of spent nuclear fuel storage period is possible but it is not included in the scope of proposed economic activity. The objectives and timetables for the implementation of nuclear waste management and for the related research and planning are defined in a policy decision of the Strategy on Radioactive Waste Management [1]. Concerning spent nuclear fuel this strategy indicates that in order to assure spent nuclear fuel disposal it is essential to:

- Analyze the possibilities to have in Lithuania a deep geological repository for spent nuclear fuel and long-lived radioactive waste;
- Analyze the possibilities to create a regional repository taking joint efforts of a few countries;
- Analyze the possibilities for disposal of spent nuclear fuel in other countries, and to estimate the justification for a price of such disposal.

Interim storage of spent nuclear fuel is foreseen only on the territory of Lithuania. The new ISFSF will be constructed in accordance with the modern environmental requirements using state-of-the-art technologies and equipment. Another spent fuel dry storage facility at Ignalina NPP is being operated for years so experienced personnel is also available.

7.3. Storage Facility Design Alternatives

There are a number of different technologies available for the dry storage of spent fuel and within each of these technologies there are several modifications. Dry storage technologies include storage only casks (unventilated and ventilated concrete casks), storage and transport (dual purpose) casks (metal, metal-concrete casks), vaults, horizontal and vertical concrete modules, silos or concrete canisters, subsurface dry caisson or drywells, and multipurpose canister systems.

Spent fuel storage systems can be implemented with forced cooling air circulation; however, if natural convection is used, the use of certain components (e.g. pumps and ventilators) is reduced, with corresponding cost reduction and higher operational reliability. As a rule, maintenance of such systems is simpler, and their operational life-time is longer.

For the systems, which require a loading of the thin walled canister with spent fuel assemblies from the transfer cask to the storage unit outside of the reactor building, possible problems in case of accidents should be mentioned. The thin walled canister is the single barrier against activity releases in these cases.

Lithuania has chosen the cask concept for ISFSF. A storage site for a large number of storage casks is relatively small. Casks typically require about 1.5 m^2 of storage pad per metric ton (Mg) of heavy metal (HM) for vertical orientation of the cask. Storage of the casks horizontally would require significantly more area per Mg HM.

Other cost benefits of cask storage system for spent fuel are: no cost for secondary waste, low operating costs for manpower and equipment, low costs for decommissioning, cask can be delivered within a relatively short period of time. Individual casks can be added as needed to expand the storage capacity to include the entire fuel discharge of the Reactor Units.

Dual purpose (storage and transport) casks take the dry storage cask concept one step further by using the cask to transport the spent fuel away from the ISFSF site at the end of the storage period without repackaging the fuel. Since the possibility to have the final repository in the territory of Lithuania is still not clear Lithuania must have the possibility to transport the stored spent fuel to the final repository without repackaging the fuel.

The CASTOR RBMK-1500 and CONSTOR RBMK-1500 casks were licensed for storage by the VATESI. Each cask represents a closed and independent safety system, fulfilling all safety-relevant requirements for both normal operational and hypothetical accident conditions.

The existing INPP dry interim storage of spent fuel is licensed for storage in total of 98 CASTOR RBMK-1500 and CONSTOR RBMK-1500 casks. So it was decided to continue good practice with dual-purpose dry type SNF storage technologies.

The CONSTOR® RBMK1500/M2 cask will meet the following design principles which guarantee that the impact to the environment under normal operation will be very low:

- Double tightness barrier system;
- Zero activity release concept;
- Zero secondary waste concept;
- Passive cooling concept;
- No contact of the cooling air with high radiation fields;
- Ability of easy repair concept for a defect tightness barrier.

8. MONITORING

8.1. 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 monitoring program is originated on the base of Lithuanian radiation protection standards [1], Law on Environment Monitoring [2] and regulatory documents on the environment [3, 4]. Monitoring data is being summarized and submitted to competent institutions annually.

The INPP Environment Monitoring Programme [5] specifies requirements for:

- Monitoring of water quality in the lake and of groundwater (physical – chemical parameters);
- Monitoring of nuclides concentration in the air and atmospheric fallouts;
- Monitoring of radioactivity of sewage and drainage water from the INPP site;
- Monitoring of radionuclide release into the air;
- Meteorological observations;
- Monitoring of nuclides concentration in the lake and underground water;
- Dose and dose rate monitoring in the sanitary protective area (3 km) and radiation control area (30 km);
- Monitoring of nuclides concentration in the fish, algae, soil, grass, sediments, mushrooms, leaves;
- Monitoring of nuclides concentration in food products (milk, potatoes, cabbage, meat, grain-crops).

The chemical content of sewage (domestic discharges) from the territory of industrial site is controlled by "Visagino energija".

The radiological measurenmets performed according to INPP current Environment monitoring Programme are summarized in Table 8.1-1.

The proposed ISFSF site is within INPP performed environment monitoring zone. Currently exiting at INPP Environment Monitoring Programme does not foresee monitoring of ISFSF. Integration of the ISFSF environment monitoring system into existing INPP environment monitoring system will be performed during preparation of the Technical Design.

Table 8.1-1 Summary of INPP current radiological monitoring system [5]

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

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
						object
			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.	$1.85 \div 3.7 \times 10^5$ 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.	$0.1 \div 3 \times 10^3$ 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.	$0.1 \div 3 \times 10^3$ Bq/l
			Volume activity of radionuclides	Spectrometric	1 per two weeks– water from installation 141; 1 per quarter – water of heating networks.	$0.74 \div 1.85 \times 10^8$ 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.	$1.5 \times 10^{-6} \div 15$ Bq/m^3
			Sr-90	Radiometric	2 times per year (in winter and summer) - atmospheric	$3 \times 10^{-5} \div 3 \times 10^2$

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
					air at points of permanent surveillance.	Bq/m^3
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	0.3 Bq/l

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
					SFSF site, water of industrial site PLK-1,2, PLK-3, PLK-SFSF, drainage water of INPP industrial site.	
			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
			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 8.1-1	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

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
					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
			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 8.1-2.	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 isotops (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	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	3 Bq/kg

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
		Druksiai are indicated in Figure 8.1-2.			Druksiai lake.	
			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
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 (mollusca); 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 (mollusca); 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

No.	Component of monitoring	Number of measuring points	Measured parameters	Measuring method	Monitoring object / location and periodicity	Measuring limits / detecting limit*)
			Activity of α nuclides	Radiochemical segregation	1 per year (in summer) – organisms of aquatic environments (mollusca).	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 radwaste treatment and bitumising building in INPP;
- D1, D2 – IAE 1 and 2 reactors control, electrical and deaerator rooms;
- Installation 153 - venting stack of the radwaste 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.

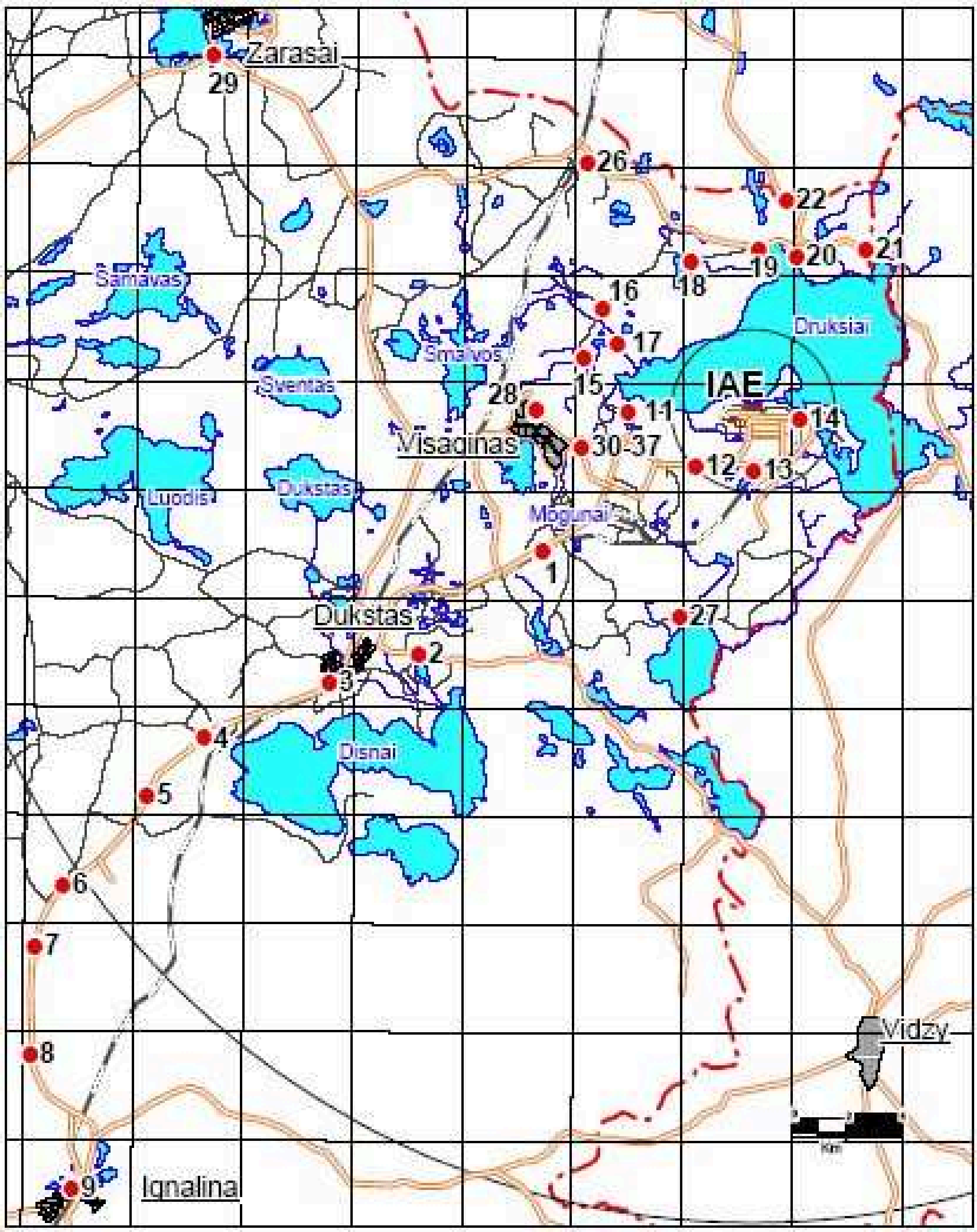


Figure 8.1-1. Location of thermoluminescent dosimeters around the INPP

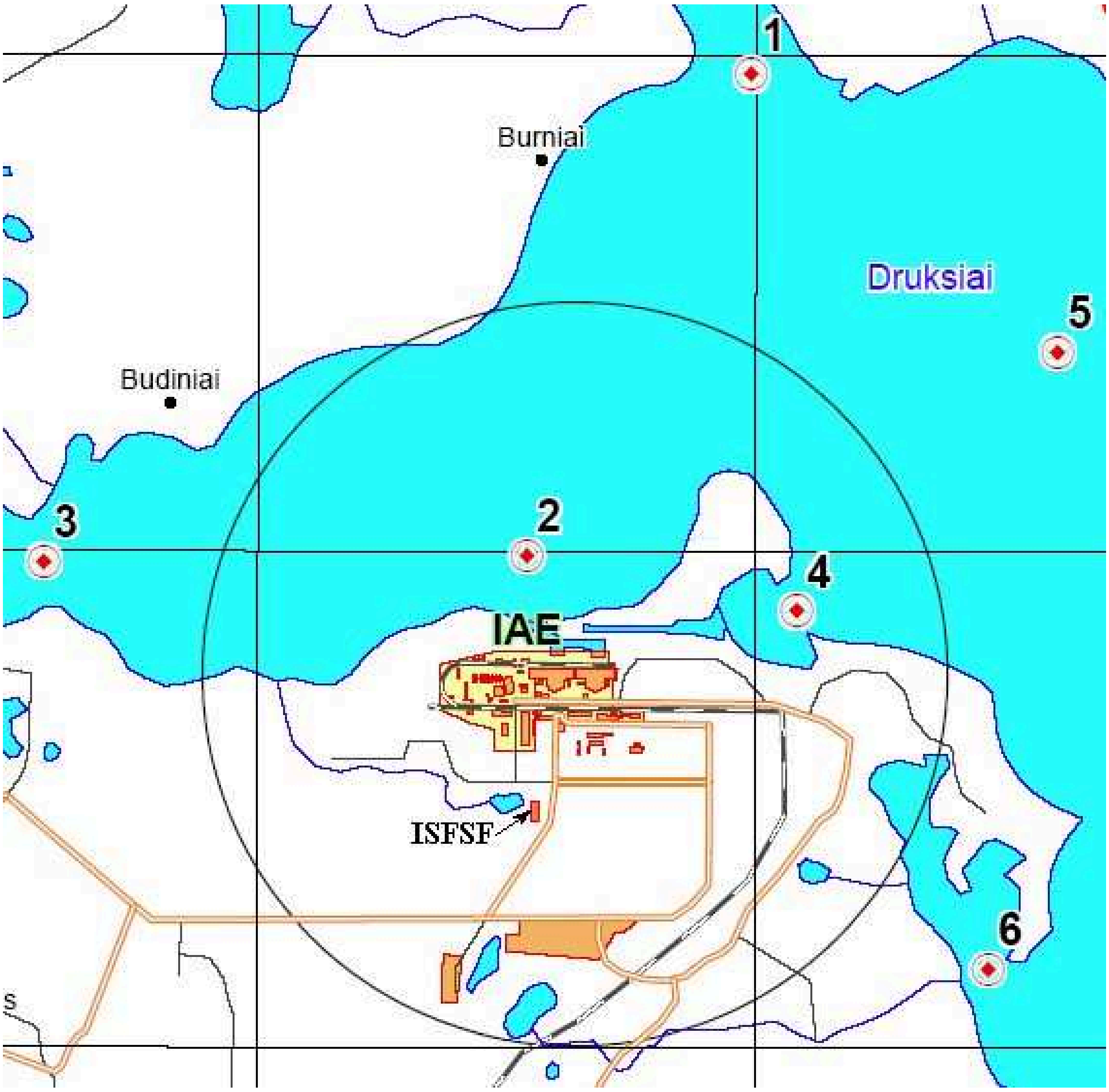


Figure 8.1-2. Sampling points in Lake Druksiai

8.2. Main Results of Radiation Monitoring in the INPP Region and ISFSF site

This subsection contains a description of INPP environment present radiological conditions based on monitoring data results [10]. Radiological characteristics at ISFSF site are presented based on INPP report [11].

8.2.1. Radioactive Releases into Atmosphere

Annual releases of radioactive inert gases, aerosols and I-131 into the atmosphere from INPP are given in Table 8.2.1-1.

Table 8.2.1-1. Annual releases of radioactive inert gases, radioactive aerosols and I-131 into the atmosphere from INPP [10]

Year	Radioactive inert gases, Bq*		Radioactive aerosols, Bq*		Radioactive I-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	5.59×10^{8}	0.12	6.81×10^{9}	1.98
2006	3.12×10^{13}	0.22	6.91×10^{8}	0.07	7.70×10^{9}	0.78

* - Data of operational twenty four hours control as per device RKS-07 including beta and gamma nuclides.
** - Total activity value of I-131 including molecular, organic and aerosolic fractions.
*** - Permissible releases (PR).

Notes:

1. From 1992 till 2000, permissible releases were defined by "Permission on the Use of Natural Resources" (registered number INPP 0-654).

2. From 2001 till 2005, permissible releases were defined by "Permission on the Use of Natural Resources" (registered number INPP V-12).

3. From 2006 permissible releases were defined by "Permission on the Release of Radioactive Substances into the Environment" (No. 1, 2005-12-16).

As Table 8.2.1-1 shows, radioactive releases into the air of INPP area did not exceed a few percents of values of permissible releases.

Calculated annual effective dose to the critical group member of population stipulated by releases into the atmosphere not exceed 1.9×10^{-6} Sv in year 2004 and 1.4×10^{-6} Sv in year 2006.

8.2.2. Radionuclides Concentration in the Atmospheric Air

Radionuclide inventory in the atmospheric air of sanitary protected zone and monitoring zone was conditioned mainly by Cs-137 and Be-7. In 2005, concentration of Cs-137 in the atmospheric air was the same both in sanitary protection and monitoring zones and constituted in average 0.2×10^{-6} Bq/m^3. According to the INPP report [11], average concentration of Cs-137 in the atmospheric air of the ISFSF site during year 2005 was 0.21 $\times10^{-6}$ Bq/m^3. Only insignificant concentrations of INPP-caused radionuclides Mn-54 and Co-60 were detected in the air of sanitary protection zone and ISFSF site.

In 2006, concentration of Cs-137 in the atmospheric air of monitoring zone constituted in average 0.37×10^{-6} Bq/m^3.

Presence of Cs-137 in the atmospheric air is connected with global pollution of atmosphere, because such radionuclides as Co-60 and Mn-54 were not found in the atmospheric air of supervised area although their concentration in releases was 1.5 to 2 times higher than concentration of Cs-137.

8.2.3. Radionuclides Concentration in the Atmospheric Precipitation

Maximum value of INPP-caused radionuclides concentration was in the atmospheric precipitation onto the area adjacent to Solid Radwaste Storage Facility, landfill of utility type waste and Chemical Department. In this area, radionuclides concentration (excluding K-40 and Be-7) was 1.1×10^{4} Bq/(km$^2\times$day) in year 2005 and 0.11×10^{4} Bq/(km$^2\times$day) in year 2006.

Average concentration of radionuclides in the atmospheric precipitation (snow) of monitoring zone (excluding K-40 and Be-7) was 0.16×10^{4} Bq/(km$^2\times$day) in year 2005 and 0.29×10^{4} Bq/(km$^2\times$day) in year 2006.

According to the INPP report [11], average concentration of Cs-137 in the atmospheric precipitation (snow) at the ISFSF site during year 2005 was 0.11×10^{4} Bq/(km$^2\times$day).

8.2.4. Radioactive Discharges into Aquatic Environment

There are 6 channels running to the Druksiai lake mainly for storm water drain from the INPP site and site surrounding area. Concentrations of Sr-90 are approximately the same in water of these channels. These concentrations are on one level with background concentrations. Alpha radionuclides are not found in silt of the purification facility.

Release of tritium through channels into Lake Druksiai was 9.2×10^{11} Bq in year 2004 and 5.8×10^{11} Bq in year 2006.

According to the INPP report [11], the gamma-emitting radionuclides of technogenic origin have not been found in the samples of water taken on March 2006 at the ISFSF site.

Calculated annual effective dose to a member of the critical group of the population stipulated stipulated by all liquid discharges from INPP was 1.42×10^{-6} Sv in year 2004 and 0.15×10^{-6} Sv in year 2006. The release of tritium constitutes 0.12×10^{-6} Sv in the dose for year 2004 and 0.02×10^{-6} Sv in the dose for year 2006.

8.2.5. Radionuclides Concentration in the Water of Observation Wells

Now there are 69 underground water observation wells – 50 wells in the INPP site and 19 wells around the existing SFSF. Insignificant amounts of Cs-137, Co-60, Sr-90, Mn-54 and Nb-95 were found in some observation wells of the INPP site. Their activity was on the same level with background concentration values.

The increase of activity of tritium is observed in water of some observation wells around the existing Solid Radwaste Storage Facility (SRWSF) and landfill of utility type waste since 1996. Since 1998 the increase of activity of tritium is also observed in the water of channel separating SRWSF and ladfill facility. The yerly average activity of tritum in the observation wells was up to 4100 Bq/l. The yearly average tritium activity in the channel water fluctuates from 6800 to 9800 Bq/l in the years 2002-2006.

The reason seems to be leaching of tritium from the existing existing SRWSF or/and landfil facility. A new project (i.e. construction of New Solid Waste Management and Storage

Facility at Ignalina NPP) is implemented at INPP, which includes retrieval of all radioactive waste from existing SRWSF and cleaning of waste storage compartments.

8.2.6. Radionuclides Content in the Soil, Flora, Bottom Sediment and Phytogenic and Animal Food Products

In 2006, radionuclide content in the soil, flora and bottom sediments remained on the level of previous years. In phytogenic and animal food products, INPP-caused radionuclides were not found.

In the bottom sediment of Druksiai lake, availability of Pu-239 and Pu-240 was found. 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 are 0.18 Bq/kg [10].

According to the INPP report [11], the main contribution to activity of the soil samples taken at ISFSF site on March 2006 is introduced by radionuclides of natural origin K-40, Ra-226 and Th-232. In the soil of the ISFSF site, the concentrations of 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.

8.2.7. Gamma Background

Dose rate in the monitoring zone in year 2006 measured by fixed gamma detectors of “Skylink”system varied in range of 0.062-0.156 μSv/hr (in 2004 was 0.107 μSv/hr). The same dose rate in the sanitary protected zone was 0.066-0.187 μSv/hr.

Dose rate was measured at seven points of the ISFSF site with portable dosimeter DRG-01T on the surface of ground and at the distance of 1 m from the ground. At the same points of the ISFSF site, the uninterrupted dose rate measurements were performed at the distance of 1 m from ground with highly sensitive scintillation dosimeter SILENA “SNIP 204G”. Inaccuracy of dose rate measurements with dosimeter DRG-01T through Co-60 and with dosimeter SILENA “SNIP 204G” through Cs-137 is within ± 15 %. Average value of dose rate measured with 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. Average value of dose rate measured with dosimeter SILENA “SNIP 204G” at the distance of 1 m from the ground is 0.08 μSv/hr [11].

There was measured gamma radiation with high sensitivity dosimeter in the vehicle in region by routine route. By these measurements there are no increase of backround radiation. Average dose rate in region of INPP was 0.063 μSv/hr in 2006.

There are 27 TLD dosimeters for measuring annual efective dose in region of INPP. Mesured average annual dose due to gamma irradiation (including natural background radiation) was 0.62 mSv in year 2006 and 0.8 mSv in year 2004.

8.2.8. Exposure of Population due to Operation of INPP

Annual effective doses to the critical group member of population stipulated by radioactive releases from of INPP are summarized in Table 8.2.8-1.

Table 8.2.8-1 Annual effective doses to the critical group member of population stipulated by radioactive releases from of INPP [10]

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}	2.69×10^{-6}

8.3. Radiation Monitoring System of ISFSF

Radiation monitoring system of ISFSF will be designed to ensure safe and accurate monitoring during both normal and accident conditions. It will be integrated into INPP radiation monitoring system. It can also be operated in independent mode. The monitoring system of ISFSF will meet all requirements of Lithuanian legislation and regulations.

Monitoring system will assure:

- Personal dosimetry;
- Contamination control in the controlled access zone;
- Measurement and control of spent nuclear fuel storage conditions;
- Measurement of radioactive releases from the ISFSF site;
- Measurement and control of gamma and neutron dose rates.

8.3.1. Personal Dosimetry

Personal dosimetry of the personnel exposure includes the following:

- Gamma-exposure dose monitoring;
- Neutron-exposure dose monitoring;
- Surface contamination level monitoring of skin, clothes, individual protectors.

The personal dosimetry of external exposure to the personnel will be performed with the help of personal dosimeters.

The stationary whole body monitor will be used when personal contamination is to be checked. It is foreseen that there will be whole body monitor, consisting of portal monitor, and monitor for extremities and clothing.

8.3.2. Contamination Control in the Controlled Access Area

Beta/gamma surface contamination in the controlled access area will be measured by the mobile devices.

It is foreseen that there will be portable systems for simultaneous (parallel) measurement of alpha, beta and gamma surface contamination. A wipe test measuring position for the manual evaluation of wipe tests is also foreseen.

8.3.3. Dose Control in the Storage Hall

A stationary neutron/gamma dose rate control system will be installed in the Storage Hall.

Both gamma and neutron radiation will be monitored separately by the relevant stationary detectors. The values will be displayed locally and also will be stored and processed in the ISFSF Radiation Assessment and Control System, where all signals from the ISFSF stationary detectors are collected. The control of this stand-alone system is made from the ISFSF Control Room. The warning lights in the Storage Hall and in the entry to the Storage Hall will be also controlled through this system, which permits connection to the existing INPP radiation monitoring system for the transfer of information regarding radiation levels.

Portable systems will be used for determination of gamma dose rate in various points from the casks in the Storage Hall.

8.3.4. Temperature Monitoring on the Outer Surface of Casks

Approximately 50 casks in the Storage Hall will be equipped with an electric resistance thermometer on the outer surface in the middle of the cask height. This is foreseen for one cask in each second row at a different position. All temperature signals will be controlled by a monitoring system and displayed in the control room of the ISFSF.

8.3.5. Airborne Activity Monitoring in the Storage Hall

Specific activity (radioactive aerosols and beta-radioactive nuclides of noble gas) in the Storage Hall controlled area will be measured.

It is foreseen that the stationary measuring device will be used for the measurement of the specific activity of beta-radioactive nuclides of noble gases (noble gas monitor).

The activity of inert gases in the air will be measured continuously with the help of fixed instruments which take the air at the roof level. The amount of airborne activity will be measured by monitoring aerosols trapped on a filter.

This measurement system will measure both beta radiation from inert gas nuclides and activity of released aerosols. The monitor will continuously measure the volume activity of inert gases in air. Monitoring of the released active aerosols will be carried out by the evaluation of aerosol filters activity (Fig. 8.2-1).

Stationary noble gases monitoring system will operate in “on-line” mode.

The mobile aerosol monitors will also be used for measuring radioactivity bonded on aerosols. Depending on the operating mode, selected measurements of fission product activity or activation products bonded on aerosols may be made.

8.3.6. Monitoring of Discharge from Fuel Inspection Hot Cell and Cask Service Station

The emission of the stack, comprising Hot Cell and Cask Service Station ventilation exhaust air, will be monitored continuously for emission of beta/gamma aerosols, Iodine and Tritium/noble gases. The measurement equipment itself will be placed near the stack to avoid long distances to the sampling points (they are located inside the stack). The details will be presented in Technical Project.

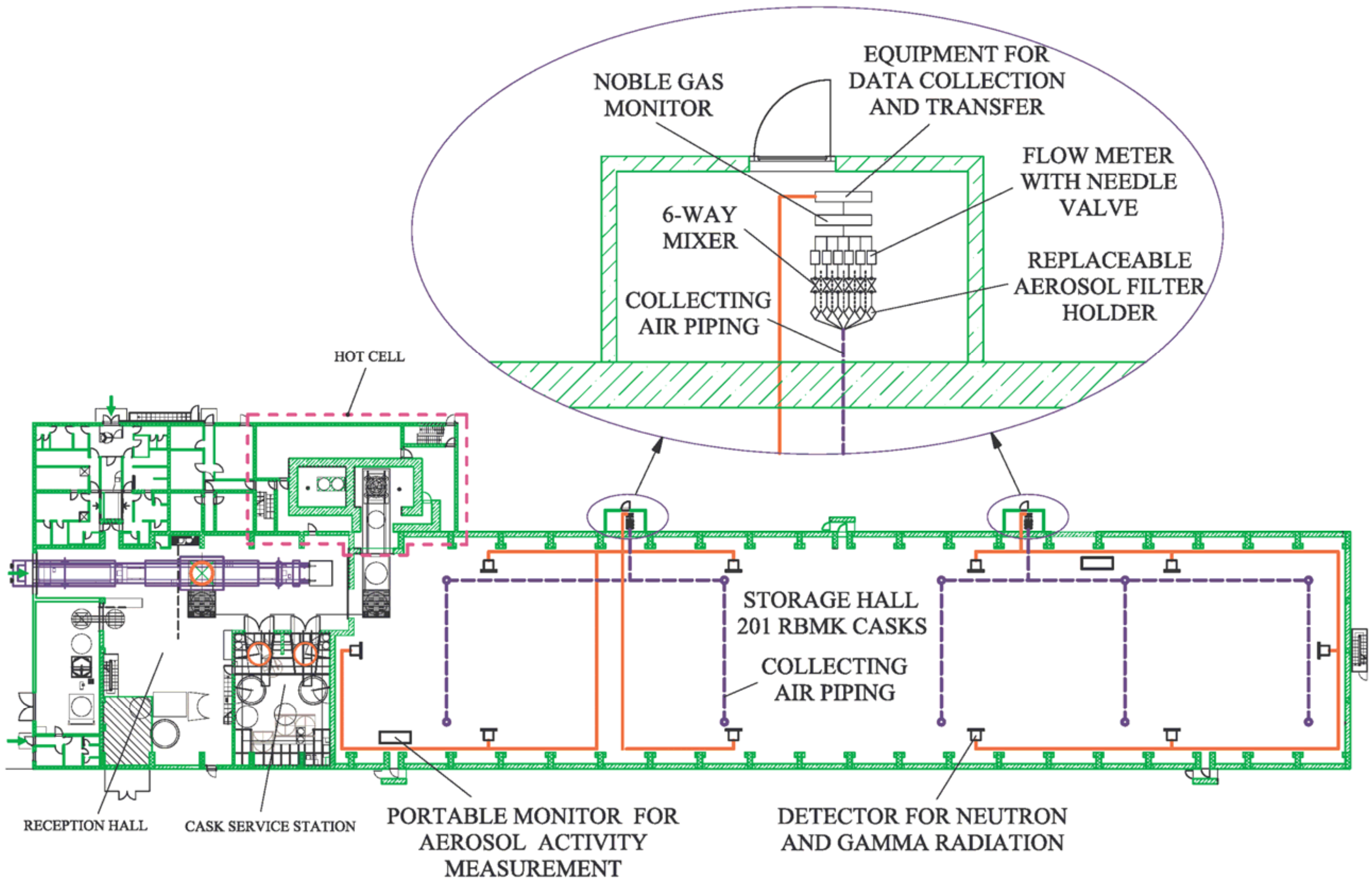


Figure 8.2-1. Concept of airborne activity monitoring in the Storage Hall

8.3.7. Monitoring of Liquid Radioactive Waste

Remains of water used for ultrasonic testing of cask closure weld, the waste water from the shower room and washbasins from controlled access area (Reception Hall) and waste water from controlled area cleaning activities will be collected in a receiving tank located in the ISFSF. The waste water from the tank will be chemically and radiologically monitored. System for collection and monitoring of liquid radioactive waste will be designed during preparation of the Technical Design.

8.3.8. Monitoring of Underground Water

The ISFSF cask storage hall is without any radioactive contamination due to the safe containment of the casks.

ISFSF will be designed in such a way that there will be no uncontrolled radioactive discharges into the environment.

Nevertheless survey boreholes (wells) for monitoring underground run-off water are foreseen around the ISFSF as part of required environmental monitoring. The underground water monitoring programme for boreholes to be arranged at ISFSF site will be developed in accordance with normative document [12] and methodological recommendations [13] and presented to the Geological Survey of Lithuania for approval. Environment Monitoring Programme [5] can be updated only on the basis of this programme.

The detail analysis of boreholes needed to be arranged at ISFSF site for underground water monitoring will be presented in Technical Design.

8.3.9. Monitoring of Storm Drain Water

Storm (surface) drain water from the ISFSF site will be channelized into the connecting point of the INPP industrial-storm water system. Chemical composition and radioactivity of storm drain water from the ISFSF site will be monitored.

The scope of storm drain water monitoring will be defined by the updated Environmental Monitoring Programme [5], which is coordinated by the Ministry of Environment and existence of which is a necessary condition for obtaining a "Permission on Integrated Prevention and Control of Pollution" [14]. For storm (surface) drain water, the requirements of the normative document [15] will be applied.

Estimation of chemical content in the samples will be carried out according to the methods approved by the Ministry of Environment.

8.3.10.Dose Monitoring Around the ISFSF Site

Effective exposure dose will be measured using stationary dosimeters and portable devices. Stationary dosimeters will be located in different directions and at different distances from the ISFSF. Integration of the effective exposure dose monitoring system into existing INPP environment monitoring system will be performed during preparation of the Technical Design.

The monitoring system of ISFSF will meet all requirements of Lithuanian legislation and regulations.

9. EMERGENCY SITUATIONS

Potential emergency situations (risks) resulting from proposed economic activity and which could lead to environmental impact are addressed in this chapter of EIA Report with purpose to demonstrate that proposed economic activity by virtue of its nature and environmental impacts may be carried out in the chosen sites. Therefore, activities and operations, which could cause potential impact on environment, are subject of investigation and assessment.

Emergency situations, which could lead to damage of fuel cladding, release of activity and in following to radiological exposure of personnel and/or general public are of primary concern. For this proposed economical activity most of potential emergency situations can cause radiological and non-radiological or only non-radiological consequences, for example drop or collision of SNF bundle. In case of light accident only non-radiological consequences like stop in operation are expected. In case of drop of SNF bundle from considerable height a damage of a certain number of fuel rods might be relevant. Accidents with non-radiological consequences as a rule lead to considerable lower impact and therefore are enveloped by consequences of radiological accidents.

Risk analysis addresses and other events which do not necessary lead to radiological consequences however could be expected during proposed economic activity or could be considered as typical for proposed design concept (i.e. malfunction in operation of cooling ventilation system).

Already licensed operations, which will become integral part of proposed economic activity (i.e. transfer of 32M basket with spent nuclear fuel using existing INPP equipment etc.), are outside the scope of this risk analysis. The safety of such operations is justified in relevant studies, which are approved by competent authorities. Already licensed systems will operate within prescribed limits without violating of licensed conditions.

Summary of potential impact on the environment due to emergency situations and conclusions made can be directly found in Chapter 9.4.

9.1. Potential Emergency Situations and Risk Analysis

The emergency situations and their potential risks are assessed following recommendations of normative document [1]. Requirements of the normative document VATESI [2] are also considered. The risk assessment as presented in EIA Report shall be considered as preliminary and does not substitutes necessity for 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 Technical Design and shall be considered in Safety Analysis Report.

The results of risk analysis are presented in Table 9.1-1. Table structure and content follow recommendations of normative document [1]. Requirements for classification of consequences of potential accident (for life, environment and property), accident development speed and probability of accident occurring are explained below. More detailed explanations can be found in [1]. In addition, a typical example is provided explaining in details how the accident seriousness (classes L, E, P, S) and risk level (classes Pb, Pr) have been defined.

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

Practical example: Preliminary risk evaluation for severe accident during operation of fuel bundle handling equipment (FBHE) - fuel bundle heavy collision (with cask or with any other massive object) or fuel bundle drop (from height exceeding safe drop height) leading to breach or damage of certain number of fuel rods

Parameter	Discussion / Evaluation	Conclusion / Classification
Accident probability	Probability of accident depends on FBHE design (such as breaking and breaking control system, over-speed protection, over-load protection, over-travel / over-hoist protection, use of dual hoisting systems to ensure load isn't dropped if one system fails, design of control / monitoring system etc.) and managerial measures (supervisory tasks, measures to reduce human error factor etc.). Probability of accident cannot be precisely assessed at the stage of conceptual design and EIA. Therefore a typical value for nuclear design general lifting equipment is used for preliminary evaluation of FBHE failure / accident probability: $P_1 = 1\times10^{-5}$ per single operation. Value could be considered as conservative as lower probability might be assured by design depending on FBHE safety classification and safety class corresponding design requirements. Total number of fuel bundle re-loadings: N = 15000; Accident probability (for whole FBHE activity lifetime): $$P_A = P_1 \times N = 0.00001 \times 15000 = 0.15$$ Years of FBHE operation T = 7; Annual accident probability: $$P_{AY} = \frac{P_A}{T} = \frac{0.15}{7} = 0.0214$$ Accident frequency, (years of operation to accident) $$Pb = \frac{1}{P_{AY}} = \frac{1}{0.0214} = 46.7$$ Accident is beyond operation time frame.	Accident is beyond operation time frame. Accident probability class (Pb) – 3 (i.e. quite probable, once every 10 – 100 years).
Accident seriousness to the life and health	In general a limited number of fuel rods would come into direct contact with collision object. These rods will absorb maximum of impact energy. Therefore severe damage (i.e. cladding rupture, release of radioactive gases from fuel rod cavity, loss of fuel pellets) of a few fuel rods could be expected during the accident. For most conservative assessment of accident consequences a damage of all 18 fuel rods is postulated. Radiological consequences of such accident are assessed in chapter 9.3. Results are as follows: Dose to the member of public < 0.01 μSv ($<10^{-8}$ Sv) – is considerably below (by factor of 100) dose limit applicable to exempted practices and therefore is considered as insignificant. Dose to member of personnel < 1 mSv (10^{-3} Sv) – is below 5 days dose limit for normal operation and therefore is considered as unimportant. The onetime 1 mSv dose (up to 50 mSv in exceptional cases) is permissible for normal maintenance activities [3]. No immediate accident management actions which could require direct involvement of personnel will be necessary. Storage pools water is cleaned using existing INPP equipment. Accident consequences management activity can be organized considering existing radiological safety requirements.	Class of consequences for life and health (L) – 1 (unimportant, temporary slight discomfort)
Accident	For most conservative case (i.e. damage of all 18 fuel rods, see	Class of consequences for

seriousness for the environment	explanations above) release of airborne activity, cf. chapter 9.3.1 is considerably below licensed limits, cf. Table 3.2.3–1 in chapter 3.2.3: Short term release of H-3 (6.3×10^{10} Bq) is by order below average daily release norm (i.e. 1/365 from annual limit) - 6.6×10^{11} Bq; Long term releases of Cs-134 (2.9×10^{6} Bq) and Cs-137 (1.3×10^{7} Bq) are by several orders below annual limits.	environment (E) – 1 (unimportant, no contamination, localized effect)
Accident seriousness for property	It will be necessary to terminate FBHE operation, retrieve and over-pack damaged fuel bundle, decontaminate equipment and pool water, retrieve fuel debris etc. It is not expected that the cask could be damaged so that it would become non usable. The damaged fuel bundle handling equipment and fuel debris retrieval equipment will be provided by proposed economical activity. Storage pools water cleaning is managed by existing INPP equipment.	Classification of consequences for property (P) – 1 (unimportant, total cost damage is less than 100000 Lt).
Accident development speed	In conservative case no warning is assumed.	Accident development speed class (S) – 5 (no warning)
Prioritization of consequences	Accident seriousness classes L, E and P are of low value, accident probability Pb is beyond operation time frame. Therefore a low priority is considered.	Prioritization of consequences (Pr) – A (unimportant)
Preventive measures	Low handling speed when collision possible, adequate design of positioning, monitoring and control system, restriction of complicated load movements (in several directions simultaneously) etc. Occurrence of accident and consequences can be limited (or prevented) by design.	

L - Life S - Speed
E - Environment Pb - Probability
P - Property Pr - Priority

Table 9.1-1. Risk analysis of potential accidents resulting from proposed economic activity

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
Fuel bundle handling equipment (FBHE)	Fuel rod bundle or over packed fuel rod bundle reloading from 32 M basket or transfer basket into cask ring basket	Spent nuclear fuel confined within fuel rod bundle or over packed fuel rod bundle (18 fuel rods), fuel pellet container. In total about 15000 reloading will be performed within 7 year period.	Fuel bundle heavy collision with cask leading to breach or damage of certain number of fuel rods, release of activity into water of storage pools, loss of fuel pallets, release of airborne activity into environment of Storage Pools Hall and, through ventilation system, into atmosphere.	Operating personnel, population, property	Exposure of operating personnel, exposure of population, pause in operation	1	1	1	5	**3**	**A**	Low handling speed when collision possible, adequate design of positioning, monitoring and control system, restriction of complicated load movements (in several directions simultaneously) etc. Occurrence of accident and consequences can be limited by design.	Limited number of fuel rods can come into direct contact with collision object. These rods will absorb maximum of impact energy. Therefore severe damage of a few fuel rods could be credible. Lost fuel pellets will be recovered using fuel debris collection equipment.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
			Drop of fuel bundle leading to breach or damage of certain number of fuel rods, release of activity into water of storage pools, loss of fuel pallets, release of airborne activity into environment of Storage Pools Hall and, through ventilation system, into atmosphere.	Operating personnel, population, property	Exposure of operating personnel, exposure of population, pause in operation	1	1	1	5	**3**	**A**	Nuclear standard grab and hoisting equipment, limiting of lifting height where feasible. Occurrence of accident and consequences can be limited by design.	Recovery of a dropped fuel bundle can be carried out by means of simple tools. Lost fuel pellets will be recovered using fuel debris collection equipment.
			Lifting of fuel rod bundle above safe water shielding level	Operating personnel, property	External exposure of operating personnel, pause in operation	3	-	1	3	**3**	**C**	Load movement in certain directions shall be limited by design or alternative adequate preventive measures can be implemented. Occurrence of accident and consequences can be limited by design.	The upper lifting position of the fuel bundle is inherently limited by design.
			Loss of electricity or other INPP services	Property	Load hang, pause in operation	-	-	-	5	**5**	**A**	Design shall assure safe hold on position.	Pause in operation does not present a safety risk. Normal plant emergency procedures on service failure shall be implemented.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
Damaged fuel handling system (DFHS)	Transfer	Spent nuclear fuel confined within SFA (36 fuel rods). In total about 56 damaged SFA and 28 experimental SFA will be processed within 2 years period (at both Reactor Units).	Fuel assembly heavy collision with worktable assembly components leading to breach or damage of certain number of fuel rods, release of activity into water of storage pools, loss of fuel pallets, release of airborne activity into environment of Storage Pools Hall and, through ventilation system, into atmosphere	Operating personnel, population, property	Exposure of operating personnel, exposure of population, pause in operation	1	1	1	5	**1**	**A**	Low handling speed when collision possible, adequate design of positioning, monitoring and control system, restriction of complicated load movements (in several directions simultaneously) etc. Occurrence of accident and consequences can be limited by design.	Limited number of fuel rods can come into direct contact with collision object. These rods will absorb maximum of impact energy. Therefore severe damage of a few fuel rods could be credible. Lost fuel pellets will be recovered using fuel debris collection equipment
			Drop of fuel assembly from worktable leading to breach or damage of certain number of fuel rods, release of activity into water of storage pools, loss of fuel pallets, release of airborne activity into environment of Storage Pools Hall and, through ventilation system, into atmosphere	Operating personnel, population, property	Exposure of operating personnel, exposure of population, pause in operation	1	1	1	5	**1**	**A**	Nuclear standard grab and hoisting equipment, limiting of drop height by design if feasible. Occurrence of accident and consequences can be limited by design.	Lost fuel pellets will be recovered using fuel debris collection equipment.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
	Cutting of central rod and removing of SFA elements do not containing nuclear fuel	Spent nuclear fuel confined within fuel rod bundle (18 fuel rods), experimental FA fuel rod bundle (<18 fuel rods).	Cutting into or cutting through the fuel rods, release of activity into water of storage pools, generation of small particles from fuel matrix, loss of fuel pallets, release of airborne activity into environment of Storage Pools Hall and, through ventilation system, into atmosphere	Operating personnel, population, property	Exposure of operating personnel, exposure of population, pause in operation	1	1	1	4	**4**	**A**	Limiting of cutting disk movement, a swarf collection unit will be provided by design	Design basis accident leading to severe damage of most of fuel rods within fuel bundle and to chopping of certain part of fuel matrix (i.e. generation of small particles from fuel matrix). Accident is selected as potentially leading to most severe impact. Assessment of radiological consequences is provided in chapter 9.2.
	Banding and clamping of distorted fuel rods	Spent nuclear fuel confined within fuel rod bundle (18 fuel rods)	Breaking of certain number of fuel rods leading to release of activity into water of storage pools, loss of fuel pallets, release of airborne activity into environment of Storage Pools Hall and, through ventilation system, into atmosphere	Operating personnel, population, property	Exposure of operating personnel, exposure of population, pause in operation	1	1	1	5	**4**	**A**	Depends on design solutions	Damage of certain number of fuel rods has been postulated as a part of normal operation. Potential impact is assessed in chapter 5.1 and concluded in chapter 5.3. The worst case – severe damage of all rods from fuel bundle is selected as potentially leading to most severe impact. Assessment of radiological consequences is provided in chapter 9.3.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
	All activities	Spent nuclear fuel confined within SFA fuel rods (36 fuel rods)	Loss of electricity or other INPP services	Property	Load hang, pause in operation	-	-	1	5	**5**	**A**	Design shall assure safe hold on position	Pause in operation does not present a safety risk. Normal plant emergency procedures on service failure shall be implemented
Fuel debris collection equipment	Handling of over pack cartridges (fuel pellet containers)	Spent nuclear fuel pellets and debris	Heavy collision leading to damage of over pack cartridge and loss of collected fuel	Property	Pause in operation, lost fuel elements shall be recollected and repacked	-	-	1	5	**1**	**A**	Low handling speed when collision possible. Occurrence of accident and consequences can be limited by design.	
			Drop of over pack cartridge leading to damage and loss of collected fuel	Property	Pause in operation, lost fuel elements shall be recollected and repacked	-	-	1	5	**1**	**A**	Nuclear standard grab and hoisting equipment, limiting of lifting height where feasible. Occurrence of accident and consequences can be limited by design.	
			Loss of electricity or other INPP services	Property	Load hang, pause in operation	-	-	1	5	**5**	**A**	Design shall assure safe hold on position	Pause in operation does not present a safety risk. Normal plant emergency procedures on service failure shall be implemented
Cask handling at Reactor	Transfer	Cask loaded with 182 typical fuel rod	Collision with other objects	Property	Pause in operation	-	-	1	4	**1**	**A**	Low handling speed under direct control of operators	The robust design of the cask excludes damages to the fuel in case of collision.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
Units		bundles (3276 fuel rods) or 102 typical fuel rod bundles and 30 over packed fuel rod bundles (2376 fuel rods)	Cask drop	Property	Pause in operation, analysis of reasons and consequences, implementation of additional preventive measures or changes in design if necessary. Change of damaged shock absorbers	-	-	2	5	**1**	**A**	Cask lifting yoke and cask trunnions are designed according to the elevated conditions of German nuclear standards. Casks are transferred 20 cm above floor. At positions where loaded casks have to be lifted substantially shock absorbers are installed (on bottom of the pond and in the floor of the transport corridor).	Due to design and according to operational experience the probability of a cask drop during crane handling is very low. Nevertheless, potential cask drops are analysed in Technical Design and it is shown that admissible loads are not exceeded.
			Fire	Property	Pause in operation	-	-	1	5	**4**	**A**	Appropriate fire prevention and fire suppression measures	Potential thermal loads to the casks from a fire in the Reactor Pools Hall are relatively low compared to the design fire (600 °C, 1 h) analysed for the storage facility.
			Loss of electricity or other INPP services	Property	Load hang, pause in operation	-	-	1	5	**5**	**A**	Design shall assure safe hold on position	Pause in operation does not present a safety risk. Normal plant emergency procedures on service failure shall be implemented

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
Cask transfer (from Reactor Units to ISFSF)	Transfer	Cask loaded with 182 typical fuel rod bundles (3276 fuel rods) or 102 typical fuel rod bundles and 30 over packed fuel rod bundles (2376 fuel rods)	Loss of leak tightness of primary lid sealing	Population, property	Release of gas (possible some radioactivity). The cask sealing, cavity vacuum drainage and helium gas filling operations shall be repeated.	1	1	1	5	**1**	**A**	Cask lid cavity will be protected by cover plate, cask cavity will be vacuum dried (removing potential airborne radioactivity) and filled with helium, leak tightness will be tested prior transfer. The primary lid and its bolting to the cask are designed for mechanical loads from accidents. And the gasket is safely protected in a groove.	Loss of leak tightness of the primary lid during transfer can be excluded.
			Train collision, external events like explosion wave from potentially dangerous INPP facilities, earthquake etc.	Property	Pause in operation	-	-	1	5	**3**	**A**	Low transfer speed, adequate (seismic qualified if relevant) cask fixing on transport platform. The railroad connection will be fenced and secured, appropriate impact limiting devices (shock absorbers) in the places of potential collision (ISFSF reception hall etc.) shall be installed. Occurrence of accident and consequences can be limited by design.	Cask and primary lid are designed to withstand severe transport accident. ISFSF site and railroad connection are distant from potentially dangerous INPP facilities, cf. chapter 4.8.5. Release of activity is not credible.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
			Severe external event: air plane crash and fire	Operating personnel, population, property	In worst case - cask damage resulting in release of radioactivity	3	4	4	5	**1**	**D**		Extremely improbable (probability <1E-8 per year), beyond design basis accident.
		Locomotive fuel	Fire	Property	Pause in operation	-	-	1	5	**4**	**A**	Appropriate fire prevention and fire suppression measures	Potential thermal loads to the casks from a fire during transfer are relatively low compared to the design fire (600 °C, 1 h) analysed for the storage facility.
Cask handling at ISFSF, including cask transfer to FIHC	Handling	Cask loaded with 182 typical fuel rod bundles (3276 fuel rods) or 102 typical fuel rod bundles and 30 over packed	Collision with other casks or objects	Property	Pause in operation	-	-	1	4	**1**	**A**	Low handling speed when collision possible, elimination of potential collision objects, application of interlocks etc. Occurrence of accident and consequences can be limited by design.	The collision of a cask with another cask during crane handling is analysed and it is shown that admissible loads are not exceeded..

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
		fuel rod bundles (2376 fuel rods)	Cask drop	Property	Pause in operation, analysis of reasons and consequences, implementation of additional preventive measures or changes in design if necessary.	-	-	1	5	**1**	**A**	Nuclear standard grab and hoisting equipment. Appropriate shock absorbers will be used where lifting height exceeds safe lifting limit. Adequate design of cask transfer bogie. Occurrence of accident and consequences can be limited by design.	Due to design and according to operational experience the probability of a cask drop during crane handling is very low. Nevertheless, potential cask drops are analysed and it is shown that admissible loads are not exceeded..
			Loss of electricity	None	Load hang, pause in operation	-	-	1	5	**5**	**A**	Design shall assure safe hold on position. Backup power (diesel generator) will be provided for safety important systems.	
Cask interim storage at ISFSF	Storage	201 casks loaded with spent nuclear fuel, about 36000 of spent nuclear fuel bundles. At least 50 years storage time.	Loss of leak tightness (double system of welded joints)	Operating personnel, population, property	Exposure of operating personnel, exposure of population, cask reloading at FIHC of ISFSF	1	1	4	4	**2**	**D**	The fully volumetrically welded double walled steel containment of the casks and the corrosion protection of the cask components ensure leak-tightness during the whole storage period. The outer containment of a loaded cask can completely be inspected,	It is not anticipated that a cask will fail during its storage life.
			Loss of electricity	None		-	-	-	-	**-**	**-**	Backup power (diesel generator) will be provided for systems required for surveillance.	

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
			Malfunction in operation of cooling ventilation system (faults in actuators which open/close air inlet/outlet openings) leading to temporary increase of temperature inside Storage Hall..	None		-	-	-	1	**2**	**A**	Appropriate maintenance. Occurrence of accident can be limited by design.	There will be a set of independently operating inlet/outlets openings. Backup power will be provided for systems required for surveillance. The casks surface temperature is permanently monitored cf. chapter 8.3.4. The speed of development of accident consequences (temperature increase) is low. The cask is designed to withstand fire accident conditions and temporary increase of ambient temperature will not affect its integrity.
			Fire	Property	Pause in operation	-	-	1	5	**4**	**A**	Appropriate fire prevention and fire suppression measures. The amount of flammable material is minimized.	For the casks the heat load of a covering 600°C fire with duration of 1 h is analysed and it is shown that admissible loads are not exceeded.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
			External events like earthquake, flooding, explosion wave from potentially dangerous INPP facilities etc.	None		-	-	-	-	-	-	The loads of earthquake and explosion waves are analysed for the casks and it is shown that stability of the casks against tilting is ensured. Flooding of the cask array by water is irrelevant for sub-criticality safety due to the neutron decoupling of the fuel by the thick wall of the cask. Burying of casks by debris is analysed and it is shown that the fuel cladding temperature limit is not exceeded after several days.	
			Severe external event: airplane crash and fire	Property, operating personnel	ISFSF can be partially destroyed	3	1	4	5	**1**	**D**	The high safety potential of the casks is demonstrated by analysing the hit of the cask by aircraft wreckage and showing that admissible loads are not exceeded. Burying of casks by debris is analysed and it is shown that the fuel cladding temperature limit is not exceeded after several days.	Extremely improbable (probability <1E-7 per year), beyond design basis accident.
Cask reloading at Fuel Inspection	FIHC operation	Cask / FIHC loaded with 182 typical fuel rod bundles (3276	Loss of electricity	None	Pause in operation	-	-	-	-	-	-	Backup power (diesel generator)will be provided for safety important systems.	

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
Hot Cell (FIHC) of ISFSF		fuel rods) or 102 typical fuel rod bundles and 30 over packed fuel rod bundles (2376 fuel rods). Exceptional operation	Loss of primary ventilation system	None		-	-	-	-	-	-	Redundancy will be assured by design.	
			Loss of primary filtering capability	None		-	-	-	-	-	-	Redundancy will be assured by design.	
			Fire	Property	Pause in operation	-	-	1	5	**4**	**A**	Appropriate fire prevention and fire suppression measures	
			External events like earthquake, flooding, explosion wave from potentially dangerous INPP facilities etc.	None		-	-	-	-	-	-	The design shall consider potential external impact sources.	
			Severe external event: air plane crash and fire	Operating personnel, population, property	In worst case – FIHC can be partially destroyed	3	4	5	5	**1**	**D**		Extremely improbable (probability <1E-8 per year), beyond design basis accident.
	FIHC operation - fuel rod bundle or over packed fuel rod bundle reloading	Spent nuclear fuel confined within fuel rod bundle or over packed fuel rod bundle (18 fuel rods). Up to 182 typical fuel rod bundles have to be reloaded from the cask	Fuel bundle heavy collision leading to breach or damage of certain number of fuel rods, release of activity, contamination of hot cell, release of airborne activity through ventilation system into atmosphere.	Population, property	Exposure of population, increased exposure of personnel due to decontamination activity, pause in operation	1	1	1	5	**2**	**A**	Low handling speed when collision possible, adequate design of positioning, monitoring and control system, restriction of complicated load movements (in several directions simultaneously) etc. Occurrence of accident and consequences can be limited by design.	Limited number of fuel rods can come into direct contact with collision object. These rods will absorb maximum of impact energy. Therefore severe damage of a few fuel rods could be credible.

Object	Operation	Hazard	Risk	Threatened object	Consequences	Seriousness				Risk level		Preventive measures	Remarks
						L	E	P	S	Pb	Pr		
		into Hot Cell and from Hot Cell into new cask.	Drop of fuel bundle leading to breach or damage of certain number of fuel rods, release of activity, contamination of hot cell, release of airborne activity through ventilation system into atmosphere.	Population, property	Exposure of population, increased exposure of personnel due to decontamination activity, pause in operation	1	1	1	5	**2**	**A**	Nuclear standard grab and hoisting equipment, limiting of lifting height where feasible. Occurrence of accident and consequences can be limited by design.	

Several conclusions could be drawn from the potential risks analysis as presented in Table 9.1-1. Risk analysis includes accidents which relevance could be ruled out during Technical Design stage. Occurrence of most accidents resulting in collision or drop of elements containing nuclear fuel can be limited by appropriate design solutions. Use of interlocks preventing load movement in certain directions or load movement when collision is possible will reduce potentiality of collision. Limiting of transfer speed will reduce consequences of collision. Application of nuclear standard grabs and hoisting equipment, selecting of site specific loads (i.e. potential earthquake, potential explosion wave etc.) and appropriate design solutions will reduce potentiality of load drop. Application of shock absorbers where cask safe lifting height is exceeded will reduce consequences of cask drop accident. The accident preventive measures shall be selected during Technical Design considering design specific and local conditions.

Most credible accidents (by risk probability class above 3 or priority class above A due to consequences on environment) which can not be ruled out due to proposed design concept are accidental cutting through the fuel rods and breaking of fuel rods during banding/clamping activity while processing fuel bundle by DFHS. In both cases the severe damage of most of fuel rods within fuel bundle is postulated as potentially possible. The consequences of selected accidents have been evaluated in chapters 9.2 and 9.3. The selected accidents also envelope consequences from most of potential fuel bundle collision or drop accidents where number of damaged fuel rods is expected to be lower.

The potential risks analysis identifies airplane crash during cask transfer or reloading at FIHC as leading to very serious environmental consequences (consequence priority D). Accident occurrence has been classified as class 1, however probability of direct hit of transferred cask or FIHC structure is extremely low (below 10^{-8} per year). The Safety Analysis Report will provide detailed evaluation of probability of this event. It will be shown, that regulatory requirement “In order to avoid the necessity of evacuating the population to distances beyond the limits laid down in the standards for nuclear plant sitting, an effort should be made to ensure that the probability of the worst possible emergency release of radioactive materials specified in the standards does not exceed 10^{-7} per reactor year” [4] will be met. Therefore airplane crash event is qualified as beyond design basis accident and is not considered by EIA Report.

9.2. Dose Assessment for the Accidental Cutting of Fuel Rods within a Fuel Bundle

The analysis provides a scoping assessment for the potential dose to operator and member of the public in the event that an operator accidentally cuts into the fuel rods while processing a damaged fuel assembly.

9.2.1. Estimation of Potential Airborne Releases

The design of the cutter movement mechanism will limit the stroke of the cutting wheel to just beyond the diameter of the central rod at which point the cutting stroke is physically stopped. Therefore, if this incident were to occur, in the worst case, 10 fuel rods would be completely cut through and 4 partially cut through; the remaining 4 fuel rods would be undamaged. It is therefore assumed that for the release of fuel pellet particulates into the pool water the equivalent of 12 fuel rods have been affected along with the release of gases from 14 fuel rods.

The worktable assembly cutting wheel will be of thickness of 3 mm. A fuel pellet is 15 mm long with a mass of 15 g, cf. chapter 2.1.1. A 3 mm slice of an individual pellet has a mass of 3 g therefore fuel particulate arising from 12 fuel pellets has a mass of 36 g. It is conservatively assumed that the cutter's swarf collection unit fails to capture any of the released particulates.

The fuel assemblies of 2.8 % enrichments of U-235 with Erbium absorber in comparison to other fuel assemblies of lower enrichment can have a higher lever of burn up and therefore will contain higher radionuclide activity, cf. chapter 2.1.3. The spent fuel of 2.8 % enrichment of U-235 with Erbium absorber is selected as to be representative in assessing of maximal release of activity.

The activity released into the water of the pool from radioactive gasses accumulated inside fuel rods cavity is then calculated:

$$A_G = \frac{A_{FA} \times GF}{N_{RA}} \times N_{AR},$$

where:

A_{FA} – activity of specific radionuclide per FA of 2.8 % enrichment fuel type, Table 2.1.3-1.

GF – fraction of released fission product (gap release fraction), cf. chapter 5.1.1.1, Table 5.1.1-2. It is conservatively assumed that prior accident all fuel rods were intact and therefore a free gas inventory accumulated in the cavity of fuel rod with decay time of at least five years is available for immediate release upon cutting into fuel rods.

N_{RA} = 36, number of fuel rods per fuel assembly;

N_{AR} = 14, amount of affected fuel rods.

The activity released into the water of the pool due to chopping of fuel matrix is then calculated:

$$A_{FP} = \frac{A_{FA} \times (1 - GF)}{M_{FA}} \times M_{FP},$$

where:

M_{FA} = 126 kg, mass of Uranium dioxide per fuel assembly, Table 2.1.1-1;

M_{FP} = 0.036 kg, mass of chopped fuel matrix.

Estimates of the potential release are presented in Table 9.2.1-1 below.

Table 9.2.1-1. Activity released into the pool water in case of fuel bundle cutting through accident (for fuel of 2.8 % enrichments of U-235 with Erbium absorber)

Radionuclide	Activity release into pools water, Bq
H-3	4.89E+10
Kr-85	1.15E+12
Y-90	7.06E+10
Sr-90	7.06E+10
Rh-106	1.45E+10
Ru-106	1.45E+10
Sb-125	2.12E+09
I-129	2.86E+06
Cs-134	2.58E+10
Cs-137	1.12E+11
Ba-137m	9.83E+10
Ce-144	1.01E+10
Pr-144	1.01E+10
Pm-147	4.66E+10
Eu-154	2.75E+09
Eu-155	1.17E+09
Np-237	1.97E+05
Pu-238	1.45E+09
Pu-239	1.95E+08
Pu-240	5.60E+08
Pu-241	7.09E+10
Am-241	7.49E+08
Am-242m	3.69E+06
Am-243	1.72E+07
Cm-242	1.98E+07
Cm-243	9.00E+06
Cm-244	1.38E+09
Total	**1.75E+12**

The estimation of potential release of airborne activity into environment of Storage Pools Hall and atmosphere through Reactors Units main ventilation stacks considers specificity of activity release from the surface of the pools and specificity of existing INPP ventilation system. The following assumptions have been used while calculating airborne activity releases from the surface of the pools:

- The retention of noble gas Kr-85 and gaseous H-3 in the pools water is negligible (i.e. decontamination factor of 1). Overall effective decontamination factor for gaseous I-129 is 200 (i.e. 99.5% of the total iodine released is retained by the water). The Cs is dissolved into the water of the pools. These decontamination factors are based on recommendations [5].
- The magnitude of release of particulate radionuclides from the surface of the pools water is determined by a release fraction of 5.0×10^{-6} per day for actinides and 2.0×10^{-6} per day for fission products (cf. chapter 5.1.1.2). These release fractions are being based on proprietary UK data applicable for activity releases from open ponds. Most of released airborne activity is than captured by ventilation air flow over the pools and is routed into existing ventilation system;
- The magnitude of release of particulate radionuclides from the surface of the pools water into the Storage Pools Hall working environment, due to the Storage Pools Hall ventilation air flow over the pools, is determined by a release fraction of 5.0×10^{-7} per day for actinides and 2.0×10^{-7} per day for fission products (cf. chapter 5.1.1.2). These release fractions are being based on proprietary UK data applicable for activity releases from covered ponds.

The following assumptions have been used while calculating airborne activity releases into atmosphere through the main ventilation stacks of Reactor Units:

- The magnitude of the release of fine particles into atmosphere through INPP ventilation system (and subsequently through the main ventilation stack) is determined by decontamination factor of existing operational filters. The decontamination factor of 1000 is used which corresponds to standard separation efficiency of existing operational filters (99.9 %) [6];
- No retention of activity by filtering for gases (H-3, Kr-85 and I-129) is assumed.

Estimation of potential releases of airborne activity into environment of Storage Pools Hall and atmosphere are summarized in Table 9.2.1-2 and Table 9.2.1-3.

Table 9.2.1-2. Release of airborne activity into Storage Pools Hall in case of fuel bundle cutting through accident (for fuel of 2.8 % enrichments of U-235 with Erbium absorber)

Radionuclide	Activity release into Storage Pools Hall, Bq		
	Short term	Long term	Total
H-3	4.89E+10	0	4.89E+10
Kr-85	1.15E+12	0	1.15E+12
Y-90	0	5.16E+06	5.16E+06
Sr-90	0	5.16E+06	5.16E+06
Rh-106	0	1.06E+06	1.06E+06
Ru-106	0	1.06E+06	1.06E+06
Sb-125	0	1.55E+05	1.55E+05
I-129	1.43E+04	2.08E+02	1.45E+04
Cs-134	0	1.88E+06	1.88E+06
Cs-137	0	8.16E+06	8.16E+06
Ba-137m	0	7.18E+06	7.18E+06
Ce-144	0	7.41E+05	7.41E+05
Pr-144	0	7.41E+05	7.41E+05
Pm-147	0	3.40E+06	3.40E+06
Eu-154	0	2.01E+05	2.01E+05
Eu-155	0	8.58E+04	8.58E+04
Np-237	0	3.60E+01	3.60E+01
Pu-238	0	2.66E+05	2.66E+05
Pu-239	0	3.56E+04	3.56E+04
Pu-240	0	1.02E+05	1.02E+05
Pu-241	0	1.29E+07	1.29E+07
Am-241	0	1.37E+05	1.37E+05
Am-242m	0	6.73E+02	6.73E+02
Am-243	0	3.15E+03	3.15E+03
Cm-242	0	3.62E+03	3.62E+03
Cm-243	0	1.64E+03	1.64E+03
Cm-244	0	2.52E+05	2.52E+05
Total	**1.20E+12**	**4.87E+07**	**1.20E+12**

Table 9.2.1-3. Release of airborne activity into atmosphere through INPP main ventilation stack in case of fuel bundle cutting through accident (for fuel of 2.8 % enrichments of U-235 with Erbium absorber)

Radionuclide	**Activity release into atmosphere, Bq**		
	Short term	**Long term**	**Total**
H-3	4.89E+10	0	4.89E+10
Kr-85	1.15E+12	0	1.15E+12
Y-90	0	5.16E+04	5.16E+04
Sr-90	0	5.16E+04	5.16E+04
Rh-106	0	1.06E+04	1.06E+04
Ru-106	0	1.06E+04	1.06E+04
Sb-125	0	1.55E+03	1.55E+03
I-129	1.43E+04	2.08E+03	1.64E+04
Cs-134	0	2.28E+06	2.28E+06
Cs-137	0	9.84E+06	9.84E+06
Ba-137m	0	7.18E+04	7.18E+04
Ce-144	0	7.41E+03	7.41E+03
Pr-144	0	7.41E+03	7.41E+03
Pm-147	0	3.40E+04	3.40E+04
Eu-154	0	2.01E+03	2.01E+03
Eu-155	0	8.58E+02	8.58E+02
Np-237	0	3.60E-01	3.60E-01
Pu-238	0	2.66E+03	2.66E+03
Pu-239	0	3.56E+02	3.56E+02
Pu-240	0	1.02E+03	1.02E+03
Pu-241	0	1.29E+05	1.29E+05
Am-241	0	1.37E+03	1.37E+03
Am-242m	0	6.73E+00	6.73E+00
Am-243	0	3.15E+01	3.15E+01
Cm-242	0	3.62E+01	3.62E+01
Cm-243	0	1.64E+01	1.64E+01
Cm-244	0	2.52E+03	2.52E+03
Total	**1.20E+12**	**1.25E+07**	**1.20E+12**

9.2.2. Personnel Exposure due to Release of Airborne Activity into Environment of Storage Pools Hall

Airborne activity released into environment of Storage Pools Hall will result inhalation and external exposure doses for operating personnel.

9.2.2.1. Dose to personnel due to short term release

During fuel bundle cutting operation the operator is situated on a working platform about

0.5 m above the pool water. The operators head height is therefore approximately 2 m from the surface of the pool water. It is therefore appropriate to model the potential effective dose to the operator using the cloud expansion model:

$$E = Q \times \left[\left(C_{inh} \times B \times e_{inh} \right) + \left(C_{sub} \times e_{sub} \right) \right],$$

where:

Q – short term release of airborne activity into environment of Storage Pools Hall, Table 9.2.1-2;

C_{inh}, C_{sub} – the cloud dispersion coefficients for inhalation and immersion, s/m^3;

B = 3.3×10^{-4} m^3/s, breathing rate for workers, [7];

e_{inh} – inhalation committed effective dose factor for workers, Sv/Bq, [8]. Data used in calculations are presented in Table 9.2.2-1.

e_{sub} – the effective dose factor for immersion, (Sv/s)/(Bq/m^3). The dose factors for semi-infinitive cloud as provided by [8] are corrected considering finitive volume of Storage Pools Hall using empirical approximation as recommended by [5].

$$e_{sub} = \frac{e_{sub-\infty} \times V^{0.338}}{1173},$$

where:

$e_{sub-\infty}$ – the effective dose factor for immersion into semi-infinitive cloud, (Sv/s)/(Bq/m^3) [8];

V - the volume of Storage Pools Hall in cubic foots (9.46×10^5).

Data used in calculations are presented in Table 9.2.2-1.

The cloud dispersion coefficient C is the time integrated air activity concentration per unit release of activity. It is a measure of the total air activity concentration a person would be exposed to if a unit of activity were released and the resulting cloud of activity passed by that person – it is based upon the change of air activity concentration with time as a result of random mixing processes following an instantaneous point release [9], [10], [11].

The cloud dispersion coefficient may be derived from the cloud expansion parameter which is in turn related to the building volume and the building air change rate as follows:

$$\alpha = \frac{V_B}{t^{3/2}},$$

where:

V_B = 26800 m^3, Storage Pools Hall air volume;

t = 1.68×10^3 s, Storage Pools Hall air exchange rate (corresponds to 28 min).

The cloud expansion parameter is therefore α = 0.39 m^3/s$^{3/2}$. The cloud dispersion coefficient then may be calculated:

$$C = \left(\frac{2}{\alpha} \right) \times \left(t_1^{-0.5} - t_2^{-0.5} \right),$$

where:

α – cloud expansion parameter as defined above;

t_1 – is the time at which exposure to the activity begins, s;

t_2 – is the time at which exposure to the activity ends, s. It is conservatively assumed that the operator remains on the work platform for 10 minutes following the activity release and evacuates on activation of the local activity-in-air monitor alarm or recognizes that a fault has occurred.

The time at which exposure to the air activity begins (t_1) may be calculated as follows assuming the cloud expands as a hemisphere:

$$t_1 = \left(\frac{2\pi}{3\alpha}\right)^{2/3} \times X^2,$$

where:

X - distance from release point.

For evaluation of inhalation dose the value of X = 2 m is used, which corresponds to approximately height of operators head. Evaluating the above equation t_1 = 12.3 s. The calculated value for the dispersion coefficient is therefore C_{inh} = 1.26 s/m^3.

For evaluation of immersion dose the value of X = 0.2 m is used to account for cloud development until it reaches the worker. Evaluating the above equation t_1 = 0.1 s. The calculated value for the dispersion coefficient is therefore C_{sub} = 14.5 s/m^3.

The dose calculation results are summarized in Table 9.2.2-1.

Table 9.2.2-1. Operator's effective dose due to short term release of airborne activity into environment of Storage Pools Hall

Radionuclide	e_{inh}, Sv/Bq	e_{sub}, (Sv/s) / (Bq/m^3)	Effective dose, Sv
H-3	1.80E-15	3.31E-19	5.74E-08
Kr-85	0	2.55E-16	3.77E-04
I-129	5.10E-08	3.80E-16	3.02E-07
Total			**3.77E-04**

9.2.2.2. Dose to personnel due to long term release

In order to determine the personnel dose it is assumed that the activity released from the pool becomes homogeneously distributed within the air of Storage Pools Hall. The Storage Pools Hall is ventilated. The annually averaged activity concentration in the environment of Storage Pools Hall is calculated:

$$C_{SPH} = \frac{Q}{V_{SPH}},$$

where:

Q – annual long term release of airborne activity into environment of Storage Pools Hall, Table 9.2.1-2;

V_{SPH} = 5.03×10^8 m^3, the annual Storage Pools Hall air exchange rate, cf. chapter 5.1.5.1.

$$E = C_{SPH} \times t_W \times \left(B \times e_{inh} + e_{sub}\right),$$

where:

t_W = 5.4×10^6 s, exposure time (assumes 1700 h working year);

B = 3.3×10^{-4} m^3/s, breathing rate, [7];

e_{inh} – inhalation committed effective dose factor for workers, Sv/Bq, [8]. Data used in calculations are presented in Table 9.2.2-2.

e_{sub} – the effective dose factor for immersion, (Sv/s)/(Bq/m^3). Dose factor for noble gas is taken from [8]. Dose factors for other radionuclides are taken from [12]. The effective dose values given in [12] have been estimated from the effective dose equivalent values for immersion in the cloud, given in [13], plus the corresponding weighted skin dose component, to provide an approximation to effective dose. Additional account of the contribution from radioactive progeny with half-lives less than 30 min has also been taken where appropriate. Therefore dose conversion factors from [12] are compatible with [8]. Data used in calculations are presented in Table 9.2.2-2.

The dose calculation results are summarized in Table 9.2.2-2.

Table 9.2.2-2. Operator's annual effective dose due to long term release of airborne activity into environment of Storage Pools Hall

Radionuclide	e_{inh}, **Sv/Bq**	e_{sub}, **(Sv/s) / (Bq/m^3)**	**Annual effective dose, Sv**
H-3	1.80E-15	3.31E-19	0
Kr-85	0	2.55E-16	0
Y-90	1.70E-09	8.24E-16	3.52E-08
Sr-90	1.50E-07	9.82E-17	3.10E-06
Rh-106	0	1.14E-14	1.47E-10
Ru-106	6.20E-08	1.14E-14	2.64E-07
Sb-125	4.50E-09	2.06E-14	2.84E-09
I-129	5.10E-08	3.80E-16	4.25E-11
Cs-134	9.60E-09	7.61E-14	7.43E-08
Cs-137	6.70E-09	2.76E-14	2.22E-07
Ba-137m	0	2.92E-14	2.55E-09
Ce-144	4.90E-08	3.49E-15	1.46E-07
Pr-144	3.00E-11	1.96E-15	1.14E-10
Pm-147	4.70E-09	8.87E-18	6.41E-08
Eu-154	5.00E-08	6.34E-14	4.05E-08
Eu-155	6.50E-09	2.54E-15	2.24E-09
Np-237	2.10E-05	1.05E-15	3.03E-09
Pu-238	4.30E-05	5.39E-18	4.58E-05
Pu-239	4.70E-05	4.44E-18	6.71E-06
Pu-240	4.70E-05	5.07E-18	1.93E-05
Pu-241	8.50E-07	7.29E-20	4.41E-05
Am-241	3.90E-05	8.24E-16	2.14E-05
Am-242m	3.50E-05	3.31E-17	9.45E-08
Am-243	3.90E-05	2.21E-15	4.92E-07
Cm-242	4.80E-06	6.02E-18	6.97E-08
Cm-243	2.90E-05	5.98E-15	1.91E-07
Cm-244	2.50E-05	5.39E-18	2.52E-05
Total			**1.67E-04**

9.2.2.3. Summary of potential radiological impact

The calculations of dose to operator in the event of accidentally cutting into the fuel rods while processing a damaged fuel assembly by defective fuel handling system are summarized in Table 9.2.2-3.

Table 9.2.2-3. Annual effective dose to operator in case of fuel bundle cutting through accident (for fuel of 2.8 % enrichments of U-235 with Erbium absorber)

Radionuclide	Annual effective dose, Sv/a		
	Short term	Long term	Total
H-3	5.74E-08	0	5.74E-08
Kr-85	3.77E-04	0	3.77E-04
Y-90	0	3.52E-08	3.52E-08
Sr-90	0	3.10E-06	3.10E-06
Rh-106	0	1.47E-10	1.47E-10
Ru-106	0	2.64E-07	2.64E-07
Sb-125	0	2.84E-09	2.84E-09
I-129	3.02E-07	4.25E-11	3.02E-07
Cs-134	0	7.43E-08	7.43E-08
Cs-137	0	2.22E-07	2.22E-07
Ba-137m	0	2.55E-09	2.55E-09
Ce-144	0	1.46E-07	1.46E-07
Pr-144	0	1.14E-10	1.14E-10
Pm-147	0	6.41E-08	6.41E-08
Eu-154	0	4.05E-08	4.05E-08
Eu-155	0	2.24E-09	2.24E-09
Np-237	0	3.03E-09	3.03E-09
Pu-238	0	4.58E-05	4.58E-05
Pu-239	0	6.71E-06	6.71E-06
Pu-240	0	1.93E-05	1.93E-05
Pu-241	0	4.41E-05	4.41E-05
Am-241	0	2.14E-05	2.14E-05
Am-242m	0	9.45E-08	9.45E-08
Am-243	0	4.92E-07	4.92E-07
Cm-242	0	6.97E-08	6.97E-08
Cm-243	0	1.91E-07	1.91E-07
Cm-244	0	2.52E-05	2.52E-05
Total	**3.77E-04**	**1.68E-04**	**5.46E-04**

The expected effective dose due to short term (immediate) release of airborne activity into environment of Storage Pools Hall is about 0.38 mSv. The expected annual effective dose due to release of airborne activity into environment of Storage Pools Hall is below 1 mSv.

9.2.3. Population Exposure due to Release of Airborne Activity into Atmosphere

9.2.3.1. Dose to the critical group member of population due to short term release

The public member dose due to short term release of activity into atmosphere through the main ventilation stack of the Reactor Units at the time of the incident can be calculated as follows:

$$E = Q \times C \times \left(B \times e_{inh} + e_{sub}\right),$$

where:

Q – short term release of airborne activity into atmosphere, Table 9.2.1-3;

C – the cloud dispersion coefficient (i.e. time integrated concentration) for the main ventilation stack of the Reactor Units, s/m^3;

B = 3.3×10^{-4} m^3/s, breathing rate for member of general public [7];

e_{inh} – inhalation committed effective dose factor for general public, Sv/Bq [8]. Data used in calculations are presented in Table 9.2.3-1.

e_{sub} – the effective dose factor for immersion, (Sv/s)/(Bq/m^3), [8, 12]. Data used in calculations are presented in Table 9.2.3-1.

The cloud dispersion coefficient and hence public dose is dependant upon a number of variables, including weather type, distance from release point to exposure point and height of release point. For the purpose of conservative assessment of the public dose (i.e. exposure of critical group member) a weather conditions and exposure point location leading to highest value of ground level concentration of activity have been assumed. The value for the dispersion coefficient has been taken from [14] for a 30 minute release in category A weather conditions and stack height of 150 m. The selected value for the dispersion coefficient is therefore C = 8.3×10^{-6} s/m^3 (in distance of 500 – 600 m).

The dose calculation results are summarized in Table 9.2.3-1.

Table 9.2.3-1. Effective dose to the critical group member of population due to short term release of airborne activity into the atmosphere through the main ventilation stack of INPP

Radionuclide	e_{inh}, **Sv/Bq**	e_{sub}, **(Sv/s) / (Bq/m^3)**	**Effective dose, Sv**
H-3	1.80E-15	3.31E-19	3.76E-13
Kr-85	0	2.55E-16	2.42E-09
I-129	5.10E-08	3.80E-16	2.00E-12
Total			**2.43E-09**

At the distances of 3000 m from the Reactor Units (border of existing INPP sanitary protection zone) and beyond the highest exposure is expected in case of category B weather conditions. The dispersion coefficient (C = 1.2×10^{-6} s/m^3) is lower than for the case of maximal exposure location. Therefore the exposure dose outside the existing INPP sanitary protection zone will be lower by factor of 6.9 as it is assessed in Table 9.2.3-1.

9.2.3.2. Dose to the critical group member of the population due to long term release

The radiation exposure of the critical group members of the population in the environment of INPP resulting from the long term release of radioactive material with air was calculated using the dose conversion factors [15]. The methodology used is described under chapter 5.1.5.2 and values for releases of long term airborne activity are provided in Table 9.2.1-3.

The dose calculation results are summarized in Table 9.2.3-2.

Table 9.2.3-2. Effective dose to a member of general public due to long term release of airborne activity into the atmosphere through the main ventilation stack of INPP

Radionuclide	***DCF*, Sv/Bq**	**Annual effective dose, Sv/a**
H-3	1.80E-21	0
Kr-85	4.50E-23	0
Y-90	3.80E-16	1.96E-11
Sr-90	7.00E-17	3.61E-12
Rh-106	6.84E-23	7.27E-19
Ru-106	7.80E-18	8.29E-14
Sb-125	3.80E-16	5.89E-13
I-129	1.20E-15	2.49E-12
Cs-134	8.30E-17	1.89E-10
Cs-137	1.20E-16	1.18E-09
Ba-137m	1.75E-22	1.26E-17
Ce-144	3.80E-16	2.82E-12
Pr-144	1.30E-22	9.63E-19
Pm-147	3.80E-16	1.29E-11
Eu-154	4.40E-17	8.85E-14
Eu-155	1.60E-18	1.37E-15
Np-237	3.80E-16	1.37E-16
Pu-238	3.80E-16	1.01E-12
Pu-239	3.80E-16	1.35E-13
Pu-240	3.80E-16	3.89E-13
Pu-241	3.80E-16	4.92E-11
Am-241	3.80E-16	5.19E-13
Am-242m	3.80E-16	2.56E-15
Am-243	3.80E-16	1.20E-14
Cm-242	3.80E-16	1.38E-14
Cm-243	3.80E-16	6.25E-15
Cm-244	3.80E-16	9.56E-13
Total		**1.47E-09**

9.2.3.3. Summary of potential radiological impact

The calculations of dose to the critical group member of the population in the event of accidentally cutting into the fuel rods while processing a damaged fuel assembly by defective fuel handling system are summarized in Table 9.2.3-3.

Table 9.2.3-3. Annual effective dose to the critical group member of the population in case of fuel bundle cutting through accident (for fuel of 2.8 % enrichments of U-235 with Erbium absorber)

Radionuclide	**Annual effective dose, Sv**		
	Short term	**Long term**	**Total**
H-3	3.76E-13	0	3.76E-13
Kr-85	2.42E-09	0	2.42E-09
Y-90	0	1.96E-11	1.96E-11
Sr-90	0	3.61E-12	3.61E-12
Rh-106	0	7.27E-19	7.27E-19
Ru-106	0	8.29E-14	8.29E-14
Sb-125	0	5.89E-13	5.89E-13
I-129	2.00E-12	2.49E-12	4.49E-12
Cs-134	0	1.89E-10	1.89E-10
Cs-137	0	1.18E-09	1.18E-09
Ba-137m	0	1.26E-17	1.26E-17
Ce-144	0	2.82E-12	2.82E-12
Pr-144	0	9.63E-19	9.63E-19
Pm-147	0	1.29E-11	1.29E-11
Eu-154	0	8.85E-14	8.85E-14
Eu-155	0	1.37E-15	1.37E-15
Np-237	0	1.37E-16	1.37E-16
Pu-238	0	1.01E-12	1.01E-12
Pu-239	0	1.35E-13	1.35E-13
Pu-240	0	3.89E-13	3.89E-13
Pu-241	0	4.92E-11	4.92E-11
Am-241	0	5.19E-13	5.19E-13
Am-242m	0	2.56E-15	2.56E-15
Am-243	0	1.20E-14	1.20E-14
Cm-242	0	1.38E-14	1.38E-14
Cm-243	0	6.25E-15	6.25E-15
Cm-244	0	9.56E-13	9.56E-13
Total	**2.43E-09**	**1.46E-09**	**3.89E-09**

The expected effective dose to the member of population due to short term (immediate) release of airborne activity into atmosphere is about 2.4×10^{-6} mSv. The expected annual effective dose to the critical group member of the population due to release of airborne activity into atmosphere (both short and long terms) is about 3.9×10^{-6} mSv. The expected exposure of population radiologically is insignificant.

9.3. Dose Assessment for the Accidental Breaking of Fuel Rods within a Fuel Bundle

The analysis provides a scoping assessment for the potential dose to operator and member of the general public in the event of accidental breaking of fuel rods within a fuel bundle while processing a damaged fuel assembly. Damage of certain number of fuel rods has been postulated as probable during normal operation. Potential impact is assessed in chapter 5.1 and concluded in chapter 5.3. The worst case – severe damage of all rods from fuel bundle is selected as accident which potentially leads to maximum release of activity.

9.3.1. Estimation of Potential Airborne Releases

The fuel bundle cutting accident, cf. chapter 9.2.1 provides assessment of release of fuel pellet particulates into the pool water from the equivalent of 12 fuel rods have been cut through. In case of accidental breaking of fuel rods a fuel fragments likely to be produced rather than particulate. Therefore it is assumed that production of fuel particles during accidental breaking of fuel rods within a fuel bundle is bounded by cutting accident as assessed in chapter 9.2.1 (Table 9.2.1-1, Table 9.2.1-2 and Table 9.2.1-3).

The fuel bundle cutting accident, cf. chapter 9.2.1 provides assessment of release of gases from 14 fuel rods. For the purposes of this assessment it is conservatively assumed that all 18 fuel rods are sufficiently damaged such as to allow escape of fission gas. Therefore release of fission gas as assessed in chapter 9.2.1 (Table 9.2.1-1, Table 9.2.1-2 and Table 9.2.1-3) has to be scaled by factor 18/14.

9.3.2. Personnel Exposure due to Release of Airborne Activity into Environment of Storage Pools Hall

The same dose assessment methodology is applicable as described in chapter 9.2.2. The annual exposure of the member of operating personnel is directly depended on amount of airborne activity released into environment of Storage Pools Hall. Therefore, dose assessment results as presented in chapter 9.2.2 are scaled appropriately as described in chapter 9.3.1.

The calculations of dose to operator in the event of accidental breaking of fuel rods within a fuel bundle while processing a damaged fuel assembly by defective fuel handling system is summarized in Table 9.3.2-1.

Table 9.3.2-1. Annual effective dose to operator in case of fuel bundle breaking accident (for fuel of 2.8 % enrichments of U-235 with Erbium absorber)

Radionuclide	Annual effective dose, Sv		
	Short term	**Long term**	**Total**
H-3	7.37E-08	0	7.37E-08
Kr-85	4.84E-04	0	4.84E-04
Y-90	0	< 3.52E-08	< 3.52E-08
Sr-90	0	< 3.10E-06	< 3.10E-06
Rh-106	0	< 1.47E-10	< 1.47E-10
Ru-106	0	< 2.64E-07	< 2.64E-07
Sb-125	0	< 2.84E-09	< 2.84E-09
I-129	3.87E-07	5.45E-11	3.87E-07
Cs-134	0	< 7.69E-08	< 7.69E-08
Cs-137	0	< 2.30E-07	< 2.30E-07
Ba-137m	0	< 2.55E-09	< 2.55E-09
Ce-144	0	< 1.46E-07	< 1.46E-07
Pr-144	0	< 1.14E-10	< 1.14E-10
Pm-147	0	< 6.41E-08	< 6.41E-08
Eu-154	0	< 4.05E-08	< 4.05E-08
Eu-155	0	< 2.24E-09	< 2.24E-09
Np-237	0	< 3.03E-09	< 3.03E-09
Pu-238	0	< 4.58E-05	< 4.58E-05
Pu-239	0	< 6.71E-06	< 6.71E-06
Pu-240	0	< 1.93E-05	< 1.93E-05
Pu-241	0	< 4.41E-05	< 4.41E-05
Am-241	0	< 2.14E-05	< 2.14E-05
Am-242m	0	< 9.45E-08	< 9.45E-08
Am-243	0	< 4.92E-07	< 4.92E-07
Cm-242	0	< 6.97E-08	< 6.97E-08
Cm-243	0	< 1.91E-07	< 1.91E-07
Cm-244	0	< 2.52E-05	< 2.52E-05
Total	**4.84E-04**	**< 1.68E-04**	**< 6.53E-04**

The expected effective dose due to short term (immediate) release of airborne activity into environment of Storage Pools Hall is about 0.5 mSv. The expected annual effective dose due to release of airborne activity into environment of Storage Pools Hall is about 0.7 mSv.

9.3.3. Population Exposure due to Release of Airborne Activity into Atmosphere

The same dose assessment methodology is applicable as described in chapter 9.2.3. The annual exposure of the member of population is directly depended on amount of airborne activity released into environment through the main ventilation stack of the Reactor Units. Therefore, dose assessment results as presented in chapter 9.2.3 are scaled appropriately as described in chapter 9.3.1.

The calculations of dose to the critical group member of the population in the event of accidental breaking of fuel rods within a fuel bundle while processing a damaged fuel assembly by defective fuel handling system are summarized in Table 9.3.3-1..

Table 9.3.3-1. Annual effective dose to the critical group member of the population in case of fuel bundle breaking accident (for fuel of 2.8 % enrichments of U-235 with Erbium absorber)

Radionuclide	**Annual effective dose, Sv**		
	Short term	**Long term**	**Total**
H-3	4.82E-13	0	4.82E-13
Kr-85	3.11E-09	0	3.11E-09
Y-90	0	< 1.96E-11	< 1.96E-11
Sr-90	0	< 3.61E-12	< 3.61E-12
Rh-106	0	< 7.27E-19	< 7.27E-19
Ru-106	0	< 8.29E-14	< 8.29E-14
Sb-125	0	< 5.89E-13	< 5.89E-13
I-129	2.56E-12	3.20E-12	5.76E-12
Cs-134	0	< 2.42E-10	< 2.42E-10
Cs-137	0	< 1.52E-09	< 1.52E-09
Ba-137m	0	< 1.26E-17	< 1.26E-17
Ce-144	0	< 2.82E-12	< 2.82E-12
Pr-144	0	< 9.63E-19	< 9.63E-19
Pm-147	0	< 1.29E-11	< 1.29E-11
Eu-154	0	< 8.85E-14	< 8.85E-14
Eu-155	0	< 1.37E-15	< 1.37E-15
Np-237	0	< 1.37E-16	< 1.37E-16
Pu-238	0	< 1.01E-12	< 1.01E-12
Pu-239	0	< 1.35E-13	< 1.35E-13
Pu-240	0	< 3.89E-13	< 3.89E-13
Pu-241	0	< 4.92E-11	< 4.92E-11
Am-241	0	< 5.19E-13	< 5.19E-13
Am-242m	0	< 2.56E-15	< 2.56E-15
Am-243	0	< 1.20E-14	< 1.20E-14
Cm-242	0	< 1.38E-14	< 1.38E-14
Cm-243	0	< 6.25E-15	< 6.25E-15
Cm-244	0	< 9.56E-13	< 9.56E-13
Total	**3.12E-09**	**< 1.85E-09**	**< 4.97E-09**

The expected effective dose to the critical group member of the population due to short term (immediate) release of airborne activity into atmosphere is about 3.1×10^{-6} mSv. The expected annual effective dose to the critical group member of the population due to release of airborne activity into atmosphere (both short and long terms) is about 5.0×10^{-6} mSv. The expected exposure of population radiologically is insignificant.

9.4. Summary of Potential Impact on the Environment due to Emergency Situations

This chapter summarizes assessment of potential radiological impacts due to emergency situations of proposed economic activity as estimated in sub-chapters above and demonstrates conformance to regulatory requirements.

The risk analysis (cf. chapter 9.1) has identified two accidents which can not be ruled out in later design steps due to concept of proposed economic activity and which due to risk level could be considered as probable and potentially leading to environmental impact. These accidents are:

- Accidental cutting of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS;
- Accidental breaking of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS.

The consequences of selected accidents have been assessed in more details (cf. chapter 9.2 and 9.3). The summary of results and conclusions are presented below. An overview of regulatory requirements for radiation protection is presented in chapter 5.3.1.

9.4.1. Potential Radiological Impact to Personnel due to Emergency Situations of Proposed Economic Activity

Potential radiological impact to personnel due to emergency situations of proposed economic activity is summarized in Table 9.4.1-1.

Table 9.4.1-1. Annual effective dose to the members of personnel due to emergency situations of proposed economic activity

Accident	Annual effective dose, Sv	Remarks and reference
Accidental cutting of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS (at Reactor Units)	5.46E-04	In total about 59 mechanically damaged and 24 experimental nuclear fuel assemblies have to be processed (at both Reactor Units), Chapter 9.2.2.
Accidental breaking of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS (at Reactor Units)	< 6.53E-04	In total about 28 heavy mechanically damaged nuclear fuel assemblies have to be processed (at both Reactor Units), Chapter 9.3.2.

The expected annual effective dose due to potential accidents is less than 1 mSv. About 70 % of exposure will result from short term (immediate) release of airborne activity at the time of accident. The annual effective dose due to accident is far below limit for annual effective dose (50 mSv, cf. chapter 5.3.1.1).

9.4.2. Potential Radiological Impact to Population due to Emergency Situations of Proposed Economic Activity

Potential radiological impact to population due to emergency situations of proposed economic activity is summarized in Table 9.4.2-1.

Table 9.4.2-1. Annual effective dose to population due to emergency situations of proposed economic activity

Accident	**Annual effective dose for exposure location, Sv**		**Remarks and reference**
	At the location of maximal exposure	**On the border of existing INPP SAZ *)**	
Accidental cutting of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS (at Reactor Units)	3.89E-09	< 1.82E-09	In total about 59 mechanically damaged and 24 experimental nuclear fuel assemblies have to be processed (at both Reactor Units), Chapter 9.2.3.
Accidental breaking of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS (at Reactor Units)	< 4.97E-09	< 2.30E-09	In total about 28 heavy mechanically damaged nuclear fuel assemblies have to be processed (at both Reactor Units), Chapter 9.3.3.

*) 3000 m radius zone from INPP Reactor Units

The expected annual effective dose to the critical group member of population due to potential accidents is below 5.0×10^{-6} mSv. The annual effective dose due to accident is far below limit for annual effective dose (1 mSv, cf. chapter 5.3.1.2).

On the border of existing INPP sanitary protected zone (i.e. 3000 m radius zone from INPP Reactor Units) the radiological impact to the critical group member can be considered as insignificant. The annual effective dose due to potential accidents of proposed economic activity is estimated to be below 2.3×10^{-6} mSv.

10.POTENTIAL IMPACT ON NEIGHBOURING COUNTRIES

Two countries, i.e. the Republic of Belarus and the Republic of Latvia, are relatively close to the sites of proposed economic activity. The state border Lithuania–Belarus is in about 5 km to the east from Ignalina NPP Reactor Units and in about 6 km to the southeast from new Interim Spent Fuel Storage Facility (ISFSF) site. The state border Lithuania–Latvia is in about 8 km to the north from INPP Reactor Units and in about 9 km from ISFSF site.

The Daugavpils region of Latvia and the Braslav region of Belarus are in the vicinity of new ISFSF (Fig. 10-1).

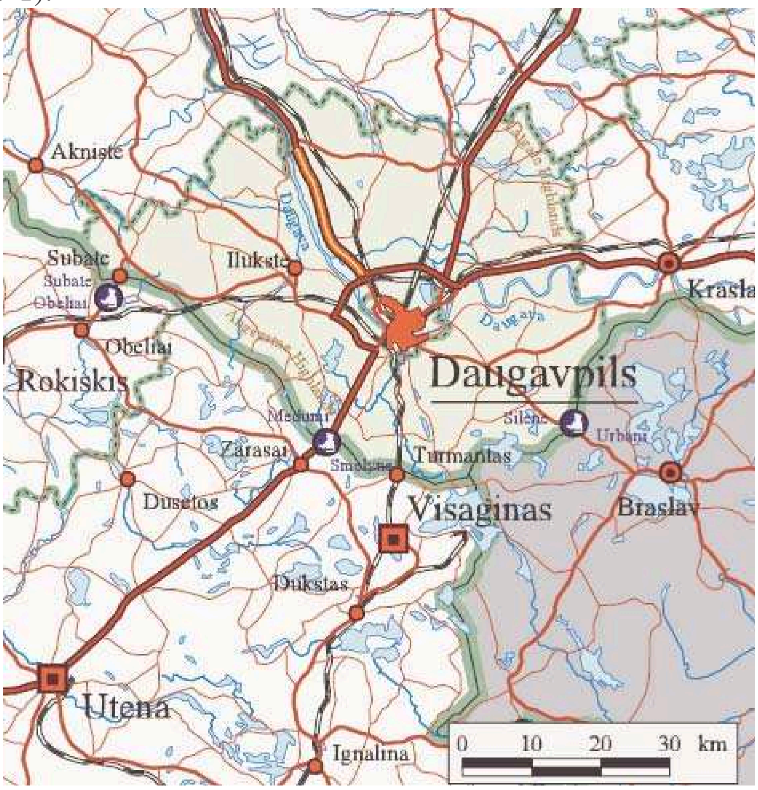


Figure 10-1. The Daugavpils region of Latvia and the Braslav region of Belarus

10.1. Short Description of the Components of the Environment

10.1.1.Daugavpils Region

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

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

Total population of the Daugavpils region is 159 503. Population density is 61 inhabitants per km^2. Daugavpils, the second big city in Latvia after Riga, is an independent structural unit with 115 300 inhabitants (2000). In the region there are 24 small rural areas and 2 towns (Ilukste – 3 177 inhabitants and Subate – 1 013 inhabitants). Approximately 75 % of the inhabitants of the Daugavpils region live in urban areas. Population density in rural areas is low and the population is rather old.

The most significant enterprises in the Daugavpils region are synthetic fibres producer *Tolaram Fibres*, with 2 840 employees, *Lokomotive*, producing rail and tram cabins and equipment (2 330 employees) and *Daugavpils pivedkezu rupnica* (1 040 employees), which produces bearings, cogwheels and steering elements. Daugavpils is an important transport crossroad. Other significant infrastructure objects are the thermoelectric power station of the Daugavas Cascade and oil transit pipeline route to Ventspils harbour.

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

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

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

10.1.2.Braslav Region

Braslav region is administrative part of Vitebsk district. The only town in the region is Braslav with 10 thousand inhabitants. Other settlements are Vidzy, Pliusy and smaller villages (Fig. 10-2). Braslav town is on a shore of lake Driviaty, in a distance of 30 km from railway station Druia, 220 km from Minsk and 238 km from Vitebsk. There are factories of building materials, greengrocery production etc. in the town.

National park "Braslav Lakes" occupies 69.1 thousand hectares or about one third of Braslav region territory. The most picturesque and precious areas around the Braslav town forms a core of the national park. Extension of the park from north to south is 56 km and the width varies from 7 to 29 km. There are more than 60 lakes in the national park; they occupy 17 % of its territory. The first-rate lakes are Driviaty, Snudy, Strusto, Boginskoie (Fig. 10-2). The lake Volos South is the deepest in the park and region; it is as deep as 40.4 m.

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

- The reserved zone – 3452 hectares (4.9 %). This zone is in the most precious area of forest tract Boginskoie. The purpose of the reserved zone is preservation in untouched condition of typical and unique ecosystems and a gene pool of flora and fauna;
- The zone of controllable use – 27746 hectares (39.0 %). The purpose of this zone is studies of restoration, moving forces and trends of inviolate ecosystems;

Figure 10-2. The Braslav region of Belarus

- The recreational zone – 12103 hectares (17.0 %). This zone is assigned for allocation of units and buildings for rest and tourism, for actions on cultural work among the masses and for car parking management;
- The zone for economical activity – 25815 hectares (36.3 %). This zone is assigned for allocation of park visitors' service units, living quarters and for economical activities.

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

The typical forest inhabitants are elk, wild boar, deer, squirrel, mountain hare (*Lepus timidus*), brown hare (*Lepus europaeus*), fox etc. The rare species from the Red Book of Belarus are badger, lynx and brown bear. There are about 200 species of birds in the national park "Braslav Lakes". The rare species are black stork, crane (*Grus grus*), herring gull (*Larus argentatus*), ptarmigan, dunlin etc.

10.2. Potential Radiological Impact on the Environment

Potential radiological impacts due to normal operation of proposed economic activity is assessed in chapter 5. Potential radiological impacts due to emergency situations of proposed economic activity is assessed in chapter 9. This chapter summarizes results as relevant for Belarus and Latvia Republics. Details on assessment assumptions, methodology etc. can be found in above mentioned chapters of EIA Report.

By this proposed economic activity radiological impact on environment potentially could be produced by release of airborne activity (aerosols, gases etc.) generated during operational processes and due to irradiation from structures and installations containing radioactive material. There will be no uncontrolled discharges of radioactive effluents into the environment from the proposed economic activity under normal operation conditions.

The state borders of both neighbouring countries are located outside the 3 km radius sanitary protected zone of INPP. Therefore, radiological impact for neighbouring countries will be lower than is assessed for the exposure location on the border of INPP sanitary protected zone.

Dose assessment results for the exposure location on the border of INPP sanitary protected zone show that potential radiological impact is extremely low and from radiological point of view can be considered as insignificant. As criterion for radiological insignificance a dose limit applicable to exempted practices can be used. Practices and sources within practices may be exempted if 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 1×10^{-2} mSv or less [1, 2]. The annual effective doses to the member of the public due to normal operation and accident situations of proposed economic activity are below exemption limit by several orders ($<10^{-4}$ mSv). Thus it can be concluded that radiological impact for Belarus and Latvia Republics will not be created. Details on expected exposure are provided in sub-chapters below.

10.2.1. Radiological Impact due to Normal Operation

Two activity phases could be distinguished in this proposed economic activity when radiological impact possible, cf. chapter 1.5. The radiological impact sources are different also. During fuel transfer to ISFSF phase (years 2008 – 2015), spent nuclear fuel will be extracted from INPP fuel storage pools and will be loaded into fuel storage casks. Casks then will be transferred to ISFSF for interim storage. Main radiological impact sources will be fuel loading and transferring activities. The maximal fuel load at ISFSF will be reached by the beginning of interim fuel storage phase (years 2016 – 2065) and the ISFSF will become a main radiological impact source. Expected annual effective doses to the member of public are presented in Table 10.2.1-1 and Table 10.2.1-2 below.

Table 10.2.1-1. Annual effective dose to population due to normal operation of proposed economic activity (SNF transfer phase, years 2008 – 2015)

Activities	Annual effective dose on the border of existing INPP SPZ *), Sv	Remarks and reference
SNF handling at Reactor Units (dose due to airborne releases)	4.15E-07	Annual effective dose to the critical group member at the location of the highest predicted exposure, Chapter 5.1.5.2
Transfer of SNF from Reactor Units to ISFSF (dose from cask)	1.31E-09	Chapter 5.2.2.2
Interim SNF storage at ISFSF (dose from ISFSF building structure)	< 2.72E-08	Maximal dose for full SNF load and critical exposure direction, Chapter 5.2.3.2
SNF reloading at IFHC of ISFSF (dose due to airborne releases)	1.24E-08	Annual effective dose to the critical group member at the location of the highest predicted exposure, Chapter 5.1.5.3
Total dose due to proposed economic activity	< 4.56E-07	

*) 3000 m radius zone from INPP Reactor Units

Table 10.2.1-2. Annual effective dose to population due to normal operation of proposed economic activity (Interim SNF storage phase, years 2016 – 2065)

Activities	Annual effective dose on the border of existing INPP SPZ *), Sv	References and remarks
SNF handling at Reactor Units (dose due to airborne releases)	-	No operations will be performed
Transfer of SNF from Reactor Units to ISFSF (dose from cask)	-	No operations will be performed
Interim SNF storage at ISFSF (dose from ISFSF building structure)	< 2.72E-08	Maximal dose for full SNF load and critical exposure direction, Chapter 5.2.3.2
SNF reloading at IFHC of ISFSF (dose due to airborne releases)	1.24E-08	Annual effective dose to the critical group member at the location of the highest predicted exposure, Chapter 5.1.5.3
Total dose due to proposed economic activity	< 3.96E-08	

*) 3000 m radius zone from INPP Reactor Units

On the border of existing INPP sanitary protected zone the radiological impact to the member of population can be considered as insignificant. The annual effective dose to the member of population located outside the border of INPP sanitary protected zone is estimated to be below 5×10^{-4} mSv (4.56×10^{-7} Sv). The exposure of member of population of Belarus and Latvia Republic will be lower as these countries are more distant.

10.2.2. Radiological Impact due to Emergency Situations

The risk analysis of potential emergency situations (cf. chapter 9) has identified two accidents which can not be ruled out in later design steps due to concept of proposed economic activity and which due to risk level could be considered as probable and potentially leading to environmental impact. These accidents are:

- Accidental cutting of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS;
- Accidental breaking of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS.

The consequences of selected accidents for the member of population, located on the border of INPP sanitary protected zone are presented in Table 10.2.2-1 below.

Table 10.2.2-1. Annual effective dose to population due to emergency situations of proposed economic activity

Accident	**Annual effective dose on the border of existing INPP SPZ *), Sv**	**Remarks and reference**
Accidental cutting of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS (at Reactor Units)	< 1.82E-09	In total about 59 mechanically damaged and 24 experimental nuclear fuel assemblies have to be processed (at both Reactor Units), Chapter 9.2.3.
Accidental breaking of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS (at Reactor Units)	< 2.30E-09	In total about 28 heavy mechanically damaged nuclear fuel assemblies have to be processed (at both Reactor Units), Chapter 9.3.2.

*) 3000 m radius zone from INPP Reactor Units

On the border of existing INPP sanitary protected zone the radiological impact to the member of population can be considered as insignificant. The annual effective dose due to potential accidents of proposed economic activity is estimated to be below 2.3×10^{-6} mSv (2.3×10^{-9} Sv). The exposure of member of population of Belarus and Latvia Republic will be lower as these countries are more distant.

10.3. Non Radiological Impacts on the Components of the Environment and Impact Mitigation Measures

10.3.1. Water

10.3.1.1. Potential Impact

There will be no uncontrolled discharges into the environment from new Interim Spent Fuel Storage Facility (ISFSF) site. The ISFSF sewage water will be released into existing INPP sewage system in controlled manner and in accordance with the requirements of normative document [3]. Flooding of storage facility by surface water will be prevented by construction and maintenance of site storm (surface) water drainage system. The ISFSF storm water drainage system shall be routed outside the territory of the ISFSF and connected to the existing industrial-storm drain system. The impact on surface water and groundwater by traffic-related substances is considered insignificant due to low forecasted traffic levels. Oil removers (mechanical) are installed just at the outlet of industrial-storm water to the lake Drisviaty (Druksiai). The ISFSF site surface water drainage system shall follow the requirements of normative document [4].

The Visaginas town waterworks is in about 2.5 km to the southwest from the ISFSF. The water is extracted from Sventoji–Upininkai aquifer complex of upper and middle Devonian formations. ISFSF site is outside the boundaries of the Visaginas town waterworks sanitary protection zone [5], [6]. Conservative evaluations of the possible migration of contamination in the water component show that ISFSF, as a local and relatively small object (in comparison to waterworks catchment area) can not substantially affect the quality of underground water of the Visaginas town waterworks [7]. The waterworks in the territories of Braslav region of Belarus and Daugavpils region of Latvia are considerably more distant in comparison with Visaginas town waterworks.

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.

So, the construction and operating of the ISFSF will not significantly affect the surface water run-off and groundwater quality neither in the territory of Lithuania, nor in the territories of Braslav region of Belarus and Daugavpils region of Latvia.

10.3.1.2. Impact Mitigation Measures

The INPP site is surrounded by existing network of groundwater monitoring boreholes. The ISFSF will be designed in such a way that there will be no uncontrolled discharges into the environment. Nevertheless survey boreholes (wells) for monitoring groundwater quality are foreseen around the ISFSF as part of required environmental monitoring. The underground water monitoring programme for boreholes to be arranged at ISFSF site will be developed in accordance with normative document [8] and methodological recommendations [9] and presented to the Geological Survey of Lithuania for approval. INPP Environment Monitoring Programme [10] can be updated only on the basis of this programme (see Chapter 8 “Monitoring”).

10.3.2. Environmental Air (Atmosphere)

10.3.2.1. Potential Impact

The ISFSF in itself does not cause perceptible atmospheric emissions. The backup power will be provided by small emergency diesel (approx. 80 kW) and limited to 24 hours. Calculated amounts of pollutants and tax for pollution of environment are presented in Section 3.1.3 and are very low.

Mobile sources, such as the existing locomotive, which will draw or push the rail transporter, vehicles during the construction of the ISFSF and personnel transport (private cars, public minivans) will not cause significant atmospheric emissions. The affected area will only include the roads connecting INPP and ISFSF sites and their direct environment in a range of about 100 m.

In summary, no significant adverse effect on the environment in the territories of Braslav region of Belarus and Daugavpils region of Latvia is to be expected from air pollutant emissions.

10.3.2.2. Impact Mitigation Measures

Due to low forecasted traffic levels the impact level of the emissions of the 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 avoid the accumulation of significant concentrations of such substances. EU standards for combustive-lubricating materials (among which sulphur content) and old cars replacement will help in the relative reduction of pollutant emissions from each individual vehicle.

10.3.3.Soil

10.3.3.1. Potential Impact

The construction of the new ISFSF will occur within the boundaries of the existing industrial site. The site previously (during construction of INPP) to some extent was used as soil buffer dump. The site does not contain valuable fertile layer of the soil. No significant impacts will occur to the soils and the vegetation outside of the footprint of this previously disturbed area.

No soil pollution is foreseen under normal operation conditions of the proposed economic activity. The proposed economic activity does not involve the use of chemical reagents that, in case of accidental releases, could contaminate the soil.

During the construction period of the ISFSF, the temporary accumulation of soil and equipment, and generation of dust from the movement of heavy vehicles and also from earth movements (dust clouds during dry periods) will be the main potential impacts on soil pollution of near-border areas of Belarus and Latvia.

In case of local soil contamination by conventional pollutants (i.e. accidental spillage of deliverables like cement etc) an appropriate procedures will be implemented to eliminate hazard and consequences of impact.

These impacts will be temporary and are expected to be low due to the site location and favourable conditions of the existing infrastructure in the region. It needs to be mentioned that all impacts will be reversible.

10.3.3.2. Impact Mitigation Measures

Construction techniques will be implemented that will minimize soil erosion and the quantities of sediment in storm water runoff from the construction area. Site grading and materials stockpiling will be performed using techniques designed to minimize potential erosion of topsoil. Where appropriate, hay bales and/or silt fencing will be installed in areas down gradient of construction activities to minimize sediment loading in storm water runoff.

All slopes and working surfaces will be returned to a stable condition. Topsoil on the final site will be graded and planted as appropriate. Re-vegetation will be performed using local plants.

10.3.4.Underground (Geology)

The territory of Lithuania is subject to earthquakes. About 20 earthquakes with intensity up to force 2–5 (on a 12-force MSK-64 scale) are recorded in the Baltic region during the last 400 years, see Subchapter 4.1.6. It is indicated that earthquakes could reach an intensity of force 6–7 in the seismically weak soil. Therefore the ISFSF will be design to withstand a design basis earthquake with the intensity of 6 force on a MSK-64 scale. A beyond design basis earthquake for the INPP area is postulated to be the intensity of 7 force with frequency 1 per 10000 years.

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

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 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 Braslav region of Belarus and Daugavpils region of Latvia.

10.3.5.Biodiversity

The ISFSF occupied area will be relatively small (300×100 m). No unique bird ecosystems or mapped critical habitats occur at the ISFSF site. Main impact during the construction phase will be the nuisance of breeding birds by the construction machines due to exhaust fumes, noise and visual irritations.

Since the new ISFSF will be built in an existing industrial area, birds can get used to the activities on the INPP site or they may go to other, calmer parts of the lake Drisviaty (Druksiai) in the territory of Braslav region of Belarus. However birds could be affected by sudden, heavy noises. It is anticipated that the area around the ISFSF may be slightly devaluated as bird habitat. The main impact mitigation measure is that noisy activities will be carried out during daytime only.

Construction and operation of the ISFSF will produce no noise that will be perceptible at the territories of Braslav region of Belarus and Daugavpils region of Latvia since they are located at least 6 km from the ISFSF site. For example, if an ambient noise at the ISFSF site reaches 85 dB (A) (which is typical of an automobile passing at a few meters), than 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.

Except 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 biodiversity outside the boundary of ISFSF site. The new ISFSF will not affect the migration of animals (e.g. birds, amphibia and flying insects). Landscape, terrain and habitat structures of the ISFSF site surroundings indicate that migration of large beasts like elk or hind is not expected. Although several of mammal species could potentially occur in the site vicinity, it is likely that several of these taxa would require more remote habitats than the territory of INPP provides.

So, there will be no relevant impact created on 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.

10.3.6.Landscape

The landscape in the lake Drisviaty (Druksiai) watershed has degraded because of the building and operation of INPP, Visaginas town and related infrastructure. From the architectural point of view the ISFSF buildings will have a clean functional design (see Figures 6.6-2 and 6.6-3). They will be not visible from the territories of Latvia and Belarus.

10.3.7.Ethnic and Cultural Conditions, Cultural Heritage

The ISFSF will be constructed in the site previously (during construction of INPP) to some extent used as soil buffer dump. There are no detected objects of cultural heritage or ethnic or cultural conditions that could be impacted by the proposed economic activity. Proposed economic activity will have no relevant interaction with ethnic and cultural conditions, cultural heritage of Latvia and Belarus.

10.3.8.Social and Economic Environment

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

The proposed economic activity will not produce any significant impacts of conventional (non radiological) nature, which could physically affect components of the environment and public health of Belarus and Latvia. The conventional impacts might be detected only in close vicinity to the ISFSF and impact sources (i.e. airborne emissions etc.) will be held within permissible limits.

New ISFSF will provide a modern spent nuclear fuel storage system according to management principles of IAEA and in compliance with good practices in other European Union Member States.

However, population discontent and distrust is possible. Such a psychological impact is stipulated by changes in existing nuclear practice (shutdown and decommissioning of INPP), which results in construction of new nuclear objects such as ISFSF and others.

Psychological impact can be mitigated explaining necessity, goals and benefits from proposed economic activity:

- There are no alternatives for proposed economic activity as decommissioning of INPP is inevitable. Therefore, a safe and reliable facility for long-term storage of spent nuclear fuel, i.e. construction of a new ISFSF is required. There could be location alternatives but the performed analysis has clearly shown that the INPP area is the most appropriate place for the ISFSF (see developments in Subsection 7.1 “Location Alternatives”);
- The new ISFSF will be constructed in accordance with the modern environmental requirements using state-of-the-art technologies;
- The new ISFSF will be built in an existing industrial area;
- 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 investor confidence not only in the domestic market but also in the international markets, including Latvia and Belarus;
- Calculations and assessments performed in this EIA Report have clearly shown, that the proposed economic activity will not produce significant impacts neither the radiological nature nor the non radiological nature, which could affect the components of the environment and public health of Belarus and Latvia.

The Republic of Latvia and the Republic of Belarus in accordance with the provisions of the Espoo Convention [11] were notified of a proposed activity and informed about the EIA Programme. Latvia and Belarus indicated that they intend to participate in the EIA procedure and proposed some additional items to be assessed in the EIA documentation [12–13]. Public organizations and separate citizens of the Republic of Belarus are worried about new ISFSF [14, 15]. All these proposed additional items and public concerns are assessed in this EIA Report.

Local communities, local and regional politicians and authorities, as well as national and regional mass media, must all be properly consulted in the ISFSF siting, planning and EIA results. Public and political acceptance can only come about through the transfer of accurate and unbiased information concerning this specific project. Public acceptance will only be gained if the debate is well-informed and dispassionate.

New ISFSF will be operated under the strict control of national regulatory authorities. These government institutions enforce state regulations that are based on the European Union practices, as well as on guidelines and conventions established by international organisations, such as the International Atomic Energy Agency (IAEA).

The proposed economic activity, which intends to introduce an advanced spent nuclear fuel storage technology, will increase nuclear safety and significantly reduce risk of possible accidents compared with the existing technology of spent nuclear fuel storage in Ignalina NPP spent nuclear fuel storage pools. Public of Daugavpils and Braslav regions should be aware that after final shutdown of Ignalina NPP no nuclear material dumps would remain in contrast with Chernobyl NPP. All nuclear materials will be managed according to management principles of IAEA and in compliance with good practices in other European Union Member States.

11.DESCRIPTION OF DIFFICULTIES

Description of difficulties (technical or practical) encountered by the developers while performing EIA or preparing the EIA Report will be presented, if any difficulties will be encountered. No difficulties are presently obvious.

12.EXECUTIVE SUMMARY

12.1. Introduction

There is only one nuclear power plant in Lithuania – Ignalina NPP (INPP). The power plant possesses two RBMK-1500 type reactors. 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 has approved an immediate decommissioning strategy for the first power unit of INPP.

The decommissioning of INPP main systems can only start when the spent nuclear fuel (SNF) is fully removed from Reactor Units. Transfer of RBMK spent nuclear fuel to other countries (e.g. for reprocessing, storage, disposal etc.) because of a number of technical and political reasons is not possible either now or in the near future. Taking into account the fact that a deep geological repository is not available in Lithuania and likely will not be available at least until the middle of this century, the long-term storage is the only one present day option for the management of INPP spent nuclear fuel. The long-term storage is a temporary solution before the final spent nuclear fuel route will be defined and necessary actions will be implemented. The Lithuanian Strategy on Radioactive Waste Management foresees several options to be investigated prior the final decision will be taken:

- Possibility to dispose off the SNF in the national deep geological repository;
- Possibility to dispose off the SNF in the regional deep geological repository;
- Possibility to transfer and dispose off the SNF in other countries;
- Possibility to safe store the SNF for 100 years and more.

In the framework of the preparation for the decommissioning of the INPP a new Interim Spent Nuclear Fuel Storage Facility (ISFSF) 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 Lithuanian Government. In addition to the ISFSF, the new spent nuclear fuel management activity will include all necessary spent nuclear fuel retrieval and packaging operations at Reactor Units, transfer of SNF from Reactor Units to the ISFSF, and other activities appropriate to the chosen design solution and required for the safe removal of the existing spent nuclear fuel from storage pools and insertion into the new ISFSF.

NUKEM Technologies GmbH and GNS mbH consortium named as “Consortium GNS – NUKEM Technologies GmbH” is contracted to fulfill the design, construction and licensing for operation of the new spent nuclear fuel management activity. The overall activity organization includes Lithuanian as well as western sub-contractors. Lithuanian Energy Institute is a local subcontractor of consortium and provides assistance, among other, in preparing of environment impact assessment documents.

12.2. Technology

The proposed economic activity is named as the “Interim Storage of RBMK Spent

Nuclear Fuel from Ignalina NPP Units 1 and 2". By this activity up to 36000 of spent RBMK-1500 nuclear fuel bundles (from about 18000 of spent fuel assemblies) can be loaded into storage casks of CONSTOR® RBMK1500/M2 type at Reactor Units. The casks then will be transferred into the newly constructed ISFSF for long-term (at least for 50 years) interim storage.

The CONSTOR® RBMK1500/M2 cask (Fig. 12-1) will be designed as multi-barrier system which shall assure confinement and long-term storage of SNF without any need for scheduled intervention during the whole storage period. The cask uses steel for the containment, heavy concrete as additional shielding, and a triple lid closure system with one bolted and two welded lids. The steel/heavy concrete/steel system provides both gamma and neutron shielding, and mechanical strength. The double-barrier welded lid system, together with the double-barrier design of the cask body will ensure tightness of activity during long-term storage.

The cask internal cavity is coated with a corrosion protection layer, which provides appropriate compatibility with the pool water during cask loading. After loading with SNF, the cask cavity is vacuum-dried and filled with inert gas (helium). In this way corrosion is inhibited and heat transfer in the cask cavity is improved. The outer cask surface is protected by multi-layer epoxy resin, or comparable coating with proven corrosion protective and decontamination properties.

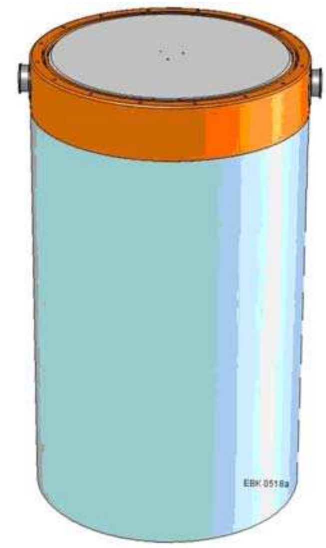


Figure 12-1. CONSTOR® RBMK1500/M2 cask

The ISFSF will be built on a new site at about 600 m to the south from the perimeter of the INPPsite. The approximate dimensions of the ISFSF site are 300×100 m.

The transfer of casks from INPP Reactor Units to the new ISFSF will take place by rail transport. A new railway line up to 1000 m length from INPP to ISFSF site will be constructed and connected to the existing railway system at INPP. The part of railway line which extends outside the INPP and ISFSF sites will be protected with a fencing system.

At the ISFSF site the main storage building (Figure 12-2) and necessary auxiliary structures (Figure 12-3) for casks reception control, site physical protection, site and personnel service etc. will be constructed. ISFSF capacity is planned for storage of 201 CONSTOR® RBMK1500/M2 casks.

Figure 12-2. Concept of the main storage building

Figure 12-3. Concept of the security and administration building (the gate-house) and the vehicle and rail transport inspection area

While it is normally not expected, it will be possible at any time during the storage period to repack the spent fuel if a cask is found to be defective. The ISFSF will have Fuel Inspection Hot Cell (FIHC) where nuclear fuel could be inspected and reloaded into new cask after dismantling of storage pools at INPP. The FIHC structure is integrated into the main building construction.

It will be possible to transport the spent fuel away from the ISFSF site after interim storage without repackaging the fuel. The casks will be designed to meet requirements for B(U) packages according to International Atomic Agency Agency (IAEA) Regulations for the Safe Transport of Radioactive Material. For the off-site transport casks are equipped with a transport over-pack and lid-side and bottom-side shock absorbers forming together with the cask the transport package. These components guarantee that the IAEA transport requirements are fully met and therefore the cask will be suitable for the off-site transport.

12.3. Potential Radiological Impacts

The evaluation of potential radiological impact to the public is of primary concern in demonstration of ability of proposed economic activity to meet the regulatory requirements. The Republic of Lithuania regulations require that the annual effective dose to a member of the population due to operation and decommissioning of nuclear facility shall not exceed the dose constraint. The established dose constraint for nuclear facilities, both operating and planned, is 0.2 mSv per year. 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/year

By this proposed economic activity radiological impact on environment potentially could be produced by release of airborne activity (aerosols, noble gases etc.) generated during operational processes and due to irradiation from structures and installations containing radioactive material or being contaminated by radioactive material. There will be no uncontrolled discharges of radioactive effluents into the environment from the proposed economic activity under normal operation conditions.

Potential radiological impact to population due to radioactive airborne emissions from the proposed economic activity is very low. Highest radioactive releases could be expected during spent nuclear fuel handling at the Reactor Units and transfer to the ISFSF phase (years 2008–2015). The estimated annual effective dose to the critical group member of population is below 0.001 mSv and from radiological point of view can be considered as insignificant.

The highest annual dose to the population may be expected only in the close vicinity of the SWTSF / ISFSF permanent security fence, Figure 12-4. The dose to the member of population is governed by external exposure from the radioactive waste and spent nuclear fuel stored within SWSF and ISFSF buildings. Conservatively calculated highest annual effective dose to the critical group member of population at the ISFSF site permanent security fence equals to about 0.17 mSv. The annual exposure including exposure from other existing and planned nuclear facilities, located in the SPZ of INPP equals to about 0.19 mSv. The annual effective dose is below dose constraint of 0.2 mSv, therefore it may be concluded that radiological protection requirements are not being violated, and the proposed economic activity is possible.

Taking into consideration the conservativeness of the assumptions used in calculations and limitation of population activity, determined by the requirements for physical protection of nuclear facilities, the real exposure of the population close to ISFSF site will be lower than it has been evaluated in this EIA Report.

With increase of distance from ISFSF site, potential exposure rapidly decreases. At the distance of 500 m from the ISFSF site the radiological impact to the member of population can be considered as very low. Calculated annual effective dose to the critical group member of population due to proposed economical activity is below 0.01 mSv (i.e. 10 µSv and below 20 µSv if considering also exposure due to existing and planned releases from INPP site).

With increasing distance from the ISFSF / SWTSF site, the potential exposure to the population rapidly decreases. At the distance of 500 m from ISFSF / SWTSF permanent security fence and railroad connection fence the radiological impact to the critical group member of population due to proposed economic activity can be considered as insignificant. The calculated annual effective dose due to proposed economic activity is below 0.002 mSv. Basing on dose assessment results an approximately 500 m wide sanitary protected zone (SPZ) could be recommended for ISFSF / SWTSF site.

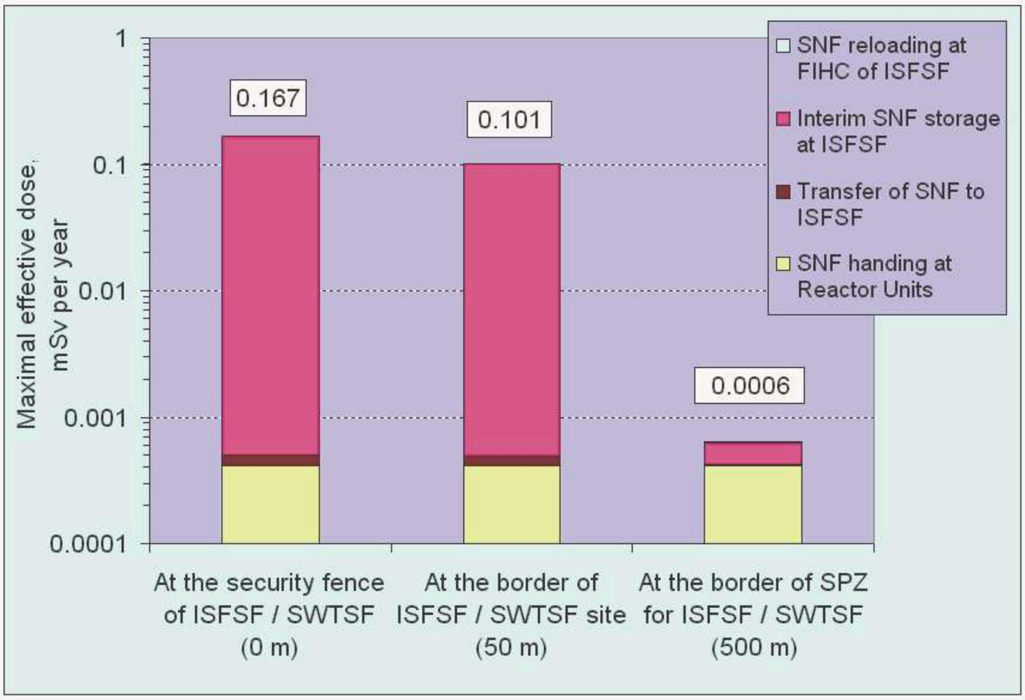


Figure 12-4. Annual exposure of the critical group member of population in the eastern direction from the ISFSF / SWTSF site due to the proposed economical activity

The calculated exposure of a critical group member of the 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. Therefore it can be stated that the radiological protection requirements are not being violated and 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.

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

During the operation of the ISFSF, small amounts of secondary radioactive waste will be generated in the controlled access area. Radioactive waste will be handled using the existing or newly planned INPP technologies. Solid radioactive waste that will arise during operation of the ISFSF will be monitored, bagged and placed in the transport containers for transfer to the appropriate INPP waste treatment or storage facilities. All liquid radioactive waste will be collected in a receiving tanks located in the ISFSF then sent for treatment to the existing INPP liquid waste treatment facility.

12.4. Potential Non Radiological Impacts

The construction of the new ISFSF will occur within the boundaries of the existing industrial site and is anticipated to have little to no impact on terrestrial ecology. No significant impacts will occur to the soils and the vegetation outside of the footprint of this previously disturbed area. No rare and endangered species of plants and animals have been identified in the vegetation communities occurring within the proposed construction site.

The main environmental, social and economic impacts during the construction period are those typical of any construction project. These include intensification of traffic due to the transportation of workers and materials, noise resulting from the operation of machinery, the temporary accumulation of soil and equipment, generation of dust from the movement of heavy vehicles and also from earth movements (dust clouds during dry periods), and air pollution from the diesel exhausts of heavy vehicles. These impacts will be temporary and are expected to be low due to the site location and favourable conditions of the existing infrastructure in the region. In case of local contamination by conventional pollutants (i.e. accidental spillage of deliverables like cement etc) an appropriate procedures will be implemented to eliminate hazard and consequences of impact. All impacts will be reversible.

In itself, the proposed economic activity does not include activities that can have a non-radioactive impact on the components of the environment. There will be no uncontrolled discharges into the environment from the ISFSF site. Once operational the proposed ISFSF will produce no noise that will be perceptible at the nearest residential receptors. Mobile sources, such as locomotive, which will draw or push the rail transporter, the ISFSF personnel transport (private cars, public minivans) will not cause significant atmospheric emissions. The affected area will only include the roads connecting INPP and ISFSF sites and their direct environment in a range of about 100 m. Except 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 biodiversity outside the boundary of ISFSF site. In itself, the ISFSF occupied area will be relatively small (300×100 m). The visibility of the buildings of the ISFSF will be mainly limited to the closest roads within INPP sanitary protection zone. Landscaping, selection of proper design materials and planting of greenery will be used to enhance the appearance of the ISFSF.

12.5. Alternative Analysis

The alternatives considered can be separated into three groups: location, spent nuclear fuel handling and storage system, and storage facility design concept.

There are no alternatives for proposed economic activity as decommissioning of INPP is inevitable. The spent nuclear fuel has been accumulated and presently is stored in the pools of Reactor Units. Therefore, a safe and reliable facility for long-term storage of spent nuclear fuel, i.e. construction of a new ISFSF is required. There could be location alternatives but the performed analysis has clearly shown that the existing sanitary protection zone of INPP is the most appropriate place for the ISFSF. Short distance to INPP is a favorable factor which asures minimal potential risk of radiological impact on environment and population. The negative impact on environment would be higher for all other possible alternative locations that are more distant or even outside the existing INPP sanitary protection zone.

There are a number of different technologies available for the wet and dry storage of spent fuel and within each of these technologies there are several designs. Lithuania has already chosen the dual purpose (storage and transport) cask concept for temporary storage of RBMK spent nuclear fuel. The existing INPP dry interim storage of spent fuel is licensed for storage in total of 98 CASTOR RBMK-1500 and CONSTOR RBMK-1500 casks. So it was decided to continue good practice with dual-purpose dry type SNF storage technologies.

12.6. Emergency Situations

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, were subject of investigation and assessment.

Emergency situations, which could lead to damage of fuel cladding, release of activity and in following to radiological exposure of personnel and/or general public are of primary concern. For this proposed economical activity most of potential emergency situations can cause radiological and non-radiological or only non-radiological consequences, for example drop or collision of SNF bundle. In case of light accident only non-radiological consequences like stop in operation are expected. In case of drop of SNF bundle from considerable height a damage of a certain number of fuel rods might be relevant. Accidents with non-radiological consequences as a rule lead to considerable lower impact and therefore are enveloped by consequences of radiological accidents.

The risk analysis of potential emergency situations has identified two accidents which can not be ruled out in later design steps due to concept of proposed economic activity and which due to risk level could be considered as probable and potentially leading to environmental impact. These accidents are:

- Accidental cutting of fuel rods within a fuel bundle while processing a damaged fuel assembly by Defective Fuel Handling System (DFHS);
- Accidental breaking of fuel rods within a fuel bundle while processing a damaged fuel assembly by DFHS.

The consequences of selected accidents have been assessed in more details. The potential radiological consequences to the population are calculated to be very low and the radiological impact can be considered as insignificant.

12.7. Potential Impact on Neighbouring Countries

Two countries, i.e. the Republic of Belarus and the Republic of Latvia, are relatively close to the sites of proposed economic activity. The state border Lithuania–Belarus is in about 5 km to the east from Ignalina NPP Reactor Units and in about 6 km to the southeast from new Interim Spent Fuel Storage Facility (ISFSF) site. The state border Lithuania–Latvia is in about 8 km to the north from INPP Reactor Units and in about 9 km from ISFSF site. The Daugavpils region of Latvia and the Braslav region of Belarus are in the vicinity of new ISFSF

The state borders of both Belarus and Latvia Republics are located outside the 3 km radius sanitary protected zone of INPP. Therefore, radiological impact for neighbouring countries will be lower than is assessed for the exposure location on the border of INPP sanitary protected zone.

Dose assessment results for the exposure location on the border of INPP sanitary protected zone show that potential radiological impact is extremely low and from radiological point of view can be considered as insignificant. As criterion for radiological insignificance a dose limit applicable to exempted practices can be used. Practices and sources within practices may be exempted if 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 0.01 mSv (i.e. 10 μSv) or less. The annual effective doses to the member of the public due to normal operation and accident situations of proposed economic activity are below exemption limit by several orders (i.e. below 0.0001 mSv or 0.1 μSv). Thus it can be concluded that radiological impact for Belarus and Latvia Republics will not be created.

The proposed economic activity will not produce any significant impacts of conventional (non radiological) nature, which could physically affect components of the environment and public health of Belarus and Latvia. The conventional impacts might be detected only in close vicinity to the ISFSF and impact sources (i.e. airborne emissions etc.) will be held within permissible limits.

New ISFSF will provide a modern spent nuclear fuel storage system according to management principles of IAEA and in compliance with good practices in other European Union Member States. However, population discontent and distrust is possible. Such a psychological impact is stipulated by changes in existing nuclear practice (shutdown and decommissioning of INPP), which results in construction of new nuclear objects such as ISFSF and others.

Psychological impact can be mitigated explaining necessity, goals and benefits from proposed economic activity:

- There are no alternatives for proposed economic activity as decommissioning of INPP is inevitable. Therefore, a safe and reliable facility for long-term storage of spent nuclear fuel, i.e. construction of a new ISFSF is required;
- The spent nuclear fuel storage in casks technology as one of the most advanced, a well-developed and practically proven technology is proposed for the spent nuclear fuel interim storage
- The new ISFSF will be built in an industrial area of the existing INPP sanitary protection zone;
- The new ISFSF will be constructed in accordance with the modern environmental requirements using state-of-the-art technologies;
- The new ISFSF will be operated under the strict control of national regulatory authorities. These government institutions enforce state regulations that are based on the European Union practices, as well as on guidelines and conventions established by international organisations, such as the International Atomic Energy Agency (IAEA).

The proposed economic activity, which intends to introduce an advanced spent nuclear fuel storage technology, will increase nuclear safety and significantly reduce risk of possible accidents compared with the existing technology of spent nuclear fuel storage in Ignalina NPP spent nuclear fuel storage pools. All radioactive materials will be managed according to management principles of IAEA and in compliance with good practices in other European Union Member States. The design of the proposed economic activity will ensure that the environmental impact due to installation and operation of the new storage facility will only be within the allowed boundaries defined by the requirements of Lithuanian and appropriate international regulations.

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14. Letter of the Ministry of the Environment of the Republic of Lithuania No. (1-15)-D8-4119 dated May 15, 2006. Re: On the Concerns of Public Organizations of the Republic of Belarus about Installation of Interim Spent Nuclear Fuel Storage Facility and Radioactive Waste Near Surface Repository.
15. Letter of the Ministry of Natural Resources and Environment Protection of the Republic of Belarus No. 03-03/1089 dated April 27, 2006.

Part II. Attached Documents

The EIA report has been presented for the public review following the requirements of the Law on the Environmental Impact Assessment of Planned Economic Activity (State News. 2005 Nr. 84-3105) and of the Order on Informing the Public and the Public Participation in the Process of Environment Impact Assessment (State News. 2005 Nr. 93-3472).

The prepared EIA report, issue date November 16, 2006, has been presented to the public. The public was informed about the possibility of getting acquainted with the prepared EIA report and planned public presentation via national, Ignalina region, Zarasai region and Visaginas town media (national newspaper "Lietuvos rytas", Ignalina region newspaper "Nauja vaga", Zarasai region newspaper "Zarasu krastas", Visaginas town newspaper "Sugardas") more than 10 work days in advance to the planned meeting with the public. An advertisement, informing about the planned meeting and a possibility of getting acquainted with the EIA report, has been published in the advertisement board of the municipality of the Visaginas town. It was possible to get acquainted with the EIA report in the municipality of the Visaginas town and Ignalina NPP information center. An advertisement, informing about the planned meeting with the public and EIA electronic version have been placed on the Ignalina NPP Internet web site (www.iae.lt).

Up till now no motivated proposals for the proposed economic activity have been received.

Public presentation and consideration of the EIA report was scheduled for January 26, 2007 in Ignalina NPP decommissioning service building, on convenient for the public and non working time. Within an hour from the scheduled time, no public representatives appeared. Therefore, it is concluded that public is not interested in the proposed economic activity and the public informing procedure has been performed.

Following the requirements of the ESPOO Convention (State News 1999, No. 92-2688), 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 (May 13, 2007 in Daugavpils, Latvia and April 19, 2007 in Vidzy, Belarus). 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. The comments of institutions and the public of the Republics Belarus and Latvia to the EIA report are presented in the Ministry of Environment letter No. (1-15)-D8-2987 from April 3, 2007.

The answers to the comments of the Republic of Belarus for the EIA report are presented in the attachment 1. The answers to the comments of the Republic of Latvia for the EIA report are presented in the attachment 2.

The prepared EIA report, issue date November 16, 2006, 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:

- 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;

- Department of Cultural Heritage under the Ministry of Culture. No remarks to be considered have been received. Inaccuracy in the EIA report was indicated concerning the information on the number of the objects of cultural heritage in the Ignalina NPP region;
- State Nuclear Power Safety Inspectorate (VATESI). No remarks to be considered have been received;
- Department of Fire Protection and Rescue under the Ministry of Inner Affairs. No remarks to be considered have been received;
- Ministry of Health. The Ministry in the letter No. 10-1231 dated March 5, 2007, has presented 5 remarks, and in the letter No. 10-2099 dated 17 April 17, 2007, has presented 6 remarks.

Answers to the remarks of the Ministry of Health are presented in the attachments 3 and 4. The presented answers have been evaluated by experts of Radiation Protection Center and State Environment Health Center. No additional remarks to the EIA Report have been presented. It is also indicated that the EIA Report presently is under review by technical support organizations and review is still not finished. Therefore the final conclusion on possibility to conduct the proposed economic activity will be taken after consideration of results of the review.

The updated EIA report, issue date June 21, 2007, has been presented for review to the Ministry of Environment. The Ministry of Environment in the letter No. (1-15)-D8-6614 dated August 2, 2007 has presented 19 remarks to be considered. Also, the results of review from technical support organizations of Radiation Protection Center have become available. Comments are provided by the Ministry of Health letter No. 10-4263 dated August 1, 2007. The Ministry of Environment obliged to consider remarks from the technical support organizations as well.

Answers to the remarks of the technical support organizations is presented in the attachment 5. The presented answers have been evaluated by experts of Radiation Protection Center. The answers have been accepted and the Ministry of Health in the letter No. 10-5524 dated October 9, 2007, concluded that proposed economical activity “Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2” is possible.

Answers to the remarks of the Ministry of Environment is presented in the attachment 6.

The following documents are attached to the Part II of the English version of this EIA report:

- Attachment No. 1 to the Part II “Answers to the questions and motivated proposals of the Republic of Belarus Ministry of Natural Resources and Environment Protection” 7 pages;
- Attachment No. 2 to the Part II “Answers to the questions and motivated proposals of the Republic of Latvia Ministry of Environment”, 4 pages;
- Attachment No. 3 to the Part II “Answers to the Remarks of the Republic of Lithuania Ministry of Health”, 8 pages;
- Attachment No. 4 to the Part II “Answers to the Remarks of the Republic of Lithuania Ministry of Health (Radiation Protection Centre)”, 10 pages;
- Attachment No. 5 to the Part II “Answers to the Remarks of the Technical Support Organizations of Radiation Protection Center”, 27 pages;

- Attachment No. 6 to the Part II “Answers to the Remarks of the Republic of Lithuania Ministry of Environment”, 15 pages.

Subcontractor
Lithuanian Energy Institute

Environmental Impact Assessment Report

Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2

Attachment No. 1 to the Part II „Attached documents"

Answers to the questions and motivated proposals of the Republic of Belarus Ministry of the Natural Resources and Environmental Protection

Prepared:	V. Ragaisis, J. E. Adomaitis
Released:	P. Poskas
Issue date:	May 25, 2007
Number of pages:	7

1 Introduction

This attachment provides answers to the questions and motivated proposals for the EIA Report of New Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2 as presented by the Republic of Belarus Ministry of the Natural Resources and Environmental Protection and provided in the Republic of Lithuania Ministry of Environment letter No. (1-15)-D8-2987 from April 3, 2007. The changes will be made in the new (revised) version of the EIA report are also indicated.

References to the EIA report used in this attachment (text location, references) comply with the EIA report version, issued on 16 November 2006.

2 Remarks and answers

Remark 1

There is no consideration of alternatives of disposal of spent nuclear fuel (SNF).

In the report it is underlined, that the construction of Interim Spent Fuel Storage Facility (ISFSF) is the only option for the management of SNF and in this connection there is no consideration of any alternative of disposal of SNF in other countries. However, one of option of Radioactive Waste Management Strategy, approved by the Lithuanian Government in 2002, is the estimation of expenses propriety of such storage.

<u>Answer</u>

Transfer of spent nuclear fuel RBMK to other countries because of a number of technical and political reasons is not possible either now or in the near future. Taking into account the fact that a deep geological repository is not available in Lithuania and likely will not be available at least until the middle of this century, the long-term storage is the only option for the management of spent nuclear fuel in Lithuania. Therefore the Government of the Republic of Lithuania has decided to start the design of the spent nuclear fuel storage facility at the INPP region.

The planned concept for the management of spent nuclear fuel foresees that after storage or when alternatives for the management of spent nuclear fuel will occur, (e.g. transfer to other countries for processing or for disposal in the international repository), it will be possible to transfer SNF from ISFSF without repacking. Containers CONSTOR ® RBMK1500/M2 will be designed according to the requirements of IAEA Regulations for the safe transport of radioactive material.

Remark 2

Considering, that in the limited territory of Lithuania near the border with Belarus there are a lot of radiation-dangerous objects, moreover, construction of new units of NPP is intended, we suppose expedient to execute long-term estimations of complex industrial environmental loads in transboundary context.

<u>Answer</u>

According to the National Energy Strategy adopted by the Lithuanian Parliament the first power unit of INPP has been stopped on December 31, 2004. Shutdown of the second power unit is planned for the end of 2009.

The decision about decommissioning of INPP power units with reactors RBMK was made not depending on a possibility or impossibility to construct new units of NPP. The proposed economic activity is a part of activities on preparation for decommissioning of INPP with RBMK reactors and decommissioning itself. Decommissioning of main INPP systems can begin only after spent nuclear fuel (SNF) is completely removed from the power units.

After shutdown of INPP power units and further, after packing SNF in leak-tight containers, deactivation and dismantling of present INPP equipment and systems, managing of existing liquid and solid radioactive waste and after their transfer into long-term and stable forms, industrial load on environment, in comparison with the present situation, will only decrease.

Consideration of a possibility to construct new units of NPP is not in the scope of tasks, being considered for this proposed economic activity. Possibilities to construct new units of NPP or other nuclear objects (if such are planned) will be considered in further EIA's, which (in conformity to requirements of laws and corresponding normative documents) should take into account present and future planned environmental impacts (including the ones from this proposed activity).

Remark 3

In the report the radiological impact on the environment, caused by airborne activity, is considered. It is supposed, that during normal operation of ISFSF and at possible emergencies no emissions of waterborne activity can be expected. In our opinion, in case of an emergency emission possible fall-out of activity can be transferred by surface water and make radiological impact on the public and the environment.

Answer

The effective dose to a member of the population due to accident emissions is approximately estimated as 0,005 µSv (see Section 9.4.2). Potential impact is negligible and basically is determined by noble gas Kr-85 which dissipates in the atmosphere. Calculating the contribution of radioactive aerosols to a dose of emergency irradiation their deposition on the surface of the ground, transfer into water component, food stuffs, etc. (as specified in Subsection 9.2.3.2, the methods described in more detail in Subsection 5.1.5.2) was taken into account.

Remark 4

In the materials of the report on the basis of the analysis of potential failures risk a conclusion is made, that such serious external incidents as a plane crash and a fire result in significant consequences for the environment. However, they are classified as beyond design basis accidents, and in section 10.2.2 scenarios of airborne and waterborne radioactive pollution transfer to the territory of Belarus are not considered in case of occurrence of such situations. At the same time according to the report, in the region under consideration the western and southern winds prevail (section 4.3.4) that makes the territory of Belarus especially vulnerable from the point of view of transfer of airborne radioactive materials when emergency situations occur.

By virtue of the existing hydrographic and hydrological conditions surface water in the area of the prospective construction of ISFSF and storage points for radioactive waste flows from the territory of Lithuania to the territory of Belarus. In case of waterborne release of radioactivity to the environment basic contamination of Belarus water-currents might occur namely by water routes. Radionuclides released into surface waters of transboundary water objects (river Drisveta, lake Drisveta) can be transferred into river Prorva, flowing in the territory of Belarus, then into the system of Boginski lakes, river Dvina and further - to Western Dvina and to Gulf of Riga of the Baltic sea. Thus, the radioactive pollution released to the system of water objects, can be distributed not only in the territory of Belarus, but also in the territory of other adjacent states.

Answer

As the mentioned external events are possible, and the release of radioactive substances from SNF to the environment can have serious consequences, engineering measures preventing occurrence of radiological consequences resulting from such accidents are undertaken - the container will be designed to sustain a plane crash or a fire. Therefore in EIA report events of damage of the container integrity and release of radioactive substances to the environment are not considered.

Remark 5

In section 8.2.6 of the report it is noted, that in the bottom sediments of Druksiai Lake the availability of isotopes of Plutonium-239,240 with activity of 0.16-3.59 Bq/kg was found, this was explained by its global spread in components of ecosystem. However, it must be noted, that Plutonium-239,240 activity of 3.59 Bq/kg in the bottom sediments exceeds the global fall-out by the entire order. We would like to receive an explanation of the given question.

Answer

EIA report is supplemented as follows:

Text location	Section 8.2.6, second paragraph
Existing text	In the bottom sediment of Druksiai lake, availability of Pu-239 and Pu-240 was found; its activity was from 0.16 to 3.59 Bq/kg. Presence of Plutonium in the bottom sediment is due to its global spread in components of ecosystem.
Supplemented text	In the bottom sediment of Druksiai lake, availability of Pu-239 and Pu-240 was found. 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 at the points of zero background, for dry air mixture are 0.18 Bq/kg [10].

Remark 6

There are some discrepancies in the data about the amount of the spent nuclear fuel of Ignalina NPP planned for storage in the new ISFSF, presented in the report.

In Chapter 2 of the report (page 13) it is underlined, that proposed activity provides loading of spent fuel assemblies (SFA) RBMK-1500 in the amount of 18000 units (36000 halves of SFA, or fuel rods with nuclear fuel) into containers CONSTOR®RBMK1500/M2 and storage of not less than 50 years in the new ISFSF which will be designed for 201 container of the specified type.

According to the information on the characteristics spent fuel assemblies, submitted in Table 2.1.1-1 of the report referring to the document of Technical specification of Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2, B1/T8/0001, Release 06, the amount of SFA with fuel of various types (depending on the degree of U-235 enrichment from 2 % up to 2.8 %) will make 16800. The difference between this number and declared for the proposed activity is equal to 18000-16800=1200 SFA, that makes more than 70 % of full fuel loading of RBMK-1500 active core. Since the capacity of a container CONSTOR®RBMK1500/M2 is 91 SFA (page 30 of the report) the discrepancy in the amount of placed containers can make 13 units.

Answer

Planned design capacity of ISFSF - approximately 36 000 of SNF RBMK-1500 rod bundles. The real amount of stored SNF RBMK-1500 rod bundles can be less; EIA report specifies only an approximate amount.

In the storage hall of ISFSF it will be maximal 202 places for placing of containers CONSTOR ® RBMK1500/M2 (including the reserve empty container). Calculating the environmental impact (potential exposure of the public and the personnel) a conservative assumption was made that the maximal possible amount of containers (202) is placed in ISFSF and all of the containers contain the maximal possible quantity of SNF rod bundles (182).

Also it must be pointed out, that capacity of some containers will be less, since they will be loaded with cartridges (probably of several types) with mechanically damaged fuel, experimental fuel, etc.

Remark 7

Now in the Ignalina NPP site the temporary storage for RBMK-1500 spent nuclear fuel from INPP units 1 and 2 is available, which contains 20 containers of CASTOR®RBM 1500 type and 60 containers of CONSTOR ® RBMK 1500 type. These types of containers use 32M baskets for insertion of 51 SFA (see section 2.2.2 of the report); therefore the assessed amount of fuel stored in the temporary storage of SNF is approximately equal to 4000 SFA.

As it can be seen from the list of potential radioactive sources of the environmental contamination caused by the proposed economic activity (see Table 1.7.-1. of the report), the management of the specified spent nuclear fuel from the Ignalina NPP is not included into the proposed economic activity. For this reason the temporary SNF storage should be considered as an additional potential source of ionizing radiation on the site of Ignalina NPP.

<u>Answer</u>

The temporary SNF storage is approximately at the distance of 1.5 km from the planned site of ISFSF. The results of actual measurements of external background, carried out in the planned site of ISFSF and in its vicinities, do not show any presence of influence of external ionizing radiation from the temporary SNF storage or from the site of INPP, see section 8.2.7. The increase in external radiation fields is monitored only in the immediate proximity to some constructions of INPP.

The contribution to the dose of the population exposure resulting from the present and planned releases of radioactive substances to the environment from INPP has been taken into account, see section 5.3.2.

Remark 8

In section 5 of the report the analysis of potential influence on the environment, resulting from the airborne activity emissions during normal operation of the proposed economic activity, is carried out - at INPP reactor units 1 and 2 (items 1-4) and ISFSF (items 5-6).

As it can be seen from the information submitted in Chapter 5 of the report, in Lithuania there are no normative requirements for the estimation of activity content that can be released from leaking fuel rods with nuclear fuel RBMK-1500. For this reason in Chapter 5 of the report requirements of corresponding international standards have been used, supposing, that RBMK fuel does not differ from fuel of light water reactors, for which the reliable database had been collected, using the experimental data obtained in the Russian Federation and in other countries (the USA, Japan). However, the operating mode of reactor RBMK-1500 of Ignalina NPP (a mode of the enhanced capacity) and types of the used fuel (both with standard initial U-235 enrichment of 2 % and nonstandard, higher enrichment), in our opinion, can result in uncertainty of estimations of radionuclide releases from the irradiated fuel.

<u>Answer</u>

Lithuania does not have normative requirements for the estimation of content and amount of activity which can be released from leaking fuel rods of nuclear fuel RBMK-1500. In INPP data on measurements of Cs-137 release are available, and these data were used for preparation of the EIA report. Also data on release of noble gases (Kr, Xe), obtained out during the "hot" tests (vacuum drying) of containers CONSTOR ® RBMK-1500 in INPP, are available. These data correspond to the published results of researches of uranium - erbium oxides in irradiated fuel RBMK-1000 where a conclusion has been made, that activity of Kr and Xe gases accumulated under the cladding of the fuel rods can reach 7 %.

Preparing the EIA report a share of activity of fission products in the gap inside a cavity of a fuel rod was assumed according to the recommendations summarizing available reliable world experimental data, which also conservatively envelope the results of the available researches of RBMK fuel (for example, release of Kr-85 has been accepted 10 %).
Also it should be considered that conservatively estimated maximal annual exposure dose of the population resulting from the release of radioactive gases and aerosols does not exceed 0.5 µSv (Table 5.1.5-2). Accepted theoretically maximal 100 % release of gas activity can increase calculated exposure dose approximately up to 5 µSv. However, this is also a very small and, from a radiation safety point of view, insignificant value.

Remark 9

In Belarus (0.1 mSv/year) and the Republic of Lithuania (1 mSv/year) different norms of exposure dose limitation for the critical group of the population are accepted for all kinds of the radwaste management. We suppose, that when estimating potential impact on the population of Belarus resulting from the airborne activity during the operation of the objects to be constructed, it would be expedient to apply the approach, proposed in the recommendations of International commission on radiological protection (ICRP-2005) where it is indicated, that in case when irradiated people receive no direct benefit from the activity causing radiation impact the exposure dose should be limited up to 0.01 mSv/year.

Answer

The specified approach of the estimation of impact on the population of neighboring countries is applied in the given EIA report. The conclusion about the insignificance of radiological impact is made, if the annual effective dose of a member of the population is equal or less than 0.01 mSv per year. The estimated potential exposure of the inhabitant of Belarus in result of the proposed economic activity is approximately by order less than the specified value, see section 10.2.

Remark 10

In subsection 5.3.3.2 of the report the maximal annual effective dose is determined at the permanent security fence of the protective zone of ISFSF/SWMSF, including radiation from the site of Ignalina NPP, caused by emissions of radioactive airborne and waterborne materials. This value is estimated as 0.177 mSv/year and it does not exceed the dose constraint of 0.2 mSv/year established by the requirements of radiation safety in the Republic of Lithuania. It is questionable, whether the annual effective dose, caused by cumulative impact of all remaining radiation-dangerous objects, existing and planned to be established in the area of Ignalina NPP, will be lower than 0.023 mSv/year.

Answer

The impact of ionizing radiation quickly decreases with distance from the site of ISFSF. At the distance of 500 m from the site of ISFSF the determined annual effective dose decreases approximately by the order (from 0.177 to 0.019 mSv). The exposure also depends on a direction (and positions in a particular direction) from the site of ISFSF. Therefore there is a much larger reserve of the dose constraint available for other nuclear objects.

Consortium

GNS – NUKEM

Subcontractor

Lithuanian Energy Institute

Environmental Impact Assessment Report

Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2

Attachment No. 2 to the Part II „Attached documents"

Answers to the questions and motivated proposals of the Republic of Latvia Ministry of Environment

Prepared:	V. Ragaisis
Released:	P. Poskas
Issue date:	May 25, 2007
Number of pages:	4

1 Introduction

This attachment provides answers to the questions and motivated proposals for the EIA Report of New Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2 as presented by the Republic of Latvia and provided in the Ministry of Environment letter No. (1-15)-D8-2987 from April 3, 2007.

The document presented by the Republic of Latvia "Opinion about the results of an Environmental Impact assessment report of the construction of Interim Storage of Spent Nuclear Fuel from Ignalina NPP" summarizes the broad range of aspects raised by the Latvian institutions and the public during the review of EIA Report. Beside the questions related to the EIA of proposed economical activity, issues concerning implementation of this project and overall INPP decommissioning, improvement of organization in information exchange, compensation of losses etc. are raised as well.

Some of issues raised extend outside the borders of EIA procedure and the scope of this proposed economical 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.

The references used in this attachment (text location, literature) are in agreement with EIA Report, issue date November 16, 2006.

2 Remarks and answers

Remark 1

There are not sufficient information in the Report regarding over-packing of damaged assemblies and fuel elements; therefore a question was raised regarding plans to implement gas tight over-packs additionally for this fuel. During public hearing an answer was, that over-packs will not be gas tight, but container (as for other types) will be gas tight and filled with inert gas.

Answer

The main purpose of the over pack cartridges is to ensure safe handling, loading into and positioning within storage cask of mechanically damaged, experimental fuel bundles and fuel debris collected from the pools, c.f. chapter 2.2.3. Also, the design of over pack cartridges shall ensure de-watering and vacuum drying of the over pack cartridge during the cask de-watering and drying processes. Therefore over pack cartridges are not designed to be leak-tight. The isolation of spent nuclear fuel from the environment is assured by the cask itself - the double-barrier welded lid system, together with the double-barrier design of the cask body.

Several types of over pack cartridges (e.g. of different size, storage volume etc.) will be used depending on fuel elements to be stored inside. Details of technical design over-packs are not important from the environment impact assessment point of view (as no assumptions are made concerning leak-tightness of over-packs and no credits are given to possible reduction of activity release from over-packed fuel elements) and therefore are not provided. Design of over pack cartridges will be developed during Technical Design stage.

Remark 2

Additional question for clarification was asked about calculated distance of maximum for exposures of critical group due to Kr-85 (an answer was ~ 500 m radius from the ventilation). There are plans, but not detailed elaboration regarding supplementary monitoring system for Kr-85.

Answer

The locations of maximum values of the atmospheric dispersion coefficient (which corresponds to the location of maximal activity concentration in the air and to the location of maximal exposure) will depend on release height and atmospheric dispersion conditions (e.g. atmospheric stability class). The requested information for maximum exposure locations for releases from ISFSF (in case of fuel reloading in the Hot Cell) are presented in the chapter 5.1.5.3 and for accidental releases from INPP reactor units are presented in chapter 9.2.3.1.

Online monitoring of inert gas releases from INPP is already performed. The same concept of online monitoring is foreseen for releases from ISFSF (both from the stack and in the storage hall, cf. chapters 8.3.5 and 8.3.6). Design of monitoring system will be developed during Technical Design stage.

Remark 3

Last question was regarding methods for calculation / assessment of total number of damaged fuel elements. An answer was based on records and that detailed investigation of all fuel assemblies will be done during reloading them from the wet storage. Supplementary question was concerning eventual plans to increase capacity of this storage due to new proposals for nuclear energy. An answer was that at this stage all plans are only for existing irradiated fuel from INPP (including fuel, from last unit under operations till final shut-down).

Answer

There might be uncertainties in estimation of amount or in classification of defective fuel. However the amount of damaged fuel is very low in comparison with the total amount of SNF. The foreseen design capacity of ISFSF is sufficient to manage possible deviations in the amount of different fuel types. The EIA Report considers effects due to possible uncertainties in fuel data. The EIA Report considers the worst case conditions – impact assessment assumes that ISFSF is loaded with maximum design amount of casks and all casks are loaded with fuel in such a way, that maximal radiation fields outside the cask are created. Under these conditions radiation fields of ISFSF and exposure of population are calculated.

As concern second part of the question – the construction ISFSF is a part of INPP decommissioning activity and is planned with purpose of interim storage of RBMK-1500 SNF from existing INPP power units until the final disposal facility will become available.

Remark 4

Possible and necessary activities in the case of dehermetization of cask caps should be reflected in a more detailed way.

Answer

The cask will be designed as double-barrier welded system for the safe operation time of at least 50 years. The loss of tightness of the cask during the design time shall be considered as exceptional case.

In the case that a cask is found to be defective during storage at ISFSF, the spent fuel will be repackaged inside the Hot Cell of ISFSF. Details are provided in the chapter 2.5.3.

Remark 5

More detailed explanation about possible alternative activities after 50 years interim storage should be relevant.

Answer

The storage of SNF in the ISFSF is a temporary solution before the final SNF route will be defined and necessary actions will be implemented. The national Radioactive Waste Management Strategy foresees several options to be investigated prior the final decision will be taken:

- Possibility to dispose off the SNF in the national deep geological repository;
- Possibility to dispose off the SNF in the regional deep geological repository;
- Possibility to transfer and dispose off the SNF in other countries;
- Possibility to safe store the SNF for 100 years and more.

The ISFSF will be designed for safe storage of SNF for at least 50 years. The design concept of the storage casks is such that it will be possible to transport the SNF away from the ISFSF site after interim storage without repackaging the fuel. After removal of SNF the ISFSF will be decommissioned, c.f. chapter 1.5.3.

Consortium

GNS – NUKEM

Subcontractor

Lithuanian Energy Institute

Environmental Impact Assessment Report

Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2
Attachment No. 3 to the Part II "Attached Documents"

Answers to the Remarks of the Republic of Lithuania Ministry of Health

Prepared:	J. E. Adomaitis, V. Ragaisis
Released:	P. Poskas
Issue date:	May 25, 2007
Number of pages:	8

1 Introduction

This attachment of the EIA report provides answers to the comments and proposals for the EIA report "Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2" as presented by the Republic of Lithuania Ministry of Health letter No. 10-1231 from May 5, 2007. The changes will be made in the new (revised) version of the EIA report are also indicated.

References to the EIA report used in this attachment (text location, references) comply with the EIA report version, issued on 16 November 2006.

2 Comments and Responses

Comment 1

The letter of State Enterprise INPP No 10S-5315 (15.10) dated September 22, 2006, replying to the letter of Republic of Lithuania Ministry of Health dated August 19, 2006 "Sub: Proposed Economic Activity Environmental Impact Assessment", states that while developing the EIA Report, the Recommendations on Assessment of Impact on the Public Health (State News, 2004, No 106-3947) will be taken into account. However the appropriate structural part of EIA report is not prepared, the reference to the Recommendations is not provided, this legal act is not included into the list of references of EIA Report. The requirements for obtaining licenses is also not taken into account according to section III of the List of Public Health Surveillance Activity Fields, Requiring the Health Surveillance Activity License, which is approved by the Government of the Republic of Lithuania (State News, 2004, No 33-1081).

Response

The EIA Report is supplemented by the new chapter 6.9, the list of references is supplemented accordingly:

Text location	
Existing text	
Supplemented text	6.9 Public Health At it is indicated in the EIA Programme, this EIA report contains data, which are mandatory for assessment of impact on the public health and other components of environment in accordance with the requirements of clause 1, article 9 of the Law on the Environment Impact Assessment of Proposed Economic Activity [7]. In accordance with the requirements of legal acts of the Republic of Lithuania, the public health impact assessment report shall be prepared by public health impact assessor as prescribed by the Recommendations on Assessment of Impact on the Public Health [8] and after EIA Programme and EIA Report have been assessed. Following the Recommendations on Assessment of Impact on the Public Health [8] the main factors and impacts of proposed economic activity are identified and evaluated in this report. The direct and indirect impacts of the proposed economic activity on factors influencing the public health are summarized in Table 6.9-1. Possible impact of proposed economic activity on public groups is summarized in Table 6.9-2. Assessment of impact features is presented in Table 6.9-3.

Remark: The indicated Tables 6.9-1, 6.9-2 and 6.9-3 are attached separately.

Text location	Chapter 13, new references are added to the list of references for Chapter 6

Existing text	
Supplemented text	7. Law on the Environmental Impact Assessment of Planned Economic Activity. State News, 1996, No. 82-1965; 2005, No. 84-3105. 8. Recommendations on Assessment of Impact on the Public Health, State News, 2004, No. 106-3947.

Comment 2

Non-radioactive waste is not classified according to the hazard and management methods, as required by the Waste Management Rules (State News, 2004, No 642381).

<u>Response</u>

EIA report is supplemented as follows:

Text location	Chapter 3.1.1, next-to-last paragraph
Existing text	Non-radioactive waste will be managed in accordance with the requirements of waste management legislation and regulations in force [1 - 4], INPP instruction [5] and permission on integrated prevention and control of pollution [6].
Supplemented text	Non-radioactive waste will be managed in accordance with the requirements of waste management legislation and regulations in force [1 - 4], INPP instruction [5] and permission on integrated prevention and control of pollution [6], and following requirements of technical regulation on Waste Removal (application attachment No. 18). It is necessary to note that earlier indicated ISFSF generated annual amounts of paper and carton waste (non-hazardous, code 15 01 02), plastic packages (non-hazardous, code 15 01 02), wooden packages (non-hazardous, code 15 01 03), mixed packages (non-hazardous, code 15 01 06), glass packages (non-hazardous, code 15 01 07) will comprise only 2 %, 1 %, 2 %, 0.5 % and 1.5 % respectively of the highest annual amounts allowed to be generated by INPP [6], absorbents, wipes, rags, filter materials, contaminated with hazardous chemical substances or oil products (H14 hazardous for environment, code 15 02 02) – 2 % of the highest annual amounts allowed to be generated by INPP [6], concrete (non-hazardous, code 17 01 01) – 2 %, bricks (non-hazardous, code 17 01 02) – 0.5 %, wood (non-hazardous, code 17 02 01) – 0,5 %, metal compounds (non-hazardous, code 17 04 07) – 1.5 %, cables (non-hazardous, code 17 04 11) – 0.5 %, mixed communal waste (non-hazardous, code 20 03 01) 1 % of the highest annual amounts allowed to be generated by INPP [6].

Comment 3

The function of foundation pit that is excavated on the ISFSF site is not clear; para. 6.1.4 contradicts the solution provided in para. 3.1.2.

<u>Response</u>

Upon changes in the technical solution the foundation pit will not be excavated, therefore subchapter 6.1.4 is deleted from the EIA report.

Comment 4

The documents of public informing and participation in the EIA process, the conclusion of the EIA subjects and the documents of other procedures are not presented in the EIA Report. This contradicts the 22 and 23 para, requirements of the Regulations for preparation of EIA Program and Report (State News, 2006, No 6-225).

Response

EIA report is supplemented as follows:

Text location	Part 2 "Attached Documents"
Existing text	Remarks and conclusions of relevant parties on the EIA Report will be attached to after they will become available. Information concerning the general public informing will be attached to after they will become available. Remarks of the general public on the EIA Report will be attached to after they will become available.
Supplemented text	The EIA report has been presented for the public review following the requirements of the Law on the Environmental Impact Assessment of Planned Economic Activity (State News. 2005 Nr. 84-3105) and of the Order on Informing the Public and the Public Participation in the Process of Environment Impact Assessment (State News. 2005 Nr. 93-3472). The prepared EIA report, issue date November 16, 2006, has been presented to the public. The public was informed about the possibility of getting acquainted with the prepared EIA report and planned public presentation via national, Ignalina region, Zarasai region and Visaginas town media (national newspaper "Lietuvos rytas", Ignalina region newspaper "Nauja vaga", Zarasai region newspaper "Zarasu krastas", Visaginas town newspaper "Sugardas") more than 10 work days in advance to the planned meeting with the public. An advertisement, informing about the planned meeting and a possibility of getting acquainted with the EIA report, has been published in the advertisement board of the municipality of the Visaginas town. It was possible to get acquainted with the EIA report in the municipality of the Visaginas town and Ignalina NPP information center. An advertisement, informing about the planned meeting with the public and EIA electronic version have been placed on the Ignalina NPP Internet web site (www.iae.lt). Up till now no motivated proposals for the proposed economic activity have been received. Public presentation and consideration of the EIA report was scheduled for January 26, 2007 in Ignalina NPP decommissioning service building, on convenient for the public and non working time. Within an hour from the scheduled time, no public representatives appeared. Therefore, it is concluded that public is not interested in the proposed economic activity and the public informing procedure has been performed. Following the requirements of the ESPOO Convention (State News 1999, No. 92-2688), 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 (May 13, 2007 in Daugavpils, Latvia and April 19, 2007 in Vidzy, Belarus). 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. The comments of institutions and the public of the Republics Belarus and Latvia to the EIA report are presented in the Ministry of Environment letter No. (1-15)-D8-2987 from April 3, 2007. The answers to the comments of the Republic of Belarus for the EIA report are presented in the attachment 1. The answers to the comments of the Republic of Latvia for the EIA report are presented in the attachment 2. The prepared EIA report, issue date November 16, 2006, 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: • 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; • Department of Cultural Heritage under the Ministry of Culture. No remarks to be considered have been received. Inaccuracy in the EIA report was indicated concerning the information on the number of the objects of cultural heritage in the Ignalina NPP region; • State Nuclear Power Safety Inspectorate (VATESI). No remarks to be considered have been received; • Department of Fire Protection and Rescue under the Ministry of Inner Affairs. No remarks to be considered have been received; • Ministry of Health. The Ministry in the letter No. 10-1231 dated March 5, 2007, has presented 5 remarks, and in the letter No. 10-2099 dated 17 April 17, 2007, has presented 6 remarks. Answers to the remarks of the Ministry of Health are presented in the attachments 3 and 4. The following documents are attached to the Part II of the English version of this EIA report: • Attachment No. 1 to the Part II "Answers to the questions and motivated proposals of the Republic of Belarus Ministry of Natural Resources and Environment Protection" 7 pages; • Attachment No. 2 to the Part II "Answers to the questions and motivated proposals of the Republic of Latvia Ministry of Environment", 4 pages; • Attachment No. 3 to the Part II "Answers to the Remarks of the Republic of Lithuania Ministry of Health", 8 pages; • Attachment No. 4 to the Part II "Answers to the Remarks of the Republic of Lithuania Ministry of Health (Radiation Protection Centre)", 10 pages.

Comment 5

The list of references includes reference to the out of force Lithuanian Hygiene Standard HN 44:2003 "Establishment and Supervision of Sanitary Protection Zones of Waterworks ". It shall be changed to: HN 44:2006 " Establishment and Supervision of Sanitary Protection Zones of Waterworks ", which is approved by the Order No V-613 of the Republic of Lithuania Minister of Health dated July 17, 2006 (State News, 2006, No 81-3217).

<u>Response</u>

EIA report is revised as follows:

Text location	Chapter 13, list of references for chapter 4
Existing text	20. Lithuanian Hygiene Standard HN 44:2003. "Establishment and Supervision of Sanitary Protection Zones of Waterworks". State Journal, 2003, No. 42-1957.
Supplemented text	20. Lithuanian Hygiene Standard HN 44:2006. "Establishment and Supervision of Sanitary Protection Zones of Waterworks". State News, 2006, No. 81-3217. 23. Project for Justification of the Ground Water Monitoring Structure for INPP Spent Nuclear Fuel Storage Site. Report of the Joint-Stock Company "Vilniaus hidrologija". Vilnius, 2007.

Text location	Chapter 13, list of references for chapter 10
Existing text	5. Lithuanian Hygiene Standard HN 44:2003 "Establishing and Supervision of Sanitary Protection Zones for Watering Places". State Journal, 2003, No. 42-1957.
Supplemented text	5. Lithuanian Hygiene Standard HN 44:2006. "Establishment and Supervision of Sanitary Protection Zones of Waterworks". State News, 2006, No. 81-3217. 7. Project for Justification of the Ground Water Monitoring Structure for INPP Spent Nuclear Fuel Storage Site. Report of the Joint-Stock Company "Vilniaus hidrologija". Vilnius, 2007.

Text location	Chapter 13, list of references for chapter 12
Existing text	7. Lithuanian Hygiene Standard HN 44:2003 "Establishing and Supervision of Sanitary Protection Zones for Watering Places". State Journal, 2003, No. 42-1957.
Supplemented text	7. Lithuanian Hygiene Standard HN 44:2006. "Establishment and Supervision of Sanitary Protection Zones of Waterworks". State News, 2006, No. 81-3217. 9. Project for Justification of the Ground Water Monitoring Structure for INPP Spent Nuclear Fuel Storage Site. Report of the Joint-Stock Company "Vilniaus hidrologija". Vilnius, 2007.

Text location	Chapter 4.4.2
Existing text	4.4.2. Quality of Underground Water In site evaluation for nuclear power plants and activities in the field of nuclear energy a detail investigation of the hydrosphere in the region should be carried out. IAEA Safety Guide No NS-G-3.2 [18] recommends assessing the potential impact to the drinking water sources in the vicinity. For this purpose by order of INPP the study [19] was prepared aiming to identify the compatibility of sanitary protection zone of the Visaginas town waterworks with the ISFSF taking into account the requirements of Lithuanian Hygiene Standard HN 44:2003 [20]. Results of detail investigations and modeling carried out by Joint-Stock Company "Vilniaus hidrologija" have shown that ISFSF is outside of sectors 3a and even 3b of sanitary protection zone of the Visaginas town waterworks (in case when yield of the waterworks does not exceed the approved amount of underground water exploitation resources which is 31 thousand m^3 per day) [19]. The aquifer complex D_{3+2}sv-up rich with underground water is exploited by the Visaginas town waterworks. The quality of underground water of exploited aquifer complex is good not only in the waterworks but also in all region and its changes happened in the waterworks are minimal [19].
Supplemented text	4.4.2. Quality of Underground Water The aquifer complex D_{3+2}sv-up rich with underground water is exploited by the Visaginas town waterworks. The quality of underground water of exploited aquifer complex is good not only in the waterworks but also in all region and its changes happened in the waterworks are minimal [19].

Text location	Chapter 4.4.4 "Underground Water in the ISFSF Site" is supplemented as follows:
Existing text	
Supplemented text	For assessment of the suitability of objects of nuclear energy sites, IAEA safety standard No. NS-G-3.2 [18] establishes the requirements for assessment of the impact area of the nearby potable water sources. For this purpose, by the order of INPP the Joint-Stock Company "Vilniaus hidrologija" prepared a study [19], where

	the assessment and recalculation of the Visaginas town waterworks sanitary protection zone (SPZ – defined protected area around the waterworks, where economic activity is limited [20]) have been performed with the regard of foreseen construction of new nuclear objects (ISFSF and Solid Radioactive Waste Management and Storage Facility). The performed investigations have shown that the future site of the nuclear objects is outside the boundaries of the Visaginas town waterworks sanitary protection zone (SPZ) (when waterworks debit does not exceed the approved amount of underground water exploitation sources – 31 thousands. m^3/d). During preparation of the project for justification of underground water monitoring structure of ISFSF site [23] additional conservative assessments of hypothetic contamination propagation have been performed, by which possible directions of contamination propagation and contamination migration velocity/duration have been established. When assessing the hypothetic contamination propagation, an extremely conservative approach has been used in the model, i.e. it is considered that concentration of contamination is present in the entire ground water layer from upper to lower layers throughout all the ISFSF site area and that this situation remains during the entire period, foreseen by the calculations (150 years). In the remaining part of the underground aquifers, and also in aquifer layers stratified below, the initial relative value of contamination set by the model equals zero. During migration, the sorption and decay processes reducing the concentration of contamination have not been considered, i.e. only advection processes have been taken into account in the model. The accepted maximal debit of the aquifer, 31 thousands. m^3/d. Modeling results show that the flow of fresh underground water in aquifer, stratified below ISFSF site significantly dilute the migrating contamination. During the forecasted 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 auriferous complex of contamination concentration in the underground water of ISFSF site could be observed. Only hundredth of percent of contamination would actually could reach the aquifer of waterworks. Thus, the results of migration model show that ISFSF, as a local and relatively small object (in comparison to waterworks catchment area) can not substantially affect the quality of underground water of the Visaginas town waterworks.

Text location	Chapter 10.3.1.1, paragraph 1
Existing text	ISFSF site is outside the boundaries of sectors 3a and 3b as defined by Lithuanian hygiene standard HN 44:2003 [5] of the Visaginas town waterworks third sanitary protection zone [6]. Therefore the operation of the ISFSF will not affect Visaginas town waterworks.
Supplemented text	ISFSF site is outside the boundaries of the Visaginas town waterworks sanitary protection zone [5], [6]. Conservative evaluations of the possible migration of contamination in the water component show that ISFSF, as a local and relatively small object (in comparison to waterworks catchment area) can not substantially affect the quality of underground water of the Visaginas town waterworks [7].

Text location	Chapter 12, p. 201, paragraph 2
Existing text	ISFSF site is outside the boundaries of sectors 3a and 3b as defined by Lithuanian hygiene standard HN 44:2003 [7] of the Visaginas town waterworks third sanitary protection zone [8]. Therefore the operation of the ISFSF will not affect Visaginas town waterworks.
Supplemented text	ISFSF site is outside the boundaries of the Visaginas town waterworks sanitary protection zone [7], [8]. Conservative evaluations of the possible migration of

	contamination in the water component show that ISFSF, as a local and relatively small object (in comparison to waterworks catchment area) can not substantially affect the quality of underground water of the Visaginas town waterworks [9].

Subcontractor
Lithuanian Energy Institute

Environmental Impact Assessment Report

Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2
Attachment No. 4 to the Part II „Attached documents"

Answers to the Comments of the Republic of Lithuania Ministry of Health (Radiation Protection Centre)

Prepared:	V. Ragaišis
Released:	P. Poškas
Issue date:	May 25, 2007
Number of pages:	10

1 Introduction

This attachment of the EIA report provides answers to the comments and proposals for the EIA report "Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2" as presented by the Republic of Lithuania Ministry of Health letter No. 10-2099 from April 17, 2007. The changes will be made in the new (revised) version of the EIA report are also indicated.

References to the EIA report used in this attachment (text location, references) comply with the EIA report version, issued on 16 November 2006.

2 Comments and Responses

Comment 1

Section 5. The assessment of workers exposure shall consider dose resulting from external exposure, and that shall be performed in the Report. It is also necessary to evaluate dose to supporting personnel (such as security guards, maintenance staff), related to planned economical activity.

Response

EIA report is supplemented as follows:

Text location	Chapter 5.2.1.1
Existing text	During the period of fuel transfer from the Reactor Units to the ISFSF doses to personnel resulting from the additional operations due to proposed economic activity are preliminary estimated below. The estimation is based on the existing INPP CONSTOR type cask handling experience considering new type CONSTOR® RBMK1500/M2 cask key features. Since EIA is performed before the Technical Design of the proposed economic activity is available, the main purpose of this Subchapter is to show that doses to personnel resulting from the additional operations due to proposed economic activity will be optimised according to the ALARA principle using appropriate shielding, remote-controlled equipment, control and instrumentation devices, ventilation, proper operational procedures etc. and in any case will not exceed the limit for annual effective dose. The detailed personnel exposure (individual and collective doses) due to handling of new type CONSTOR® RBMK1500/M2 cask and due to other operations introduced by proposed economic activity will be assessed in Safety Analysis Report considering Technical Design issues.
Supplemented text	The EIA report presents preliminary assessment of collective exposure of the personnel during handling of SNF and casks at the Ignalina NPP Reactor Units. The assessment is based upon the INPP experience of handling the existing CONSTOR and CASTOR casks, taking into consideration key features of the new type CONSTOR® RBMK1500/M2 casks and additionally planned operations of casks and SNF handling. Such analogy is partly possible as the design limit values for the external radiation fields of the new type CONSTOR® RBMK1500/M2 casks do not differs from the design limit values of the existing casks (e.g. surface dose rate of the cask should not exceed 1 mSv/h). Handling of SNF is performed at the same halls of reactor units. Since EIA is performed before the Technical Design of the proposed economic activity is available, the main purpose of such assessment is to show that personnel exposure resulting from existing and additional operations of the proposed economic activity will not exceptionally increase, and, therefore, can be limited using necessary

	shielding, remote-controlled equipment, appropriate operational procedures etc. Exposure of the supporting personnel is not additionally assessed in the EIA report, as the existing Ignalina NPP practice shows that (in case of appropriate organization of working activity) exposure of the supporting personnel is always lower than that of the operating personnel, directly handling SNF and casks. The detailed personnel exposure (individual and collective doses) due to handling of new type CONSTOR® RBMK1500/M2 casks and due to other operations introduced by proposed economic activity can be assessed only in Safety Analysis Report considering Technical Design issues. According to the requirements of legal acts in force, Safety Analysis Report is a part of Technical Design and shall as well be presented to Authorities for review and evaluation.

Text location	Chapter 5.2.3.1 is revised as follows
Existing text	
Supplemented text	The EIA Report presents preliminary assessment of collective exposure of the personnel during SNF and casks handling at the ISFSF. Assessment is based on the INPP handling experience of the existing type CONSTOR and CASTOR casks, taking into consideration key features of the new CONSTOR® RBMK1500/M2 casks and additionally planned operations of casks and SNF handling. Such analogy is partly possible as the design limit values for the external radiation fields of the new type CONSTOR® RBMK1500/M2 casks do not differs from the design limit values of the existing casks (e.g. surface dose rate of the cask should not exceed 1 mSv/h). Since EIA is performed before the Technical Design of the proposed economic activity is available, the main purpose of such assessment is to show that personnel exposure resulting from existing and additional operations of the proposed economic activity will not exceptionally increase, and, therefore, can be limited using necessary shielding, remote-controlled equipment, appropriate operational procedures etc. The detailed personnel exposure (individual and collective doses) due to handling of new type CONSTOR® RBMK1500/M2 casks and due to other operations introduced by proposed economic activity can be assessed only in Safety Analysis Report considering Technical Design issues. Exposure of the supporting personnel (such as security guards, maintenance staff) is not additionally assessed in the EIA report, as the existing Ignalina NPP practice shows that (in case of proper organization of working activity) exposure of the supporting personnel is always lower than that of the operating personnel, directly handling casks. According to the requirements of Technical Specification [1], the design of ISFSF shall ensure conditions at the work places that shall be in conformance with radiation protection requirements (rooms of controlled areas have to be categorized as prescribed by HN 87:2002 [30], according to the category of the room appropriate and controlled conditions of radiological exposure and contamination have to be assured, monitoring has to be performed, permissible work time has to be foreseen, protections measures have to be taken, if necessary etc.). The conservatively evaluated maximal effective dose rate at the ISFSF site does not exceed 0.23 μSv/h, c.f. chapter 5.2.3.2. Conservatively evaluating (assuming exposure time 2000 h per year), such dose rate may cause annual exposure of 0.46 mSv. Therefore, exposure of the supporting personnel at the ISFSF site will not exceed limiting doses. The exposure of supporting personnel may be evaluated in more details in the Safety Analysis Report considering Technical Design issues.

Comment 2

In Section 5 cl. 5.3.3.1, it is stated, "During preparation of technical design and Safety Analysis Report, the personnel exposure (more accurately it shall be written as application of the radiation safety means) will be optimized according to ALARA principle". We suppose that the concept of application of this principle and description of means for protection against ionizing irradiation shall be presented in the Report in more details. The same comment is applicable for evaluation of population exposure. Please, explain in details whether these means were optimized according to ALARA principle, while evaluating the population annual dose and envisaging specific means of protection (e.g., selecting the thickness of the storage walls, distance to the secured fence, etc.)? If so, what criteria were followed while selecting optimal means of protection?

Response

EIA report may indicate only principles of reduction of radiological impact. Application of ALARA in a specific work place or when performing specific operations will depend on solutions of the Technical design.

EIA report is supplemented as follows:

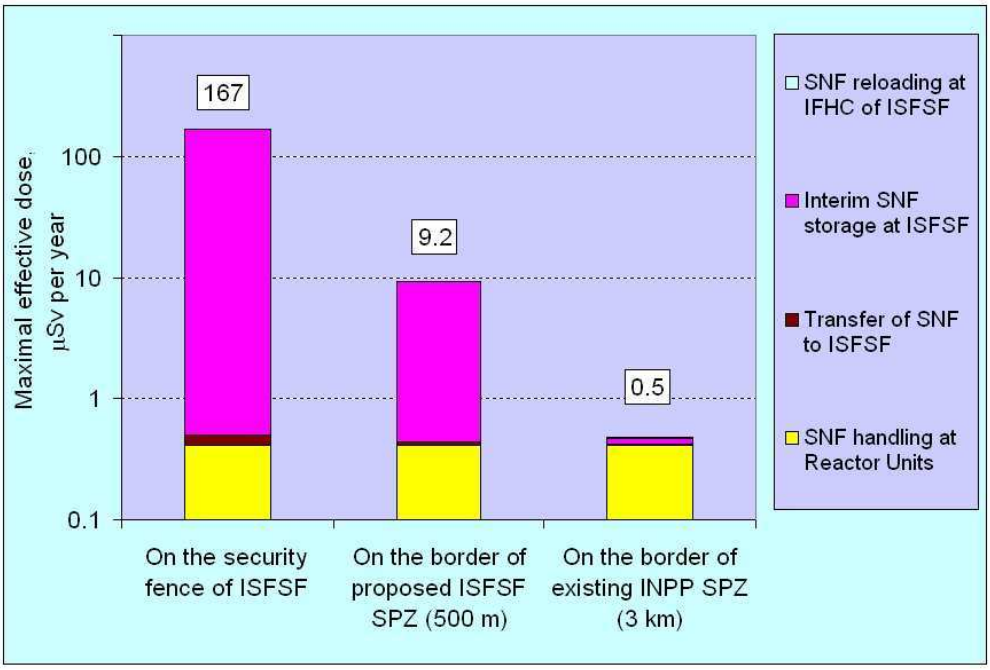
Text location	Chapter 5.3.3.1, last paragraph
Existing text	The operator exposure will be governed by external irradiation. During preparation of the Technical Design the doses to personnel will be optimised according to the ALARA principle using appropriate shielding, remote-controlled equipment with closed circuit television system (CCTV), proper operational procedures etc. and in any case will not exceed the limit for annual effective dose. Justification of this will be performed in the Safety Analysis Report and Technical Design
Supplemented text	The operator exposure will be governed by external irradiation. During preparation of the Technical Design and Safety Analysis Report application of radiation protection measures will be optimised according to the principle ALARA. Means of radiological impact reduction are implemented both during design and operation stages. During design stage: • The principle of “protection in depth” is implemented foreseeing the complex system of barriers that restrict spread out of radioactive substances into premises and environment; • Safety SSC preferred over Administrative Controls; • Passive SSC preferred over active SSC; • Preventive controls preferred over mitigate controls; • Adequate facility physical design to potential hazards, alternatives are considered, ALARA principle is applied (e.g. area layout, equipment layout, shielding, confinement and ventilation etc.). Means of radiological impact reduction during operation: • Implementation of preventive maintenance and repair concept; • Implementation of preventive cleaning / decontamination concept; • Application of ALARA principle (planning of the operations and personnel exposure; planning and preparation of operations which may cause significant exposure; personnel training, considering of gained experience, improvement of operation and etc.); • Monitoring of casks surface dose rate and contamination (and decontamination if necessary); • On-line monitoring of airborne releases to the environment; • Monitoring of radiological contamination of environment air, soil, ground

	and underground water; monitoring of ionizing radiation dose rate at the Ignalina NPP and ISFSF sites. Personnel exposure during normal operation in any case will not exceed dose limits. This will be justified in the Safety Analysis Report.

Anticipated radiological impact due to radioactive airborne releases is very low (for details see responses 3 and 4 to the comments) and application of additional protection means is not reasonable. The exposure resulting from transportation of SNF casks is likewise not high, annual effective exposure dose to the member of population is about 2 µSv, see Figure 5.2.2-2 and Figure 5.2.2-3. Potential impact to population from proposed economic activity results due to direct ionizing radiation exposure from ISFSF that is rapidly reduced with the distance from ISFSF site.

EIA report is supplemented as follows:

Text location	Chapter 5.3.3.2, last two paragraphs
Existing text	The highest annual doses to population could be expected only in the close proximity of nuclear facilities constructed by proposed economic activity. The maximal annual effective dose at the permanent security fence of the ISFSF/SWTSF protection zone including exposure due to releases from INPP site is estimated to be 0.177 mSv (1.77×10-4 Sv). The dose is governed by external irradiation from ISFSF and SWTSF structures. The annual effective dose is below dose constraint of 0.2 mSv, cf. chapter 5.3.1.2, therefore radiological protection requirements are not violated. On the border of proposed sanitary protection zone for ISFSF/SWTSF (i.e. 500 m from ISFSF/SWTSF site and railroad connection) the radiological impact to the member of population due to proposed economic activity can be considered as insignificant. The annual effective dose due to proposed economic activity is estimated to be below 10 µSv (9.22×10^{-6} Sv). The radiological impact on environment outside the border of proposed sanitary protection zone for ISFSF/SWTSF is governed by impact from existing (and future planned) nuclear facilities located at INPP site
Supplemented text	The highest annual dose to population may be expected only in the close vicinity to ISFSF, Figure 5.3.3-1. Dose to the member of population is governed by external exposure from the casks that are stored in the ISFSF building and is in directly proportional to the exposure time. Conservatively assuming that exposure duration of the member of population close to ISFSF/SWTSF protection zone permanent security fence is not specially limited (annual exposure time – 2000 h), the calculated annual effective dose due to proposed economic activity equals 166 µSv (1.66×10^{-4} Sv). Keeping the same conservative approach, the calculated highest annual effective dose at the ISFSF/SWTSF protection zone permanent security fence, including exposure due to airborne and waterborne releases from INPP site, equals 177 µSv (1.77×10^{-4} Sv), Figure 5.3.3-2. The annual effective dose is below dose constraint of 200 µSv (e.i. 0.2 mSv, cf. Chapter 5.3.1.2), therefore it may be concluded that radiological protection requirements are not being violated, and proposed economic activity is possible. Also it should be indicated, that permanent economical activity of the population in the vicinity of ISFSF/SWTSF permanent security fence is not foreseen. According to the requirements of physical protection of nuclear facilities [36], presence of the population in the vicinity of the ISFSF/SWTSF site must be controlled (and limited). Moreover, calculations of ISFSF radiation fields are based on (see Chapter 5.2.3.2), conservative source term and assuming completely filled ISFSF. ISFSF shielding calculation [26] sensitivity analysis of conservative assumptions shows, that consideration of realistic fuel data, cooling time in storage pools and ISFSF filling

	schedule leads to 45% lower exposure (in the vicinity of ISFSF) due to neutron flux in comparison with evaluation, currently presented in the EIA Report. Therefore, actual population exposure will be lower than it is evaluated in this EIA Report. With increase of distance from ISFSF/SWTSF site, potential population exposure rapidly decreases (see Picture 5.3.3-1). On the border of proposed sanitary protection zone of ISFSF/SWTSF (i.e. at the distance of 500 m from ISFSF/SWTSF site and railroad connection) the radiological impact to the member of population due to proposed economic activity can be considered as insignificant. Calculated annual effective dose due to proposed economic activity is below 10 µSv (9.22×10^{-6} Sv). The radiological impact on the environment outside the border of proposed ISFSF/SWTSF sanitary protection zone is governed by impact from existing (and future planned) nuclear facilities located at INPP site (see Figure 5.3.3-2). Outside the boundary of the proposed SPZ the new ISFSF practically imposes no restrictions regarding the use of the dose constraint for other nuclear activities with precondition, that the impacts from these new activities are limited by the border of the proposed SPZ for the SWMSF/ISFSF site.  Figure 5.3.3-1. Annual exposure of the population due to proposed economic activity (data from Table 5.3.3-2)

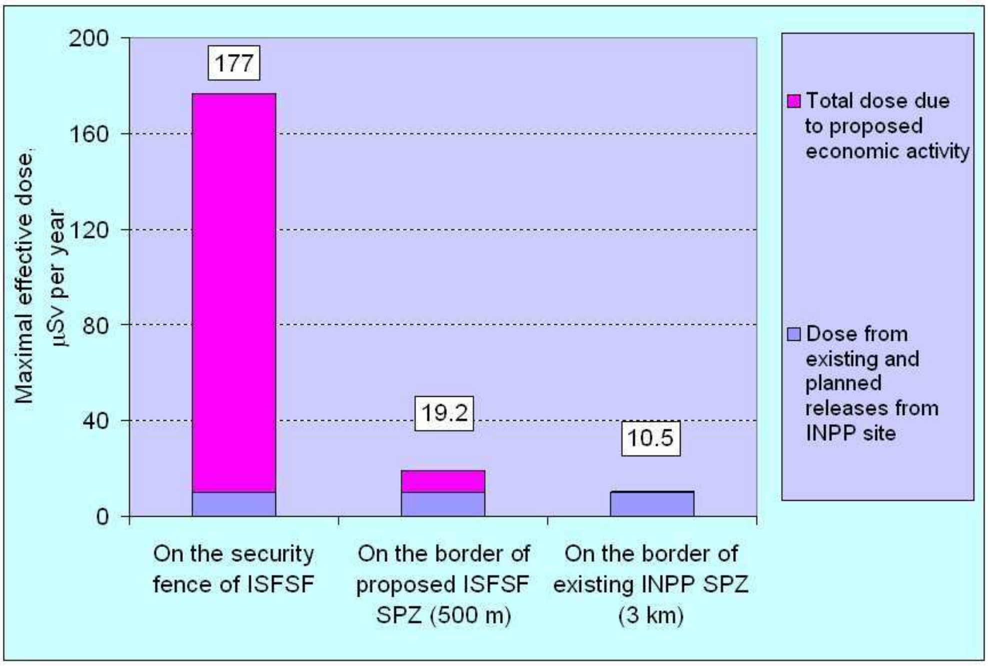


Figure 5.3.3-2. Annual exposure of the population due to proposed economic activity and existing and planned releases from Ignalina NPP site (data from Table 5.3.3-2)

Text location	Chapter 13, a new reference is added to the list of references for chapter 5
Existing text	
Supplemented text	36. General Requirements of Physical Safety for Nuclear Objects and Materials, P-2005-01. The State Nuclear Power Safety Inspectorate (VATESI), 2005. State News, 2005, No. 75-2737.

Text location	Chapter 12 "Summary", p. 200.
Existing text	The highest annual doses to population could be expected only in the close proximity of nuclear facilities constructed by proposed economic activity. The maximal annual effective dose at the permanent security fence of the ISFSF/SWTSF protection zone including exposure due to releases from INPP site is estimated to be 0.177 mSv (1.77×10-4 Sv). The dose is governed by external irradiation from ISFSF and SWTSF structures. The annual effective dose is below dose constraint of 0.2 mSv [4], therefore radiological protection requirements are not violated. On the border of proposed sanitary protection zone for ISFSF/SWTSF…
Supplemented text	The highest annual dose to population may be expected in the close vicinity to ISFSF. Dose to the member of population is governed by external exposure from the casks that are stored in the ISFSF building and is in directly proportional to the exposure time. Conservatively assuming that exposure duration of the member of population close to ISFSF/SWTSF protection zone permanent security fence is not specially limited, the calculated highest annual effective dose to the member of population at the ISFSF/SWTSF protection zone permanent security fence including exposure due to airborne and waterborne releases from INPP site, equals to 0.177 mSv. The annual effective dose is below dose constraint 0.2 mSv [4], therefore it may be concluded that radiological protection requirements are not being violated, and proposed economic activity is possible. Taking into consideration the conservativeness of the assumptions used in calculations and limitation of population activity, determined by the requirements for physical protection of nuclear facilities, the real exposure of the population close to ISFSF/SWTSF site will be lower than it

	has been evaluated in this EIA Report. With increase of distance from ISFSF/SWTSF site, potential population exposure rapidly decreases. On the border of proposed sanitary protection zone for ISFSF/SWTSF…

Comment 3

Section 5. The assessment of radiological impact as presented in this section includes evaluation of potential releases and resulting doses for the workers and population. However, the evaluation of radiological impact on the environment, in addition to the impact on the people, shall also include impact to the other components of the environment (evaluate and show how the parameters, characterizing the radiological situation in the site and the environment will change (or will not change)):

- *Volumetric activity of aerosols and radioactive particles in the air;*
- *Radioactive contamination due to precipitation and/or fall-out of radioactive particles;*
- *Volumetric activity of soil and surface waters;*
- *Specific activity of soil;*
- *Radiological impact on the flora and fauna.*

Response

Assessment of radiological impact on the environment (both during normal operation and accidents) was based on two main principles, indicated in normative document LAND 42:2001 [18]:

- 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 (clause 8);
- Assessments of doses are performed gradually: first by applying the simplest and most conservative models, which do not take into account radionuclide dispersion in the environment (screening approach). If the results of simple models do not meet requirements, a generic models taking into account dispersion and dilution of radionuclides in the environment with generic factors describing life style and diet shall be (mandatory appendix A, clause A3).

Calculated annual exposure of both personnel and population due to radioactive airborne releases is very low. In specific case (conservatively assuming that the all damaged and experimental fuel at the Ignalina NPP reactor unit is managed and collection of fuel fragments is performed within a single year) potential annual dose to member of personnel due to radioactive airborne releases to the working premises is about 3.5 mSv (see Chapter 5.3.3.1). As well in a specific case (conservatively assuming that all Ignalina NPP leaking fuel is managed within a single year) effective dose to member of the critical group of population in the location of maximal exposure is about 0.42 μSv (see Chapter 5.3.3.2). In case of population exposure (when airborne radioactivity is released into the environment) the calculation of effective dose includes exposure pathways due to radionuclides, present in the air and due to activity fall-out on to the ground surface or spread in to the water component (see Chapter 5.1.5.2). Therefore, the effective dose, as an integral impact assessment parameter, as well reflects impact to other environment components. In case of radiological insignificant effective dose the contamination of environment components is as well insignificant.

Therefore, detailed analysis of the contamination of environment components is not performed in the EIA Report.

It should be noted that management of SNF at Ignalina NPP is already performed for a long time. The spent nuclear fuel loading into casks CASTOR RBMK-1500 and CONSTOR RBMK-1500 is performed at the reactor units since 1999. By the end of 2004, a total number of 73 casks has been loaded and transferred to the existing INPP dry type spent nuclear fuel storage. The monitoring of the environment in the region of Ignalina NPP is performed and no increase in environment contamination or exposure of the population due to existing spent nuclear fuel management at the power units is observed (c.f. Chapter 5.3.2).

Comment 4

Section 9. The evaluation of radiological impact on the environment due to emergency situations shall include evaluation of possible impact on the components of the environment, listed in comment 3.

Response

See also response to comment 3.

In case of emergency situations resulting in radioactive airborne releases into environment, the effective dose to the member of population due to releases may be about 0.005 μSv (c.f. Chapter 9.4.2). The possible impact is exceptionally low, exposure mainly results from inert Kr-85 which is dispersed in the atmosphere, and therefore is not analyzed in detail.

Comment 5

Section 9. Taking into consideration that the major part of the planned economical activity will be related to installation and operation of ISFSF, while performing possible risk analysis, we propose to consider requirements of (and cite in the list of references) the document "General Requirements to the Dry Type Storage for Spent Nuclear Fuel", VD-B-03-99 (State News. 1999, 56-1828).

Response

The risk assessment considers requirements of proposed document VD-B-03-99.

EIA report is supplemented as follows:

Text location	Chapter 9.1, first paragraph
Existing text	The emergency situations and their potential risks are assessed following recommendations of normative document [1].
Supplemented text	The emergency situations and their potential risks are assessed following recommendations of normative document [1]. Requirements of the normative document VATESI [2] are also considered.

Text location	Chapter 13, a new reference is added to the list of references for Chapter 9
Existing text	
Supplemented text	2. General Requirements for Dry Type Storage for Spent Nuclear Fuel VD-B-03-99, The State Nuclear Power Safety Inspectorate (VATESI), 1999. State News, 1999, No. 56-1828.

Comment 6

In the Lithuanian document text in the list of references, we propose to write the titles of legislating acts of the Republic of Lithuania in Lithuanian (e.g. “Bendrieji atominių elektrinių saugos užtikrinimo nuostatai", VD-B-001-0-97).

Response

The Lithuanian translation of EIA Report is updated in accordance with the remark.

Consortium

GNS – NUKEM

Subcontractor

Lithuanian Energy Institute

Environmental Impact Assessment Report

Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2

Attachment No. 5 to the Part II "Attached Documents"

Answers to the Remarks of the Technical Support Organizations

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1 Introduction

This attachment of the EIA report includes answers to the comments and proposals for the EIA report "Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2" as provided by the Technical Support Organizations and presented in the Republic of Lithuania Ministry of Health letter No. 10-4263 from August 1, 2007. The changes will be made in the new (revised) version of the EIA report are also indicated.

References to the EIA report used in this attachment (text location, references) comply with the EIA report version, issued June 21, 2007.

2 Comments and Responses

Comment 1

Section 1.6.3 – Other Materials

Table 1.6.3-1, page 21

Comment 1 (Category 3)

In table 1.6.3-1 the construction area of 6200 m^2 is given. The whole site area is 300*100 = 30 000 m^2. Does the 6200 m^2 apply to the area of constructed rooms?

Clarify text, e.g. by a footnote and/or by a cross reference to Figure 2.5.1-1 (p.36).

<u>Response</u>

The EIA Report is supplemented as follows:

Text location	Table 1.6.3-1
Existing text	Construction area Constructed volume
Supplemented text	Construction area (ground area for the main and auxiliary structures of the ISFSF) Constructed volume (main and auxiliary structures of the ISFSF)

Comment 2

Section 1.7 – Potential Environment Impact Sources

Table 1.7-1, page 21/22

Comment 2 (Category 2)

In table 1.7-1 the column "Comments" should include additional remark, indicating that the given dose limit and constraint applies to the whole INPP site and installations. The radiological impact from all installations at INPP site shall not exceed these values.

Consider to amend the table.

<u>Response</u>

The EIA report is supplemented as follows:

Text location	Table 1.7-1, column "Comments"
Existing text	Maximum allowable pollution (harmless to the environment and humans): - dose limit – 1 mSv per year; - dose constraint – 0.2 mSv per year. Natural background radiation – approx. 0.9 mSv per year.

Supplemented text	Maximum allowable impact to the population (still harmless to the environment and humans): - dose limit – 1 mSv per year; - dose constraint – 0.2 mSv per year (impacts from all nuclear facilities located within the same INPP sanitary protection zone shall be included).

Comment 3

Table 1.7-1, page 21/22

Comment 3 (Category 3)

In table 1.7-1, column "Comments", the dose to man by natural background radiation of approx. 0.9 mSv/yr is given. This value corresponds to the dose without inhalation of Radon contrary to the figure given in the EIA programme, where the Radon exposure is included (2.3 mSv/yr).

Harmonise the concerning figure in Table 1.7-1 between EIAR and EIAP or give both values.

Response

It is proposed to delete this sentence. Description of existing radiological conditions in the region of INPP and particularly the proposed site of ISFSF are provided in the chapter 8.2.

Comment 4

Section 2.1.2 – Damaged and Experimental Spent Nuclear Fuel

Para. 1, page 23pp

Comment 1 (Category 2)

In section 2.1.2 it is stated, that amount of damaged SFA will be below 3%. In other paragraph of the same section it is stated that up to 105 SFA with mechanical damages are anticipated after the INPP final shutdown. There is disagreement in the number of damaged SFA.

Consider to improve the data on the fuel state to be handled.

It would be very useful to include the table summarizing data about fuel state and categorizing it into corresponding categories (e.g., leak tight, not tight or leaking, mechanically damaged, etc).

Response

The Ignalina NPP classifies the damaged SFA by two criteria (1) SFA with visual mechanical damages and (2) SFA with cladding leakage. A combination of both defects is possible. According to the Technical Specification for the ISFSF project the total number of existing and future damaged SFA will be below 3%. SFA with so called major mechanical defects (i.e. 105 SFA) forms just a fraction from the total amount of damaged SFA. These SFA cannot be processed (or are not licensed to be processed) in the existing INPP Hot Cell and therefore should be processed using the new Damaged Fuel Handling System.

The EIA report is supplemented as follows:

Text location	Chapter 2.1.2. Last sentence in the fourth paragraph.
Existing text	Up to 105 SFA with mechanical damages are anticipated after the INPP final shutdown.
Supplemented text	Up to 105 SFA with major mechanical damages are anticipated after the INPP final

	shutdown.

EIA Report does not provide exact data on state and statistic of damaged fuel. At first, the INPP is still in operation. The final amount of damaged fuel and damage statistic will become evident only after shut down and defueling of power units. The ISFSF project shall account for possible uncertainties in estimation of amount of damage fuel. Secondly, the assessment of potential impact on environment is not based on damage specific data. EIA considers bounding case conditions – it is assumed that maximally expected amount of damaged SFA (i.e. 3% from total amount) is to be leaking, c.f. subchapter "Estimation of potential annual releases due to processing of damaged and experimental fuel and collecting of fuel debris" in chapter 5.1.1.1.

Comment 5

Whole Chapter 2

Comment 2 (Category 2)

During the handling of SNF, the possibility to damage it exists.

The probability to damage the fuel during its handling shall be evaluated and indicated.

Response

The probability to damage the fuel during its handling can only be evaluated basing on the real technical design solutions which will be detailed during development of technical design. The EIA report is based on the concept of proposed economical activity. Therefore only conceptual considerations can be provided. The potential emergency situations and risk analysis (including potential accidents during fuel handling) is presented in chapter 9 "Emergency situations". Chapter 2 describes main equipment and technological processes.

Comment 6

Whole Chapter 2

Comment 3 (Category 2)

If during the handling the fuel will be damaged, some radionuclides accumulated in the fuel-to-clad gap will be released. This is also important in case of some accidents. Release of radionuclides will occur when experimental SFA will be cut. The amount of accumulated radionuclides in the gap of normal and experimental SFA shall be evaluated.

Provide information on the amount of accumulated radionuclide activity in the fuel-to-clad gap.

Response

Chapter 2 describes main equipment and technological processes. The details on estimation of radionuclide release fractions from SFA are provided in chapter 5.1.1.1 (normal operation conditions) and chapter 9.2.1 (accident conditions).

Comment 7

Section 2.1.3 – Activity inventory

Para. 1, page 24

Comment 4 (Category 2)

Section 2.1.3. *"Activity values for experimental fuel assemblies were calculated using SAS2/ORIGEN-S code from the SCALE computer codes system"* 2D fuel depletion codes e.g. TRITON from the SCALE 5 computer codes system would be more suitable for fuel inventory calculation.

The activities for experimental fuel assemblies should be checked by additional calculations.

Response

The SAS2/ORIGEN-S code from the SCALE computer codes system is verified and validated code and is widely used for the estimation of SNF radiological characteristics. Applicability of the SAS2/ORIGEN-S code for the evaluation of the RBMK fuel characteristics was demonstrated in several studies where calculation results are compared with available experimental results. Also ORIGEN-S code was used for the estimation of nuclide content of the irradiated INPP RBMK-1500 nuclear fuel in the safety analysis of the existing CASTOR RBMK-1500 and CONSTOR RBMK-1500 storage casks.

Comment 8

Section 2.1.3 – Activity Inventory

Table 2.1.3-1, page 26

Comment 5 (Category 2)

Has been activation of Co from ZrNb alloy in fuel cladding included in calculations?

Clarify Co-60 activity calculations.

Response

Estimations of airborne releases from SFA not account for release of activation products from the fuel cladding. Details on EIA airborne source term are provided in chapters 5.1 (normal operation conditions) and chapter 9.2 (accident conditions).

Assessment of potential impact due to irradiation from structures and installations containing radioactive material (during transfer of SNF storage cask, ISFSF structure etc) accounts for cladding activation, c.f. for example chapter 5.2.2.1.

Comment 9

Section 2.1.3 – Activity Inventory

Table 2.1.3-1, page 26

Comment 6 (Category 2)

In Table 2.1.3-1, the activity of Fe55 is higher for 2.0% fuel in comparison with 2.8%. The reasons of this are not clear.

The assumptions of the radionuclide composition evaluation shall be provided.

Response

Fe-55 (2.7 year half-life) is an activation product of Fe-54 contained in cladding and structural materials. The accumulation of Fe-55 during the residence of the FA in the core is determined by several parameters:

- average nuclear power per FA;
- initial enrichment of U-235;
- residence time of FA in core until final burnup is achieved (different for both FA-types);
- decay of Fe-55 during irradiation (Fe-55 does not achieve to saturation during usual periods of 3 to 5 years in a nuclear reactor).

1. The average power per FA of both fuel types is nearly the same. As the enrichment is very different, the average neutron flux is very different too, i.e. higher for 2%type fuel than for 2.8% one (first guess 40% higher). This fact results in an increased Fe-55 activation rate in the 2%type fuel and thus accumulates to higher Fe-55 activities than for the higher enriched fuel.

2. As the average power per FA is the same for both FA types, the residence time to achieve final burnup of the 2.8% type is longer than for the 2% type. This tends at first to higher Fe-55 activation due to accumulation and second to longer decay periods, i.e. larger decay, of Fe-55. Which effect becomes dominant can only be shown in a detailed calculation.

Valuating 1 and 2 comes to the conclusion, that the higher activation rate and the shorter residence time of the 2% type fuel overrule the effects described in 2.

Comment 10

Section 2.2.1

Para. 8, page 29

Comment 7 (Category 2)

Evaluated probability of cask lid malfunction shall be given in order to be able to evaluate the whole system functionality and quantify possible environmental impact due to fuel reloading operations.

Provide probability on the cask lid malfunction.

Response

The combination of welded seal plate and welded secondary lid provides a full metal double containment lid system. The double-barrier welded lid system, together with the double-barrier design of the cask body, will ensure tightness of activity during long-term storage.

The occurrence of a fuel repackaging operation is very low – there has been no requirement for the repackaging of spent fuel stored in GNS storage casks during presently more than 4000 cask storage years (corresponding to about half of the expected ISFSF cask storage years).

Although it is not anticipated that a cask will fail during its storage life, the EIA Report includes environment impact assessment in case of fuel reloading in the FIHC, c.f. chapter 5.1.4.

Comment 11

Section 2.2.2 – Fuel Baskets

Page 29pp

Comment 8 (Category 2)

In section 2.2.2 as well as in the whole Chapter 2, no information about the criticality issue of cask loaded with SNF or other SNF handling operations is provided.

Indicate how criticality issue will be assessed and subcriticality during all fuel handling will be maintained.

Response

EIA not addresses cask design safety issues. Performing the EIA it is assumed that cask will be designed to meet all design conditions and functional requirements as specified in the Ignalina NPP issued "Technical Specification for Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Unit 1 and 2". The nuclear fuel sub-criticality, heat removal, cask mechanical strength and stability and other cask safety issues shall be assured by appropriate Technical Design and shall be analyzed and justified in the Safety Analysis Report.

Comment 12

Section 2.3.2 – Processing of Mechanically Damaged and Experimental Fuel

Page 32/33

Comment 9 (Category 2)

In section 2.3.2 it is written, that a Damaged Fuel Handling System (DFHS) as well as Fuel Debris Collection Equipment will be designed. It is not mentioned that it should be analysed in the Safety Analysis Report. It is important because these systems shall assure safe removal of spent fuel pellets and fuel pellet debris from the floor of the storage pools.

Both these systems should be included in the Safety Analysis Report.

Response

EIA has not a goal to define the content of the SAR. Therefore not the all issues that shall be addressed and analyzed by SAR are indicated. According to the existing regulatory requirements, the content of SAR has to be coordinated and approved by VATESI. The basis for the SAR content will be VATESI normative document VD-B-03-99.

Comment 13

Section 3.2.1 – Solid Waste and Section 3.2.2 – Liquid Waste

Comment 1 (Category 2)

In sections 3.2.1.3 - 3.2.1.9, 3.2.2 it is stated, that waste generated during cask opening operations, or other cask handling and management operations in FIHC or Cask Service Station will be transferred to INPP. How this waste will be managed after the decommissioning of INPP? How long the presently planned radioactive waste installations will be in operation and how the radioactive waste from ISFSF will be managed?

Provide information on ISFSF waste management perspective.

Response

Solid waste will be managed by INPP or by the new Solid Waste Treatment and Storage facility (SWTSF), which will operate until 2030 - 2040. The SWTSF will be constructed aside the ISFSF.

Liquid waste will be managed by the existing INPP Liquid Waste Treatment Facility (LWTF), which will operate until 2030 - 2040.

The waste handling option in the period 2040 – 2070 and management of future arising ISFSF decommissioning waste are not finally defined. Several options are possible. The INPP final decommissioning plan is revised in each 5 years and shall be accordingly updated.

Comment 14

3.2.1.7 – Hot Cell Miscellaneous Maintenance Equipment

Para. 2, page 43

Comment 2 (Category 2)

In sections 3.2.1.7, it is stated, that defective cask, if it is not possible to refurbish it, can be decontaminated and disposed off as solid waste. Due to activation in neutron flux it will be necessary to manage it as radioactive waste. It is doubtful whether it will meet the waste acceptance criteria (dimensions, mass, etc). Is it foreseen to dismantle the cask? The same applies to the 32M and other fuel baskets.

Provide more information on defective cask disposal options.

Response

The cask will be designed as double-barrier welded system for the safe operation time of at least 50 years. The loss of tightness of the cask during the design time (and necessity to reload the SNF) shall be considered as exceptional case.

The emptied defective cask could be closed and stored in the ISFSF until decommissioning of facility. Decommissioning options are discussed in the chapter 1.5.3.

The EIA report is supplemented as follows:

Text location	Chapter 3.2.1.7, second paragraph
Existing text	The TS [12] requires the possibility of fuel repackaging if a storage unit is found to be defective. The cask after fuel repackaging is not operational waste and should be part of decommissioning waste. The cask may, depending on the defect, be refurbished. Otherwise it may be decontaminated and disposed of as solid waste. 32M-Basket after fuel reloading will be decontaminated and disposed of as solid waste.
Supplemented text	The TS [12] requires the possibility of fuel repackaging if a storage unit is found to be defective. The cask after fuel repackaging is not operational waste. The cask may, depending on the defect, be refurbished. Otherwise it should be a part of decommissioning waste. The emptied defective cask can be stored in the ISFSF until the decommissioning of facility. Decommissioning options are discussed in the chapter 1.5.3.

Comment 15

Section 3.2.3 – Gaseous Emissions

Page 44/45

Comment 3 (Category 2)

In sections 3.2.3, the gaseous emissions from leaking fuel management are assessed. The method how the release activities where assessed shall be clearly identified.

Provide information on the gaseous emissions evaluation.

Response

Chapter 3.2.3 gives summary of the assessment. The second paragraph in the chapter provides reference to the chapter 5.1 "Potential Impact on Environment due to Release of Airborne Activity" where assessment of emissions (including description of assessment method) is presented.

Comment 16

Section 4.1.6 – Seismic Activity

Page 55/56

Comment 1 (Category 2)

In section 4.1.6, the potential of the liquefaction of soils in the ISFSF area during design basis earthquake shall be discussed. It might be necessary to include this in the SAR.

Consider liquefaction hazard of the territory of ISFSF soils.

Response

The ISFSF foundation design will be developed and justified during Technical design stage. The local site conditions, design concept, loads and associated effects as well as soil improvement actions (if necessary) etc shall be considered as well.

The design safety aspects will be addressed in the SAR. The basis for the SAR content will be VATESI normative document VD-B-03-99. According to the existing regulatory requirements, the content of SAR has to be coordinated and approved by VATESI.

Comment 17

Missing section on local background concentrations and radiation

Comment 2 (Category 1)

The comment raised for EIA Programme Chapter 4, aiming to include information of radiological and conventional pollutants background of the site is not addressed in Chapter 4.

Include required information which is in detail mentioned in the remark raised for EIAP. Use the data and information from annual monitoring reports of INPP according to Chapter 8 (values from background measuring or sampling stations).

Response

The radiological situation in the INPP region and in the potential ISFSF site is described in section 8.2. This section includes the remark questioned information:

- gamma dose rate is described in chapter 8.2.7,

- airborne aerosol and radioactive particles activity concentration is described in chapter 8.2.2,

- radioactive contamination caused by precipitations and/or radioactive particles is described in chapters 8.2.2 and 8.2.3;

- groundwater and surface water activity concentration is described in chapters 8.2.4 and 8.2.5;

- soil specific activity is described in chapter 8.2.6.

It is proposed to keep information on radiological situation in one place and also not to provide the same information twice in the same documents. Link to the monitoring chapter will be added in the beginning of chapter 4.

The EIA report is supplemented as follows:

Text location	Chapter 4, introduction. The new (third) paragraph is added.
Existing text	
Supplemented text	Monitoring of radiological situation in the environment of INPP region is carried out in accordance with the regulatory approved environment monitoring programme. Description of the INPP radiological monitoring system and the present radiological

	state of the environment is presented in the chapter 8.

Comment 18

5.1.1.1 - Assessment of potential activity release sources

Para. 5, page 90

Comment 1 (Category 3)

The document states: "*To a small degree in free state under fuel rod cladding there are present halogens and alkali metals,...*"

It seems very unlikely that the extremely reactive alkali metals and halogens will remain in a free state especially after a long period of cooling. Far more likely would be the presence of the metal halides – caesium iodide, for example.

Modify text.

Response

The sentence is extraction from the reference [6].

It is agreed that the wording in the referenced document might be better. Important aspect of this sentence is identification of the elements, which may be released in case of loss of fuel cladding integrity.

Comment 19

5.1.1.1 - Assessment of potential activity release sources

Para. 5, page 90

Comment 2 (Category 2)

The document states: "*The remaining radionuclides contained in irradiated fuel with long half-life (Ba-137,Sr-90) are in solid phase and practically do not leave fuel through cladding defect,...*"

Surely strontium – and some other fission products – would exhibit a similar behaviour to caesium in the fuel and also be present in the gap inventory. What evidence is there that these nuclides are not present in the gap?

Include Sr-90 in nuclide list for gap release or justify in more detail why the omit of alkaline earth metals is negligible for this assessment.

Response

The sentence is extraction from the reference [6].

The fission product inventory in gap and released fractions were selected following recommendations of U.S. Nuclear Regulatory Commission Regulatory Guide 1.183. The guide attributes Sr to the Tellurium group metals (Te, Sb, Se, Ba, Sr). The release of Sr is not included into the source term for fuel handling accidents (for non-LOCA events). The fuel handling accident source term includes noble gases, halogens and alkali metals. Among them, the I-131 and Kr-85 are addressed separately.

The INPP practice could also be indicated. The content of Sr-90 in the water of SNF pools and associated radioactive waste is considerable lower the content of Cs-137.

Comment 20

5.1.1.1 - Assessment of potential activity release sources
Para. 6, page 90
Comment 3 (Category 2)

The release fraction of 0.01% for caesium is not obviously conservative since it states for long term release are higher by a factor of 10 than short term releases which range from 0.0001% to 0.01% (geometric mean 0.001%). Therefore a value of 0.1% would be demonstrably conservative.

Either justify why the longer term release fractions are not appropriate in this case or use the higher value.

Response

The activity release (and exposure) scenarios consider potential releases expected during the whole year period. During the year a number of SFA will be handled. Therefore mean values were used.

Comment 21

5.1.1.1 - Assessment of potential activity release sources
Para. 8, page 90 and Table 5.1.1-2
Comment 4 (Category 2)

The USNRC Regulatory Guide 1.183 seems to be used for the fraction of the fission product inventory in the gap. Are these values appropriate for fuel that has been cooled this long? The title of the report ('Alternative Radiological Source Terms for Evaluating Design Basis Accidents in Nuclear Power Reactors') suggests it applies to reactors at power. One might expect greater fractions of volatile fission products such as tritium and Kr-85 to accumulate in the gap over longer periods.

Also does the report give zero for the gap fraction for Sr-90 and other fission products or does it just not mention it?

It states that an exception is made for Cs with a lower value being selected. How much lower? It would have been useful to have the original values reproduced.

Reproduce the actual values from the USRNC Guide and clearly state under what conditions they apply and how they might differ from those prevailing here.

Response

U.S. Nuclear Regulatory Commission Regulatory Guide 1.183 provides representative accident source terms for the most typical DBA of NPP. It considers not only reactor core related accidents. It can be indicated that the guide supersedes (among others) the well-known Regulatory Guide 1.25 "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors".

The discussion on selection and justification of selection of the source term is provided in the EIA report. Known studies and publications indicate that NRC Regulatory Guide 1.183 recommendations conservatively envelops results of existing RBMK fuel investigations. An exception was made just for release of Cs products where lower values of release fraction are supported (in addition to other known studies) by existing INPP measurements.

The Regulatory Guide 1.183 is publicly available. Electronic copy can be free downloaded from official NRC website.

Comment 22

5.1.1.2 - Assessment of Airborne Activity Release into the Environment

Para. 2, page 95

Comment 5 (Category 2)

It states that 99.5% of the total iodine released is retained by the water in the pools. This figure is not justified. In fact the fraction of iodine retained will be critically dependent on the pH of the water. Aqueous iodine behaviour is governed by the equilibrium below:

$$3I_{2(g)} + 3H_2O_{(l)} \leftrightarrow 5I^-_{(aq)} + IO^-_{3(aq)} + 6H^+_{(aq)}$$

If the pH of the water can be maintained above 7 then very little iodine will be released to the atmosphere. However, if the pH is below 7 then most it will be released over time (certainly more than 0.5%).

Either make some statement that the pH of the pool water is greater than 7 or assume a higher release fraction for iodine.

Response

The pools water decontamination factors were selected basing on recommendations of U.S. Nuclear Regulatory Commission Regulatory Guide 1.183. The INPP SNF pools water is kept within pH range from 5.5 to 8.0.

Comment 23

Table 5.1.1-6 and other source term tables in Chapter 5 and Chapter 9.

Comment 6 (Category 2)

See comment above about the gap inventory of Sr-90. If Sr-90 and other fission products are included in the gap inventory then these tables would have to be modified to include these nuclides.

Modify tables to include Sr-90, if appropriate (see comment 2 to chapter 5)

Response

See answer to the comments 19 and 21.

Comment 24

5.1.5.1 - Annual exposure of personnel due to release of airborne activity intoenvironment of Storage Pools Hall

Pages 101-102

Comment 7 (Category 2)

Collective dose for workers is not calculated or discussed and nor are any mitigation measures.

Discuss mitigation measures and collective dose.

Response

The assessment provided in the chapter 5.1.5.1 jus demonstrates that that potential expose of operating personnel due to release of airborne activity into environment of Storage Pools Hall is expected to be sufficiently low and requirements on limitation of annual worker exposure can be met. The detailed assessment of personnel exposure (individual and collective doses), exposure optimization and implementation of ALARA can be performed only in Safety Analysis Report considering Technical Design issues.

The EIA report presents some preliminary estimation of expected personnel collective dose due to external exposure, c.f. chapter 5.2.1.1. The assessment is based upon the INPP experience of handling the existing CONSTOR and CASTOR casks, taking into consideration key features of the new type CONSTOR® RBMK1500/M2 casks and additionally planned operations of casks and SNF handling. The main purpose of such assessment is to show that personnel exposure resulting from existing and additional operations of the proposed economic activity will not exceptionally increase, and, therefore, can be limited using necessary shielding, remote-controlled equipment, appropriate operational procedures etc.

Comment 25

5.1.5.2 - Annual exposure of population due to release of airborne activity into atmosphere from Reactor Units

Page 103/104

Comment 8 (Category 2)

It states that Document 18, a Lithuanian normative document does not provide dose conversion values for some radionuclides and then goes on to use values for other nuclides as being representative. Why not use standard ICRP published values (ICRP-71 etc.)?

Consider using ICRP data.

Response

The document [18] specifies release-to-dose conversion factors, which give a relation between a nuclide specific permanent long-term activity release from the INPP site and the dose caused to a critical group member of the population of the INPP region. ICRP publications do not provide INPP environment specific values.

Comment 26

5.1.5.3 - Annual exposure of population due to release of airborne activity into atmosphere from operation of the Fuel Inspection Hot Cell

Pages 105-106

Comment 9 (Category 2)

Only the inhalation and immersion pathways are considered. What about the dose from deposited activity and from ingestion of contaminated foodstuffs?

Consider all pathways.

Response

The cask repacking in the new FIHC is normally not expected. Therefore the operation of the FIHC should not consider as part of normal plant operations. The FIHC will be used only in the exceptional event that fuel needs to be transferred from a suspect defected cask to a new cask.

Due to nature of cask preparation and fuel repacking operations (evacuation of cask cavity, relatively short time fuel reloading process and low probability of annual fuel repacking occurrence) a relatively short time release of activity via ISFSF ventilation stack may be expected.

For low probable and short time release a dose due to passing through cloud was calculated only. Due to the activity dispersion in the atmosphere, these radiological consequences cannot be avoided or mitigated.

Comment 27

5.2.1.1 - Estimated collective doses to personnel due to external irradiation during normal operation of the proposed economic activity

Pages 106-107

Comment 10 (Category 2)

The important aspect in demonstrating that doses to workers from the fuel transfer operations will be ALARP is the annual dose to an individual worker. Clearly the number of personnel involved is not the actual number of individuals who will carry out the work (the operations will be carried out by a team or teams, if there is shift work). There is no explanation of why there were more personnel involved in each operation in the second campaign of 60 casks which significantly reduces the average dose per person.

Depending on the number of individuals over whom the dose is spread (i.e. those qualified to undertake the operations) the annual average individual dose could be several mSv and particular operators may receive significantly more.

Give an indication of the number of individuals that will be involved in the operations.

Response

The EIA report presents some preliminary estimation of expected personnel collective dose. Estimation is based on INPP experience of handling the existing CONSTOR and CASTOR casks. The main purpose of this assessment is to show that personnel exposure resulting from existing and additional operations of the proposed economic activity will not exceptionally increase, and, therefore, can be limited using necessary shielding, remote-controlled equipment, appropriate operational procedures etc.

The detailed assessment of personnel exposure (individual and collective doses), exposure optimization and implementation of ALARA are the tasks for the Technical Design and Safety Analysis Report.

Apart similarities in performed SNF handling operations, the CONSTOR and CASTOR casks handling campaigns had some differences in work organization, experience gained and tasks to be performed. They also are of different duration. Therefore the number of people involved into these campaigns is different.

Comment 28

5.2.1.1 - Estimated collective doses to personnel due to external irradiation during normal operation of the proposed economic activity

Page 108

Comment 11 (Category 3)

According to Section 5.3.1.1, the annual limit on effective dose is 50 mSv with a running limit of 100 mSv in a continuous period of 5 years. Many operators have set a limit of 20 mSv per year to simplify the control of dose.

Mention of compliance with the annual limit must also include reference to compliance with the limit for 5 consecutive years.

Response

The EIA chapter 5.3.1.1 provides overview of the main regulatory established radiation protection requirements. Certainly, operator has additional criteria to simplify the control of dose, assure ALARA implementation and optimize work organization. The INPP has its safety procedures which controls annual dose, day dose etc. These additional criteria are included into the Technical Specification and have to be implemented by the design of ISFSF. Analysis of the technical design solutions is in the scope of the SAR. See also explanations provided in the firs paragraph of chapter 5.3.1.

Comment 29

Section 5.3 - Summary of Potential Impact on the Environment due to Normal Operation of Proposed Economic Activity

Pages 117-123

Comment 12 (Category 1)

The summary section could usefully include some discussion of the impact in the longer term (up to 50 years). The discussion quite reasonably focuses on the early years when the impact will be at its highest however there should be some statement about its impact over the whole life of the facility even it is just to say that it is insignificant.

Discuss environmental impact of the project over its entire life.

Response

The EIA report is supplemented as follows:

Text location	A new paragraph is added at the end of chapter 5.3.3.2
Existing text	
Supplemented text	The highest radiological impact on environment could be expected during spent nuclear fuel handling and transfer to the ISFSF phase. When the fuel will be removed from the power units and safely stored in the ISFSF, the impact on environment will become decreasing. The nuclear fuel will be confined into long-term stable, steel-welded and double-barrier casks. The hazardous radionuclides will become isolated from environment. There will be no radioactive releases into the environment (the cask repacking in the new FIHC is normally not expected). There will be no off-site cask transfer operations. Due to the natural radioactive decay the radioactive fields around the ISFSF will become gradually decreasing. When the interim storage is finished, it will be possible to transport the spent fuel away from the ISFSF site without repackaging the fuel. The CONSTOR® RBMK1500/M2 type casks will be designed to meet requirements of IAEA Regulations for the Safe Transport of Radioactive Material.

Comment 30

Section 5.3 - Summary of Potential Impact on the Environment due to Normal Operation of Proposed Economic Activity

Pages 117-123

Comment 13 (Category 1)

There should also be some statement about the impact on fauna and flora and other aspects of the environment again even if only to say that it is insignificant.

Make some statements about the impact of other aspects of the environment.

Response

The EIA follows the Lithuanian normative document LAND 42:2001 statement (clause 8), which indicates that "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". Therefore the radiological impact on fauna, flora and other environment components is not addressed separately.

It can also be indicated that description of environment components do not identified any specific environment components, which may have a reason to be addressed specifically. The results of assessment shows that only a minor impact on environment could be expected due to radioactive releases. The impact due to direct irradiation from ISFSF will be relevant only in the close proximity to the facility site.

The EIA report is supplemented as follows:

Text location	New chapter 5.3.1.3 is added
Existing text	
Supplemented text	5.3.1.3 Radiation protection requirements for other environment components The Republic of Lithuania normative document [18] 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.

Comment 31

CHAPTER 7 - ANALYSIS OF ALTERNATIVES

Pages 134-138

Comment 1 (Category 2)

Was any public consultation carried out? None is mentioned.

Discuss any consultation.

Response

Public involvement in the EIA process is described in Part II of EIA Report. This part is permanently upgraded in accordance with the new results and conclusions received.

Comment 32

Section 7.2 – Spent Nuclear Fuel Handling and Storage System Alternatives

Pages 136-137

Comment 2 (Category 2)

An option that doesn't seem to be discussed is sending the spent fuel to Russia. **Please insert.**

Response

The EIA report is supplemented as follows:

Text location	A new paragraph is added into the beginning of chapter 7.1
Existing text	
Supplemented text	Transfer of spent nuclear fuel RBMK to other countries because of a number of technical and political reasons is not possible either now or in the near future. Therefore the Government of the Republic of Lithuania has decided to start the design of the spent nuclear fuel storage facility at the INPP region.

Text location	Second and third paragraphs in chapter 7.2
Existing text	Reprocessing is not foreseen by Lithuanian legislation. In addition, RBMK spent fuel is not suitable for reprocessing and there is no installations in the world concerning RBMK spent fuel reprocessing. The direct disposal option requires long-term interim storage of spent fuel. Taking into account the fact that the first demonstrations of the direct disposal of spent fuel are expected only after the year 2020, long-term storage will be the primary option for the management of spent fuel all over the world at least until the middle of this century. The proven wet and dry long-term storage concepts are expected to continue to be used in the future. Three alternatives have been investigated which assume the wet and dry long-term storage of spent nuclear fuel.
Supplemented text	Reprocessing is not foreseen by Lithuanian legislation. Also, presently there is no installations in the world concerning RBMK spent fuel reprocessing. Taking into account the fact that the first demonstrations of the direct disposal of spent fuel are expected only after the year 2020, long-term storage will be the primary option for the management of spent fuel all over the world at least until the middle of this century. The storage of SNF in the ISFSF is a temporary solution before the final SNF route will be defined and necessary actions will be implemented. The national Strategy on Radioactive Waste Management [1] foresees several options to be investigated prior the final decision will be taken: • Possibility to dispose off the SNF in the national deep geological repository; • Possibility to dispose off the SNF in the regional deep geological repository; • Possibility to transfer and dispose off the SNF in other countries; • Possibility to safe store the SNF for 100 years and more. The proven wet and dry long-term storage concepts are expected to continue to be used in the future. Three alternatives have been investigated which assume the wet and dry long-term storage of spent nuclear fuel.

Comment 33

Section 8.1 - INPP Current Environment Monitoring Programme

Figure 8.1-2, page 141

Comment 1 (Category 2)

The text of the legend of Figure 8.1-2 *"... investigation of the "zero" background ..."* could be misleading. There is no need to investigate the background of cosmic radiation, because it is relatively constant. Otherwise, such measurements – if they are carried out as continuous gamma ray measurements - are of high relevance as part of the early warning system.

Please explain.

Response

Indicated locations are used for sampling in Lake Druksiai starting from INPP pre-construction time. Therefore historically these points are called as "zero background" points. It is agreed that name can be misleading.

The chapter 8.1 is rewritten.

The updated chapters 8.1 and 8.2 are attached separately.

Comment 34

Section 8.1 - INPP Current Environment Monitoring Programme

Pages 139-141

Comment 2 (Category 1)

The information given in section 8.1 is not well structured and incomplete. Surely, the main measurements which are carried out at the INPP site and the surrounding environment are shortly described but without any further explanations. The reader do not get a clear impression on the functionality of the existing monitoring system for both cases, routine operation or emergency situations. The description of the early warning system and the emergency measurement programme is totally missing.

There is also an information missing if measurements of H3 and C14 in atmospheric releases are now implemented in the monitoring programme or not. This was remind in the review report of EC experts (DG TREN H4, Ref. LT-05/1; visit to INPP, 21 – 25 February, 2005).

It must therefore be urged to rewrite section 8.1 totally in consideration of the following:

The first paragraphs on p. 139 could remain up to "... in accordance with the documents 4, 6-8]".

Afterwards information on the monitoring programme with kind of samples/measurements, applied sampling/measuring methods, frequency of sampling/measurement etc. should be given in table form and, if appropriate with additional information, e.g. the enhancement of measurement frequency in emergency situations. The table should at least include:

- **Monitored media and number of sampling/measurement points**
- **Sample/measurement type**
- **Sampling/measurement frequency**
- **Indication to on-site or laboratory measurements**
- **Measurement method applied**
- **Detection limits**

The chapter shoud be completed by 1 or 2 maps with all sampling/measurement stations. A clear indication shoud be given of such stations which are part of the early warning system and/or measurements in emergency case. .

Response

The chapter 8.1 is rewritten.

The updated chapters 8.1 and 8.2 are attached separately.

Comment 35

Section 8.2 - Main Results of Radiation Monitoring

8.2.1 – Radioactive Releases into Atmoshere

Page 143, last sentence of section 8.2.1

"...and constitute only 1.9% of dose constraint (0.1 mSv/y)." By contrast, in Table 1.7-1 (p. 21) the dose constraint is 0.2 mSv/y.

Clarify text

Response

The chapter 8.2.1 is rewritten. More recent radiation monitoring results are added. Misinterpretation of dose constraint is deleted.

The updated chapters 8.1 and 8.2 are attached separately.

Comment 36

8.2.4 – Radionuclides Concentration in the Aquatic Environment

Text intentation, page 144

Comment 3 (Category 3)

The annual Tritium discharge into the Druksiai lake is given together with the annual dose caused by all liquid discharges from INPP.

Distingish between dose caused by Tritium and by the other dischared nuclids or indicate percentage of dose due to Tritium discharge.

Response

The chapter 8.2.4 is updated. More recent radiation monitoring results are added. Information on Tritium discharge stipulated dose is added.

The updated chapters 8.1 and 8.2 are attached separately.

Comment 37

8.2.5 - Radionuclides Concentration in the Water of Observation Wells

Para. 2, page 144

Comment 4 (Category 2)

A Tritium concentration of more than 100 Bq/l was measured in wells around the existing Solid Radwaste Storage Facility and landfill.

What is the reason for the enhanced concentrations?

Response

The chapter 8.2.4 is updated. Explanations are provided.

The updated chapters 8.1 and 8.2 are attached separately.

Comment 38

Section 8.2 - Main Results of Radiation Monitoring
After Section 8.2.7
Comment 5 (Category 2)

It is recommended to insert a summary of Section 8.2 after 8.2.7 in tabular form (similar to Section 9.2.2.3 and 9.2.3.3 "Summary of potential radiological impact; Tables 9.2.2-3 and 9.2.3-3) with the following columns

- **Radionuclide concentration or gamma-radiation in concerning environmental media**
- **Pathway**
- **Annual dose per path (maximum and mean) and overall dose**

Response

A new chapter is added 8.2.8 where exposure of population due to operation of INPP is summarized.

The updated chapters 8.1 and 8.2 are attached separately.

Comment 39

9.2.2.1 - Dose to personnel due to short term release
Page 170-172
Comment 1 (Category 1)

The methodology of using the integrated concentration factor, C, to calculate the dose to an operator from inhalation should be referenced. The basic reference is:
Holloway, N, (1993), Models for Operator Dose Assessment in Radioactive Materials Handling Accidents SRD/CLM(93) P47

The model is only applicable to inhalation dose and should not be applied to submersion dose except to determine the variation of cloud dimension with time. A cloud of gamma emitting noble gas will result in radiation exposure to operators before it has expanded sufficiently to engulf them (i.e. before t_1). As stated below, the use of the semi infinite cloud dose rate factor in ICRP68 is incorrect for a finite gas cloud. The dose rate will fall off as the cloud expands but not in the same way that inhalation dose falls. It is possible to carry out calculations of dose rate external to a spherical cloud using a simple computer code such as Microshield and to use the internal cylinder geometry in Microshield to approximate the submersion dose from a finite cloud.
Reference the methodology for the cloud expansion.

Review the method used to calculate external dose from the noble gas release.

Response

The indicated methodology is already referenced, c.f. reference [10] the text of chapter 9.2.2.1. The reference is included into chapter 13 "References and sources of information", c.f. reference 10 under "Chapter 9".

It is agreed that methodology do not considers external exposure during cloud development until it reaches the worker (the first 12.3 seconds of the release) and could be not sufficiently conservative. Therefore calculations are updated - the cloud dispersion coefficient for external exposure is calculated separately for reduced exposure startup time t_1 of 0.1 sec.

Also see discussion to comment 41.

The chapter 9.2.2.1 is updated.

The updated chapter 9.2.2.1 is attached separately.

Comment 40

9.2.2.1 - Dose to personnel due to short term release

Page 171

Comment 2 (Category 2)

The exposure duration of 10 minutes is based on the accidental release being detected or the operator becoming aware of the accident. The activity in air detectors capture particulate on a filter and will not respond to noble gases or vapours. Also (see comment on Table 9.2.2-1 below), the γ dose rate from the expanding cloud is unlikely to be sufficient to trigger a γ monitor (typically set to 100 $\mu Sv.h^{-1}$) unless it is close to the point of origin of the gas bubble from the pond (about 2 m).

However, the dose received is likely to be less than that calculated for the reasons given below and it is probable that the operator would be alerted to an error by gas bubbling from the cut.

Consider whether the available monitors will actually alarm or what other means will alert the operator that the fuel has been cut into.

Response

The remark will be taken into consideration during developing of Technical design and SAR.

Comment 41

9.2.2.1 - Dose to personnel due to short term release

Table 9.2.2-1, page 172

Comment 3 (Category 2)

The submersion dose rate used, taken from Table D.1 of ICRP 68, is for a semi-infinite cloud; the dose rate from a discrete cloud at the same concentration is much lower. Even the reactor hall dimensions do not approximate to a semi infinite cloud (the half thickness of air for the 0.51 MeV γ ray from Kr85 is 65 m).

If the Kr85 release filled reactor hall the concentration would be 4.3E7 $Bq.m^{-3}$ which would result in a dose rate of 1.1E-8 $Sv.s^{-1}$ or 39 $\mu Sv.h^{-1}$ using the semi infinite cloud values; however, even this is likely to be an order of magnitude too high (ICRP 30 tabulated the submersion dose rates for semi infinite cloud and room volumes of 1000 m^3, 500 m^3 and 100 m^3 –the semi infinite cloud dose rate is 1.5 orders of magnitude more than that for the 1000 m^3 room).

The dose factor in ICRP68 from tritium gas is from inhalation not from cloud immersion. Tritium is a pure β emitter with a low energy and gives no external dose; there is absorption in the lungs and Table C1 of ICRP 68 suggests a possible increase of 20% from irradiation of the lungs from tidal tritium (inhaled but not absorbed).

It is not usual to include the immersion dose from I129 which is a βγ emitter because the committed dose from inhalation dominates.

The dose from I129 can either be inhalation of type F particulate (value tabulated is for 5 µm AMAD) or for inhalation in the vapour. The vapour phase inhalation factor is slightly higher (9.6E-8 $Sv.Bq^{-1}$).

The final result is, therefore, pessimistic by at least an order of magnitude and probably more (this misuse of the data would be a category 1 comment if the result was not so pessimistic and even then quite low).

Revisit the dose calculation for personnel from this event.

Response

The use of dose factors derived for semi-infinitive cloud for bounded environment usually leads to conservative (even very) results. However, it could be pointed out that EIA task is to demonstrate that proposed concept could be implemented without leading to violation of regulatory requirements. The calculation of actually expected doses, optimization of exposure etc. is a task for Technical design and SAR, where actual design solutions could be considered.

The conservatism could be reduced, for example, by application of empirical recommendations that are practically used in nuclear industry. The US NRC regulatory guide 1.183 could be referenced which recommends to use the following expression for correction of the semi-infinite cloud dose to a finite cloud dose

$$DDE_{finite} = \frac{DDE_{\infty} V^{0.338}}{1173}$$

Where DDE is dose equivalent from external exposure and the room is modeled as a hemisphere that has a volume, V, in cubic feet, equivalent to that of the volume of the room. The equation leads to reduction of semi-infinitive cloud dose by factor of 11.2 for the volume of INPP Storage Pools Hall (of 2.68E+04 m^3 or 9.46E+5 ft^3).

Other points addressed in the remark are discussed below:

"The dose factor in ICRP68 from tritium gas is from inhalation not from cloud immersion…". The dose factors for inhalation were selected from national normative document HN 73:2001, which is in compliance with IAEA Safety Series No. 115. The IAEA SS-115 (Table II-V which is identical to HN 73:2001 Table B1) does not provide neither inhalation factors for H-3 nor the link to other source as is a case with ICRP68 (Table B1 and link to Annex C where effective dose coefficient for soluble or reactive tritium gas is set to be 1.8E-15 Sv/Bq). The inhalation pathway for tritium gas can be included into calculation. That will lead to additional exposure of 3.66E-08 Sv and to increase of total dose due to release of tritium from 2.04E-08 to 5.70E-08 Sv.

"It is not usual to include immersion dose from I-129…". The dose factor for immersion is of the same order (even slightly higher, c.f. Table 9.2-4) as for Kr-85 therefore it was included. Certainly, inhalation dose from I-129 prevails.

"The dose from I-129 can be of type F…". The dose factors for inhalation were selected from national normative document HN 73:2001, which is in compliance with IAEA Safety Series No. 115. The IAEA The SS-115 Table II-V "Committed effective dose per unit intake via inhalation and ingestion for workers" data were used.

The chapter 9.2.2.1 is updated.

The updated chapter 9.2.2.1 is attached separately.

Appropriate changes are made in related chapters:

Text location	Chapter 9.2.2.2, sepatate line in Table 9.2.2-2
Existing text	(table below)

Radionuclide	e_{inh}, Sv/Bq	e_{sub}, (Sv/s) / (Bq/m^3)	Annual effective dose, Sv
H-3	0	3.31E-19	0

Supplemented text	(table below)

Radionuclide	e_{inh}, Sv/Bq	e_{sub}, (Sv/s) / (Bq/m^3)	Annual effective dose, Sv
H-3	1.80E-15	3.31E-19	0

Text location	Chapter 9.2.3, sepatate lines in Table 9.2.2-3
Existing text	(table below)

Radionuclide	Annual effective dose, Sv/a		
	Short term	Long term	Total
H-3	2.04E-08	0	2.04E-08
Kr-85	3.68E-04	0	3.68E-04
I-129	3.03E-07	4.25E-11	3.03E-07
Total	**3.68E-04**	**1.67E-04**	**5.36E-04**

Supplemented text	(table below)

Radionuclide	Annual effective dose, Sv/a		
	Short term	Long term	Total
H-3	5.74E-08	0	5.74E-08
Kr-85	3.77E-04	0	3.77E-04

Total	**3.77E-04**	**1.68E-04**	**5.46E-04**

Text location	Chapter 9.2.3, paragraph below Table 9.2.2-3
Existing text	The expected effective dose due to short term (immediate) release of airborne activity into environment of Storage Pools Hall is about 0.37 mSv.
Supplemented text	The expected effective dose due to short term (immediate) release of airborne activity into environment of Storage Pools Hall is about 0.38 mSv.

Text location	Chapter 9.2.3.1, sepatate line in Table 9.2.3-1

Existing text

Radionuclide	e_{inh}, **Sv/Bq**	e_{sub}, **(Sv/s) / (Bq/m^3)**	**Effective dose, Sv**
H-3	0	3.31E-19	1.34E-13

Supplemented text

Radionuclide	e_{inh}, **Sv/Bq**	e_{sub}, **(Sv/s) / (Bq/m^3)**	**Effective dose, Sv**
H-3	1.80E-15	3.31E-19	3.76E-13

Text location	Chapter 9.2.3.3, separate line in Table 9.2.3-3

Existing text

Radionuclide	**Annual effective dose, Sv**		
	Short term	**Long term**	**Total**
H-3	1.34E-13	0	1.34E-13

Supplemented text

Radionuclide	**Annual effective dose, Sv**		
	Short term	**Long term**	**Total**
H-3	3.76E-13	0	3.76E-13

Text location	Chapter 9.3.2, separate lines in Table 9.3.2-1

Existing text

Radionuclide	**Annual effective dose, Sv**		
	Short term	**Long term**	**Total**
H-3	2.62E-08	0	2.62E-08
Kr-85	4.72E-04	0	4.72E-04
I-129	3.89E-07	5.45E-11	3.89E-07
Total	**4.73E-04**	**< 1.67E-04**	**< 6.40E-04**

Supplemented text

Radionuclide	Annual effective dose, Sv		
	Short term	Long term	Total
H-3	7.37E-08	0	7.37E-08
Kr-85	4.84E-04	0	4.84E-04
I-129	3.87E-07	5.45E-11	3.87E-07
Total	**4.84E-04**	**< 1.68E-04**	**< 6.53E-04**

Text location: Chapter 9.3.3, separate lines in Table 9.3.3-1

Existing text

Radionuclide	Annual effective dose, Sv		
	Short term	Long term	Total
H-3	1.73E-13	0	1.73E-13
Total	**3.11E-09**	**< 1.85E-09**	**< 4.97E-09**

Supplemented text

Radionuclide	Annual effective dose, Sv		
	Short term	Long term	Total
H-3	4.82E-13	0	4.82E-13
Total	**3.12E-09**	**< 1.85E-09**	**< 4.97E-09**

Text location: Chapter 9.4.1, dose values in Table 9.4.1-1

Existing text

Accident	Annual effective dose, Sv	Remarks and reference
Accidental cutting …	5.36E-04	In total about 59 …
Accidental breaking …	< 6.40E-04	In total about 28 …

Supplemented text

Accident	Annual effective dose, Sv	Remarks and reference
Accidental cutting …	5.46E-04	In total about 59 …
Accidental breaking …	< 6.53E-04	In total about 28 …

Comment 42

Chapter 9 – whole chapter

Comment 4 (Category 1)

Also as with Chapter 5, there is no discussion on the impact on the environment (fauna and flora etc.). Clearly, the impacts will be negligible but a statement along those lines should be added.

Response

See answer to Comment No. 30.

Comment 43

Chapter 9 – whole chapter

Comment 5 (Category 2)

In assessing the tolerability of the accident scenarios no discussion is made of the frequencies of the scenarios. This may not be required under Lithuanian legislation but for information, the methodology and criteria that would be required in the UK is attached as Appendix 1.

Response

The risk of potential emergency situations (including preliminary evaluation of accidents probability and practical example) is addressed in chapter 9.1.

Comment 44

CHAPTER 12 – EXECUTIVE SUMMARY

Pages 192-201

Comment 1 (Category 1)

A non-technical summary according to the requirements of EU Directive 85/337/EEC is missing.

The executive summary seems to be more technical and must be replaced.

Response

The article 5 of the Council Directive 97/11/EC (of 3 March 1997 amending Directive 85/337/EEC) requires to provide non-technical summary which should include:

- a description of the project comprising information on the site, design and size of the project;
- a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects;
- the data required to identify and assess the main effects which the project is likely to have on the environment;
- an outline of the main alternatives studied by the developer and an indication if the main reasons for his choice, taking into account the environmental effects.

It can be agreed that existing executive summary, while it provides summary of the report, might be too technical. The executive summary has been revised considering requirements of indicated Council Directive. Excessive material (including references to technical documents) has been removed.

The updated chapter 12 is attached separately.

The EIA report is supplemented as follows:

Text location	Chapter 13, list of references for chapter 11 and 12 is removed.
Existing text	CHAPTER 11

	CHAPTER 12 1. Resolution of the Government of the Republic of Lithuania No. 352 dated March 25, 2003 "Resolution on Design of the Spent Nuclear Fuel Storage Facility at the State Enterprise Ignalina Nuclear Power Plant". 2. Technical Specification for Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Unit 1 and 2. B1/TS/0001, Issue 06. 3. Regulations for the Safe Transport of Radioactive Material. IAEA Safety Standards Series No. TS-R-1. 2005 Edition, Safety Requirements. IAEA, Vienna, 2005. 4. Regulatory document on the environment LAND 42-2001 "On the Restrictions on the Release of Radionuclides from Nuclear Installations and Procedure for the Authorisation of Release of Radionuclides and Radiological Monitoring", State Journal, 2001, No. 13-415. 5. Order on Use of Water Resources and on Primary Records and Control of Pollutants Released with Sewage. Approved by Ordinance No. 171 of the Minister of Environment of the Republic of Lithuania dated March 30, 2001. State Journal, 2001, No. 29-941. 6. 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. 7. Lithuanian Hygiene Standard HN 44:2006. "Establishment and Supervision of Sanitary Protection Zones of Waterworks". State News, 2006, No. 81-3217. 8. Report on Assessment of Sanitary Protection Zone for Visaginas Town Waterworks and Recalculation of its Limits (SPZ Design). UAB Vilniaus Hidrogeologija, 2003. 9. Project for Justification of the Ground Water Monitoring Structure for INPP Spent Nuclear Fuel Storage Site. Report of the Joint-Stock Company "Vilniaus hidrologija". Vilnius, 2007. 10. Lithuanian Hygiene Standard HN 73:2001. "Basic Standards of Radiation Protection", State Journal, 2002, No. 11-388. 11. Council Directive 96/29/EURATOM of 13 May 1996 Basic Safety Standards for the Protection of the Health of Workers and General Publics against the Dangers Arising from Ionizing Radiation No. L 159, Volume 39. 12. International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources. IAEA Safety Series No. 115, IAEA, Vienna, 1996.
Supplemented text	

Consortium

GNS – NUKEM

Subcontractor

Lithuanian Energy Institute

Environmental Impact Assessment Report

Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2
Attachment No. 6 to the Part II "Attached Documents"

Answers to the Remarks of the Republic of Lithuania Ministry of Environment

Prepared:	V. Simonis, V. Ragaisis, J. E. Adomaitis, R. Kilda
Released:	P. Poskas
Issue date:	October 22, 2007
Number of pages:	15

1 Introduction

This attachment of the EIA report includes answers to the comments and proposals for the EIA report “Interim Storage of RBMK Spent Nuclear Fuel from Ignalina NPP Units 1 and 2” as presented in the Republic of Lithuania Ministry of Environment letter No. (1-15)-D8-6614 from August 2, 2007. The changes will be made in the new (revised) version of the EIA report are also indicated.

References to the EIA report used in this attachment (text location, references) comply with the EIA report version, issued June 21, 2007.

2 Comments and Responses

Comment 1

Chapter 3.2.3 states that the activity of the radionuclide released into the environment during the planned economic activity and operation of Ignalina Nuclear Power Plant (hereafter - INPP) is much lower than the limiting values defined in the permission for release of radioactive materials into the environment issued by the Ministry of Environment, therefore, the limiting values shall not be updated. As seen from the evaluation of radionuclide composition and activity provided in the Report, during the planned economic activity the environment will get the radionuclides which are not foreseen in the valid permission (e.g. Kr-85, 1-129, etc.). Therefore, the permission for release of radioactive materials into the environment shall be updated.

Response

The indicated statement is deleted from the EIA report.

The EIA Report is supplemented as follows:

Text location	Chapter 3.2.3, last paragraph
Existing text	It can be observed from Table 3.2.3-1 that assessed radioactive emissions due to proposed economic activity together with planned emissions for INPP site are considerably below licensed limits. The review of already licensed limits will not be necessary.
Supplemented text	It can be observed from Table 3.2.3-1 that assessed radioactive emissions due to proposed economic activity together with planned emissions for INPP site are considerably below licensed limits.

Comment 2

Chapter 4.1 shall name all the authors of the figures (Figures 4.1.1-1, 4.1.1-2, 4.1.2-1 and 4.1.2-6).

Response

The EIA report is supplemented as follows:

Text location	Chapter 4.1.1, legend of figure 4.1.1-1
Existing text	Fig. 4.1.1-1. Pre-Quaternary geological map of the ISFSF region
Supplemented text	Fig. 4.1.1-1. Pre-Quaternary geological map of the ISFSF region [2]

Text location	Chapter 4.1.1, legend of figure 4.1.1-2

Existing text	Fig. 4.1.1-2. Geological-tectonic cross-sections of the ISFSF region
Supplemented text	Fig. 4.1.1-2. Geological-tectonic cross-sections of the ISFSF region [2]

Text location	Chapter 4.1.2, legend of figure 4.1.2-1
Existing text	Fig. 4.1.2-1. Scheme of sub-Quaternary surface of the ISFSF area:
Supplemented text	Fig. 4.1.2-1. Scheme of sub-Quaternary surface of the ISFSF area [2]

Text location	Chapter 4.1.2, legend of figure 4.1.2-6
Existing text	Quaternary geology map of the ISFSF area (legend see in Fig. 4.1.2-3)
Supplemented text	Quaternary geology map of the ISFSF area [2], (legend see in Fig. 4.1.2-3)

Text location	Chapter 13, references to Chapter 4
Existing text	2. Marcinkevicius V., Buceviciute S. et al., Hydrogeological and Engineering-Geological Mapping of Ignalina NPP Area at a Scale 1:50 000 in Topographical Sheets N-35-5-G-v, g; N-35-17-B; N-35-18-A; N-35-17-G-a, v; N-35-18-V-a, b (Druksiai object). Report. Archive of Geological Survey of Lithuania, Vilnius, 1995, 4436 p. (in Russian).
Supplemented text	2. Marcinkevicius V., Buceviciute S., Vaitonis V., Guobyte R., Danseviciene D., Kanopiene R., Lashkov E., Marfin S., Rackauskas V., Juozapavicius G., Hydrogeological and Engineering-Geological Mapping of Ignalina NPP Area at a Scale 1:50 000 in Topographical Sheets N-35-5-G-v, g; N-35-17-B; N-35-18-A; N-35-17-G-a, v; N-35-18-V-a, b (Druksiai object). Report. Archive of Geological Survey of Lithuania, Vilnius, 1995, 4436 p. (in Russian).

Comment 3

Chapter 4.4 uses the unclear term "aktyvaus, sulėtinto ir lėto pasikeitimo hidrodinaminės zonos" which should be replaced by "aktyvios, sulėtintos ir lėtos požeminio vandens apykaitos zonos". The aquifers are called "apribotais" or "neapribotais", though the terms "spūdiniai" and "nespūdiniai" are used in Lithuania. The Report calls the sediments providing the aquifers as "mažai skvarbiomis", but they shall be called "mažai laidžios vandeniui". The term "underground water" in the English version of the Report (chapter 4.4) shall not be used; therefore, we propose to replace it by the term "groundwater".

Response

Translation of specific Lithuanian terms is corrected in the Lithuanian version of the EIA report. The term "underground water" in the English version of the Report (chapter 4.4) is replaced by the term "groundwater".

The updated chapter 4.4 is attached separately.

Comment 4

Chapter 4.5.1. (page 67) incorrectly states that "Natura 2000 is a network of protected areas in the European Union"; please pay your attention that a reserve ("draustinis" - in Lith.) is a particular category of the protected area, therefore, it should be written as "a network of protected areas of European Community importance". The areas of Natura 2000 are named incorrectly – "Sites of Community Interest (SCIs)" and "Special Areas of Conservation (SACs)". According to the Law of

LR on Protected Areas (State News, 2001, No 108-3902), the areas of Natura 2000 are divided into the areas of importance for the protection of birds (AIPB) and areas of importance for habitat protection (AIHP).

Besides, the stages for creation of Natura 2000 areas are stated inaccurately. Creating the AIHP, first of all the potential AIHP are selected based on scientific criteria and research and the list of them is submitted to European Commission (EC). When the EC approves the list of potential AIHP, the Member States start creating them. Creating the AIPB, first of all the most suitable areas are selected based on scientific criteria and researches. Based on the selected areas, the national protected areas are created in Lithuania and later the status of protected areas of European Community importance is given to them (part 2, article 24 of the Law of LR on Protected Areas).

Response

The EIA report is supplemented as follows:

Text location	Chapter 4.5.1, first, second and third paragraphs
Existing text	NATURA 2000 is a network of protected areas in the European Union (EU) covering fragile and valuable natural habitats and species of particular importance for the conservation of biological diversity within the territory of the EU. The creation of the NATURA 2000 network is a very important and difficult task. In order to carry out this work successfully, the Member States (and the former Candidate Countries) have to pass the following three stages in dialogue with the European Commission: • Preparation of national lists of candidate NATURA 2000 areas; • Identification of Sites of Community Interest (SCIs); • Nomination of Special Areas of Conservation (SACs). At the present stage, SCIs were identified and proposed to the EU Commission for designation.
Supplemented text	NATURA 2000 is a network of protected areas of European Community importance covering fragile and valuable natural habitats and species of particular importance for the conservation of biological diversity within the territory of the EU. According to the Law on Protected Areas of the Republic of Lithuania [41] the areas of NATURA 2000 are divided into the Areas of Importance for the Protection of Birds (AIPB) and Areas of Importance for Habitat Protection (AIHP). Creating the AIHP, first of all the potential AIHP are selected based on scientific criteria and research and the list of them is submitted to European Commission (EC). When the EC approves the list of potential AIHP, the Member States start creating them. Creating the AIBP, first of all the most suitable areas are selected based on scientific criteria and research. Based on the selected areas, the national protected areas are created in Lithuania and later the status of protected areas of European Community importance is given to them (part 2, article 24 of the Law on Protected Areas [41]).

Text location	Chapter 13, references to Chapter 4
Existing text	-
Supplemented text	41. Law on Protected Areas of the Republic of Lithuania. State Journal, 2001, No. 108-3902

Comment 5

The second paragraph of Chapter 4.5.1. (page 68) provides old data. Please be informed that EC has already approved the list of potential AIHP which includes the Smalvos landscape protected reserve too. The complex of Dysnai ir Dysnykstis lake area is also approved as AIBP by Resolution *of LR Government No 339 dated 2004-04-08 (State News, 2004, No 55-1899).*

Response

The EIA report is supplemented as follows:

Text location	Chapter 4.5.1, fourth paragraph
Existing text	A large part of the lake Druksiai and some territories (a part of the Smalvos protected hydrographical reserve and two areas along the Druksa river) are proposed as NATURA 2000 areas (Fig. 4.5.1-1). Other such zones are also proposed (not yet approved by EU Commission at this stage), but they are located far from the ISFSF (the Smalvos landscape protected reserve – at about 10 km from the ISFSF, and the Dysnai and Dysnykstis lake – at about 12 km from the ISFSF).
Supplemented text	A large part of the lake Druksiai and a part of other territories (a part of the Smalvos protected hydrographical reserve and two areas along the Druksa river) are approved as NATURA 2000 areas (Fig. 4.5.1-1). EC has also approved the list of potential AIHP which includes the Smalvos landscape protected reserve. The complex of Dysnai and Dysnykstis lake area is approved as AIBP by the Resolution No. 339 of the Government of the Republic of Lithuania dated 2004-04-08 [42]. These areas are located far from the ISFSF (the Smalvos landscape protected reserve – at about 10 km from the ISFSF, and the complex of Dysnai and Dysnykstis lake area – at about 12 km from the ISFSF).

Text location	Chapter 13, references to Chapter 4
Existing text	-
Supplemented text	42. Government of the Republic of Lithuania Resolution No. 339 dated 2004-04-08. State Journal, 2006, No. 92-3635.

Comment 6

Describing the bird species, chapter 4.5.1 (page 69) mentions "other species of Appendix I", not clarifying of what Appendix. This shall be clearly indicated (indicating the Directive). Besides, there is insufficient information about the breeding species of national importance - it is necessary to indicate them, provide information on their inclusion into the Red Book. Please pay attention that, indicating the bird species, the Lithuanian names of those species shall also be provided, as now only Latin names are indicated.

Response

The EIA report is supplemented as follows:

Text location	Chapter 4.5.1, paragraph below Table 4.5.1-1
Existing text	Species of ornithological importance are: • As qualifying species: the Bittern (*Botaurus stellaris*); • As additional species: *Gavia arctica*, *Circus aeruginosus*, *Porzana porzana*, *P.parva*, *Chlidonias niger*, *Luscinia svecica;* • As of national importance: 18 breeding species; *Phalacrocorax carbo*.
Supplemented text	Species of ornithological importance are (species included in Lithuanian Red Book [39] are highlighted in bold): • As qualifying species: the **Bittern** (*Botaurus stellaris*); • As of European importance [40]: **Black-throated Diver** (*Gavia arctica)*, Marsh Harrier (*Circus aeruginosus)*, **Spotted Crake** (*Porzana porzana)*, **Little Crake** *(Porzana parva)*, **Black Tern** *(Chlidonias niger)*, **Bluethroat** (*Luscinia svecica)*;

	• As of national importance: 11 breeding species: **Eurasian Hobby** *(Falko subbuteo),* **Black Grouse** *(Tetrao tetrix),* **Eurasian Pygmy Owl** *(Glaucidium paserinum),* **Grey-headed Woodpecker** *(Picus canus),* **Green Woodpecker** *(Picus viridis),* **White-backed Woodpecker** *(Dendrocopos leucotos),* **Citrine Wagtail** *(Motacilla citreola),* **Great White Egret** *(Egretta alba),* **Red-breasted Merganser** *(Mergus serrator),* **Corn Bunting** *(Miliaria calandra),* **Goosander** *(Mergus merganser)*; and also Cormorant (*Phalacrocorax carbo*).

Text location	Chapter 13, references to Chapter 4
Existing text	-
Supplemented text	39. Lithuanian Red Book. Ministry of Environment of the Republic of Lithuania. Vilnius, 2007. 800 p. 40. Birds Directive, 1979: Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds. O. J. L103, 25.04.79.

Comment 7

Table 4.5.2-1 (pages 71-72) incorrectly highlights the fish species of the Red Book. Incorrect information on Belica spread is provided.

Response

The EIA report is supplemented as follows:

Text location	Chapter 4.5.2.2, Table 4.5.2-1
Existing text	Table 4.5.2-1. Lake Druksiai fishes inventoried in the pre-operating period of INPP and during the research period of 1993–1999 (species included into Lithuanian Red Book are highlighted in bold)

Families	**Species**	
	In the pre-operating period	**During the period 1993–1999**
Cyprinidae	Roach (Rutilus rutilus) **Bleak** (Alburnus alburnus) **Belica** (Leucaspius delineatus) **Dace** (Leuciscus leuciscus) Carp (Cyprinus carpio) Ide (Leuciscus idus) **Rudd** (Scardinius erythrophthalmus) **Minnow** (Phoxinus phoxinus) **Tench** (Tinca tinca) Silver bream (Blicca bjoerkna) Bream (Abramis brama) Crucian carp (Carassius carassius) **Gudgeon** (Gobio gobio)	Roach (Rutilus rutilus) **Bleak** (Alburnus alburnus) *No more observed nowadays in Lithuania* *No more observed* In little proportion In little proportion **Rudd** (Scardinius erythrophthalmus) *No more observed* **Tench** (Tinca tinca) Silver bream (Blicca bjoerkna) Bream (Abramis brama) In little proportion In little proportion
Percidae	Perch (Perca fluviatilis) Ruff (Gymnocephalus cernuus) **Pike-perch** (Stizostedion lucioperca)	Perch (Perca fluviatilis) Ruff (Gymnocephalus cernuus) *No more observed*
Coregonidae	**Vendace** (Coregonus albula) **European whitefish** (Coregonus lavaretus)	**Vendace** (Coregonus albula) *No more observed*
Osmeridae	**Smelt** (Osmerus eperlanus m. relicta)	In little proportion
Esocidae	**Pike** (Esox lucius)	**Pike** (Esox lucius)
Cobitididae	**Loach** (Cobitis taenia)	In little proportion
Gadidae	**Four-bearded rockling** (Lota lota)	In little proportion

Anguillidae	Common eel (Anguilla anguilla)	*No more observed*
Cottidae	**Freshwater sculpin** (Cottus gobio)	*No more observed*
Gasterosteidae	Three-spined stickleback (Pungitius pungitius)	*No more observed*
Siluridae	**Sheatfish** (Silurus glanis)	*No more observed*

Supplemented text

Table 4.5.2-1. Lake Druksiai fishes inventoried in the pre-operating period of INPP, during the research period of 1993–1999 and until the 2005 (species included into Lithuanian Red Book are highlighted in bold)

Families	**Species**		
	In the pre-operating period [30]	**During the period 1993–1999 [30, 31]**	**Until the 2005 [39]**
Cyprinidae	Roach (Rutilus rutilus) **Bleak** (Alburnus alburnus) **Belica** (Leucaspius delineatus) **Dace** (Leuciscus leuciscus) Carp (Cyprinus carpio) Ide (Leuciscus idus) **Rudd** (Scardinius erythrophthalmus) **Minnow** (Phoxinus phoxinus) **Tench** (Tinca tinca) Silver bream (Blicca bjoerkna) Bream (Abramis brama) Crucian carp (Carassius carassius) **Gudgeon** (Gobio gobio)	Roach (Rutilus rutilus) **Bleak** (Alburnus alburnus) In little proportion *No more observed* In little proportion In little proportion **Rudd** (Scardinius erythrophthalmus) *No more observed* **Tench** (Tinca tinca) Silver bream (Blicca bjoerkna) Bream (Abramis brama) In little proportion In little proportion	Roach (Rutilus rutilus) Bleak (Alburnus alburnus) Belica (Leucaspius delineatus) No more observed In little proportion In little proportion Rudd (Scardinius erythrophthalmus) No more observed Tench (Tinca tinca) Silver bream (Blicca bjoerkna) Bream (Abramis brama) In little proportion In little proportion
Percidae	Perch (Perca fluviatilis) Ruff (Gymnocephalus cernuus) **Pike-perch** (Stizostedion lucioperca)	Perch (Perca fluviatilis) Ruff (Gymnocephalus cernuus) *No more observed*	Perch (Perca fluviatilis) Ruff (Gymnocephalus cernuus) *No more observed*
Coregonidae	**Vendace** (Coregonus albula) **European whitefish** (Coregonus lavaretus)	**Vendace** (Coregonus albula) *No more observed*	Vendace (Coregonus albula) *No more observed*
Osmeridae	**Smelt** (Osmerus eperlanus m. relicta)	In little proportion	In little proportion
Esocidae	**Pike** (Esox lucius)	**Pike** (Esox lucius)	Pike (Esox lucius)
Cobitididae	**Loach** (Cobitis taenia)	In little proportion	In little proportion
Gadidae	**Four-bearded rockling** (Lota lota)	In little proportion	In little proportion
Anguillidae	Common eel (Anguilla anguilla)	*No more observed*	*No more observed*
Cottidae	**Freshwater sculpin** (Cottus gobio)	*No more observed*	*No more observed*
Gasterosteidae	Three-spined stickleback (Pungitius pungitius)	*No more observed*	*No more observed*
Siluridae	Sheatfish (Silurus glanis)	*No more observed*	*No more observed*

Comment 8

Chapter 4.7 (page 82) indicates wrong pottage of the Grazutes Regional Park which is now 29 471 ha. Besides, the Smalvos protected area is not hydrological but hydrographical.

Response

The EIA report is supplemented as follows:

Text location	Chapter 4.7, fourth paragraph
Existing text	The most valuable landscape areas are located far away from ISFSF (about 15 km at the northwest), with the Grazutes Regional Park which covers more than 2.8 thousand hectares and is aimed at preserving the landscape of the Sventoji river basin with its lakes, forests, its natural ecosystem as well as the cultural heritage values, maintaining them and rationally using them.
Supplemented text	The most valuable landscape areas are located far away from ISFSF (about 15 km at the northwest), with the Grazutes Regional Park which covers 29471 hectares and is aimed at preserving the landscape of the Sventoji river basin with its lakes, forests, its natural ecosystem as well as the cultural heritage values, maintaining them and rationally using them.

Text location	Chapter 4.7, fifth paragraph
Existing text	The Smalvos protected hydrological territory (6 km at the northwest of ISFSF) also presents landscape value with its undulated relief and particular ecological formations.
Supplemented text	The Smalvos protected hydrographical territory (6 km at the northwest of ISFSF) also presents landscape value with its undulated relief and particular ecological formations.

Comment 9

Taking into account the information provided in the letter of Culture Heritage Department No (1.29)2-242 dated 2007-02-07, complete chapters 4.9 and 6.7 accordingly.

Response

The EIA report is supplemented as follows:

Text location	Chapter 4.9, third paragraph
Existing text	-
Supplemented text	There are seven cultural heritage objects in the vicinity of the INPP: Petriskes settlement antiquities I, Petriskes mound, Petriskes settlement antiquities II, Grinkiskes settlement antiquities III, Grinkiskes settlement antiquities II, Grinkiskes settlement antiquities I and Stabatiskes manor place (Figure 4.9-2).

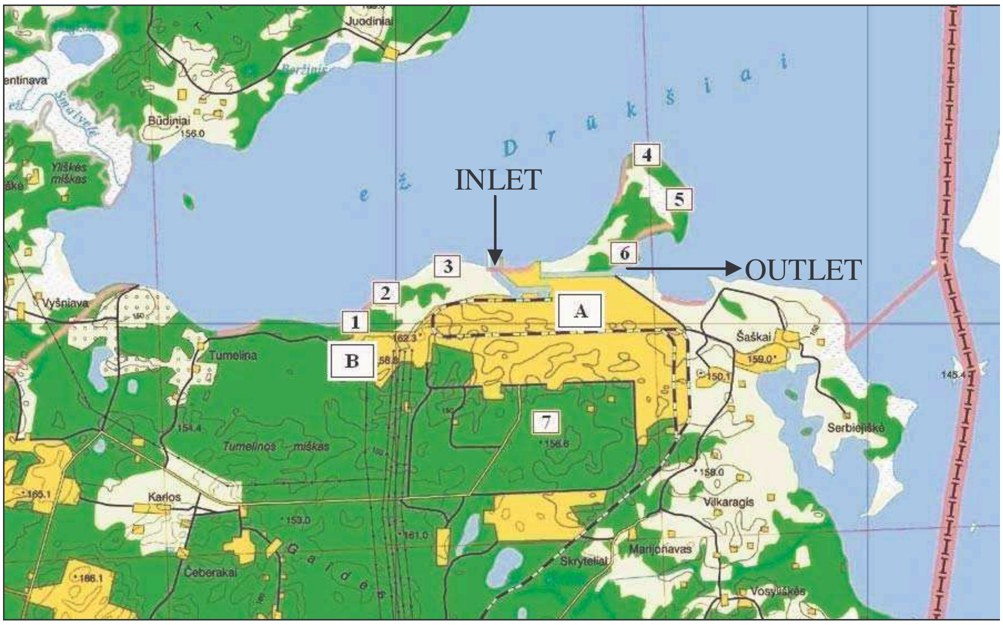

Figure 4.9-2. Cultural heritage objects in the vicinity of the INPP Reactor Units (A) and switchyard (B): 1 – Petriskes settlement antiquities I; 2- Petriskes mound; 3 – Petriskes settlement antiquities II; 4 – Grinkiskes settlement antiquities III; 5 – Grinkiskes settlement antiquities II; 6 – Grinkiskes settlement antiquities I; 7 – Stabatiskes manor place

Text location	Chapter 6.7, first paragraph
Existing text	Based on available information there is no objects of cultural heritage, archaeological and historical monuments which might be affected by the ISFSF.
Supplemented text	Cultural heritage objects in the vicinity of the INPP (see Chapter 4.9) will not be affected by the construction of new ISFSF while they are distant from the foreseen ISFSF site.

Comment 10

Chapter 5.1.4 (page 103) indicates that the radionuclides may release into the environment while operating the Fuel Inspection Hot Cell (hereafter - FIHC) only after the whole spent fuel is unloaded from the Reactor Units, i.e. after 2008-2015, therefore, radionuclide activities from Reactor Units and from FIHC are not summed. Taking this into account, the radiation doses for personnel and population due to the planned activity shall be evaluated accordingly. However, in chapter 5.3.3.2 (page 125) in Table 5.3-2 the annual effective dose for population due to FIHC operation is summed with the doses foreseen for the period of 2008-2015.

Response

The new FIHC will become available for operation in year 2008, c.f. chapter 1.5.1. However, the cask repacking in the FIHC is normally not expected. The cask will be designed as double-barrier welded system for the safe operation time of at least 50 years without any need for intervention. Therefore the operation of the FIHC should not be considered as a part of normally expected plant operations (like planned handling and processing of leaking or damaged fuel).

To demonstrate compliance with regulatory requirements even under normally unexpected conditions, contribution to annual dose resulting from operation of FIHC is included into the both phases of operation of ISFSF – SNF transfer phase, c.f. Table 5.3-2 and SNF interim storage phase, c.f. Table 5.3-3.

The EIA report is supplemented as follows:

Text location	Chapter 5.1.4, last paragraph
Existing text	The potential annual releases to atmosphere from operation of the FIHC are summarized in Table 5.1–8. It should be pointed out, that operation of FIHC could be necessary only after transfer of all nuclear fuel from Reactor Units. Releases into atmosphere from Reactor Units (Table 5.1–7) and from FIHC (Table 5.1–8) will not occur at the same time and therefore shall not be summed.
Supplemented text	The potential annual releases to atmosphere from operation of the FIHC are summarized in Table 5.1.4–1.

Text location	Chapter 3.2.3, first paragraph
Existing text	Gaseous radioactive emissions from main ventilation stacks of Reactor Units are expected during spent nuclear fuel transfer from Reactor Units to ISFSF phase, years 20082015. Gaseous radioactive emissions from ISFSF ventilation stack can be expected in case of spent nuclear fuel repacking at FIHC during interim spent fuel storage phase, years 20162065. 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. Releases into atmosphere from Reactor Units and from FIHC will not occur at the same time and therefore shall not be summed.
Supplemented text	Gaseous radioactive emissions from main ventilation stacks of Reactor Units are expected during spent nuclear fuel transfer from Reactor Units to ISFSF phase. Gaseous radioactive emissions from ISFSF ventilation stack can be expected in case of spent nuclear fuel repacking at FIHC during interim spent fuel storage phase. 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.

Text location	Chapter 3.2.3, remark (4) for the Table 3.2.3-1
Existing text	(4) – Annual releases due to reloading of the cask containing leaking fuel at FIHC of ISFSF, cf. Table 5.1.4-1. Releases into atmosphere from Reactor Units and from FIHC will not occur at the same time and therefore shall not be summed.
Supplemented text	(4) – Annual releases due to reloading of the cask containing leaking fuel at FIHC of ISFSF, cf. Table 5.1.4 1. 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 plant operations.

Comment 11

Figure 1 of chapter 5.3.2 shall be completed by the dose evaluation data of 2005 and 2006. Figure 2 of the same chapter shall be specified too.

<u>Response</u>

The chapter 5.3 is rewritten.

The updated chapter 5.3 is attached separately.

The list of references for chapter 5 is updated. The EIA report is supplemented as follows:

Text location	Chapter 13, references for chapter 5

Existing text	31. Report on Radiation Monitoring Results at the INPP Region for year 2004. INPP, PTOot-0545-12.
Supplemented text	31. Report on Radiation Monitoring Results at the INPP Region for year 2006. INPP, PTOot-0545-14.

Text location	Chapter 13, references for chapter 5
Existing text	
Supplemented text	37. Final Decommissioning Plan for Ignalina NPP Units 1 and 2. A1.1/ED/B4/0004, Issue 06. INPP Decommissioning Project Management Unit, 2004. 38. Ignalina NPP Decommissioning Environmental Impact Assessment Programme. A1.1/ED/B4/0001, Issue 05. INPP Decommissioning Project Management Unit, 2004. 39. New Solid Waste Management and Storage Facility at Ignalina NPP. Environmental Impact Assessment Report, revision 3, issue date June 18, 2007. NUKEM Technologies GmbH and Lithuanian Energy Institute, 2007. 40. Supplemented Environmental Impact Assessment Report for Construction of a Near-surface Repository for Radioactive Wastes. Revision 3-2, RATA, 2007. 41. Jan Dahlberg, Ulla Bergström. INPP Landfill. Studsvik Report. ISBN 91-7010-371-2. Studsvik RadWaste AB, Sweden, 2004. 42. Derivation of Preliminary Waste Acceptance Criteria for Landfill Facility. Final report, Lithuanian Energy Institute, 2006. 43. Annual Reports on Operation of SNF Storage Facility, years 2000 – 2006. INPP, PTOot-1245.

Comment 12

Chapter 5.2 shall indicate the doses of which public critical group/groups have been evaluated, conditioned by direct ionizing radiation while transporting the spent fuel to the storage facility, storing it in ISFSF and storing the radioactive waste in the Solid Waste Storage Facilities.

Response

The impact resulting from direct irradiation is considered to be relevant to any member of population including any member of critical groups as defined by normative document LAND 42:2001. The distinction between critical groups like farmers, fishermen, gardeners etc. is not made. Particular exposure conditions depend on situation and scenarios considered and are defined in appropriate chapters where dose calculation methodology is explained. In case of casks transfer, c.f. chapter 5.2.2.2, the exposure duration is the same as duration of casks transfer. In case of irradiation from ISFSF structure, c.f. chapter 5.2.3.2, the dose calculations assume that any member of population can be exposed up to 2000 h per year in any location within sanitary protection zone. For locations outside sanitary protection zone a condition of non-restricted exposure duration (8760 h per year) is used.

The EIA Report is supplemented as follows:

Text location	Chapter 5.2, a new paragraph is added before chapter 5.2.1
Existing text	
Supplemented text	The impact resulting from direct irradiation is considered to be relevant to any member of population including any member of critical groups. Therefore distinction between different critical groups like farmers, fishermen, gardeners etc. [18] is not made. Particular exposure conditions depend on situation and scenarios considered and are defined in appropriate chapters where dose calculation methodology is

	explained.

Comment 13

The evaluation of impact to the public from operation of nuclear facilities located in the INPP site is justified only by the evaluation of the doses to the critical group members of the population conditioned by radionuclide releases into the environment. The direct ionizing radiation dose from the existing Spent Fuel Storage Facility is not taken into account (the modifications performed to increase the number of stored casks shall be considered). Moreover, the impact of the new nuclear facilities located within and nearby the INPP site - Near Surface Repository for Low- and Intermediate-Level Short-Lived Radioactive Waste (the environmental impact of which has already been evaluated) and Landfill Facility for Short-lived Very Low Level Waste is not considered; the impact of Solid Waste Management and Storage Facilities is not completely evaluated (there is no evaluation of the doses conditioned by the radionuclide release into the environment). The public impact of all the mentioned facilities shall be evaluated in a complex way, as according to the requirements of the legal acts, it shall be ensured that the annual effective dose for the public critical group due to the activity of all the nuclear facilities located nearby does not exceed 0,2 mSv.

<u>Response</u>

The chapter 5.3 is rewritten. Chapters 5.2.2.2, 5.2.3.2 and 10.2.1 are updated accordingly.

The updated chapter 5.3 is attached separately.

Comment 14

The Report shall be supplemented by the scheme which would indicate the existing and planned sites of nuclear facilities located within and nearby the INPP site (including the existing Spent Fuel Storage Facility, Near Surface Repository for Low- and Intermediate-Level Short-Lived Radioactive Waste, Solid Waste Management and Storage Facilities, Landfill Facility for Short-lived Very Low Level Waste). The scheme shall indicate the boundaries of existing and planned sanitary protection zones and the distances between the identified facilities.

<u>Response</u>

See answer to comment 13.

Comment 15

Chapter 8.1 (page 159) states that "Preparation and measurement of radionuclide content and concentration of the detected radionuclides in the environmental samples are carried out in accordance with the documents [4, 6-8]". However, the indicated documents do not include the documents valid in Lithuania:

LAND 64-2005 "Evaluation of Radioactive Sr-90 in the Samples of Environment Elements. Radiochemical Method" (State News, 2005, No 24-786);

LST ISO 9698:2006 "Water Quality. Evaluation of Tritium Content Activity. Liquid Scintillation Calculation Method" (Analogical to ISO 9698:1989);

LST ISO 9697:2004 "Water Quality. Measurement of General Content Beta Activity in Low Mineralised Water" (Analogical to ISO 9697:1992);

LST ISO 9696:1998 "Water Quality. Measurement of General Content Alfa Activity in Low

Mineralised Water. Thick Layer Method" (Analogical to ISO 9696:1992).

The laboratories performing surveys shall follow the normative documents and standards valid in Lithuania. Based on the valid documents, the internal standard activity procedures can be developed. However, providing information on the survey methods used, the primary valid normative documents or standards shall also be indicated.

Response

Details on compliance of INPP used measuring and sampling methods with specific standards are not important for EIAR. The INPP performs monitoring in accordance with regulatory approved environment monitoring program and certified methods. The goal of this chapter 8.1 is to provide a brief overview of what environment components are monitored and how. Apart indicated documents, the other standards, normative documents etc. could be mentioned as well. Therefore the statement on compliance of some methods with some of regulations in force is removed from EIA report.

The chapter 8.1 is rewritten.

The updated chapters 8.1 and 8.2 are attached separately.

Comment 16

Different places of EIA Report indicate the analysis data of different periods. Some places indicate the survey results before 2004 (e.g. page 162, Table 8.2.1-1; chapters 8.2.2, 8.2.5), other places indicate the data of 2005 and 2006 (e.g. chapters 8.2.3, 8.2.4). It would be expedient to complete all the chapters by available information of not earlier than 2004.

Response

The chapter 8.2 is rewritten.

The updated chapters 8.1 and 8.2 are attached separately.

Comment 17

Chapter 8.2.5 (page 164) states that "In water of some observation wells around the Solid Radwaste Storage Facility and landfill of utility type waste, activity of Tritium was over 100 Bq/1". It shall be indicated that the excess may be up to several tens times, for example, in 2006 the water of household waste polygon channel contained the Tritium concentration of 2500 - 13000 Bq/1; some wells - up to 4100 Bq/1 (the data are taken from the Report on INPP Region Radiation Monitoring Results for 2006).

Response

The chapter 8.2 is rewritten.

The updated chapters 8.1 and 8.2 are attached separately.

Comment 18

Chapter 8.3.9 indicates the incorrect name of the Ministry of Environment.

Response

The translation mistakes are corrected in the Lithuanian version of the EIA report.

Comment 19

Different places of the Report (chapters 5, 8.3.7, 10.2) indicate that the liquid waste from the controlled area the activity of which will not excess the clearance levels (according to LAND 34-2000) will be discharged to the household sewerage system.
Chapter 2 of normative document LAND 34-2000 "Clearance Levels of Radionuclides, Conditions of Reuse of Materials and Disposal of Waste" defines the application sphere of this document: "The requirements of this normative document are applied to the materials, devices, machines, equipment, facilities, solid waste and spent oil generated or appeared during operation or dismantling of nuclear energy facilities and radioactive waste management facilities using the radioactive materials in industry, medicine, education institutions and other places as well as to the spent close ionizing radiation sources (hereafter - materials and waste)".

LAND 34-2000 is not applied to liquid waste. The liquid waste generated in the controlled area shall be managed as radioactive or in the case of its release into the environment it shall not exceed the activities of released radionuclides defined in the permission.

Response

The chapter 3.2.2 presented description of liquid radioactive waste management is updated (attached separately). The statement on application of LAND 34-2000 is removed.

The EIA report is supplemented as follows:

Text location	Chapter 8.3.7. last paragraph of the chapter is deleted
Existing text	Liquid waste can be released to the sewerage if it is non-radioactive, i.e. it shall meet the requirements of the LAND 34-2000 [12]. Furthermore, the chemical evaluation shall confirm that it meets requirements [13].
Supplemented text	-

Text location	Chapter 13, references 12 and 13 are deleted from the list of references for chapter 8
Existing text	12. Normative document of environmental protection of the Republic of Lithuania LAND 34-2000 "Clearance Levels of Radionuclides, Conditions of Reuse of Materials and Disposal of Waste". Approved by the Ordinance No. 194 of the Minister of Environment dated May 3, 2000. State Journal, 2000, No. 38-1075. 13. Regulation for Sewerage 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.
Supplemented text	-

Text location	Chapter 5, second paragraph
Existing text	No releases of activity (above clearance level) by water path from proposed economic activity under normal operation conditions are expected.
Supplemented text	There will be no uncontrolled discharges of radioactive effluents into the environment from the proposed economic activity under normal operation conditions.

Text location	Chapter 10.2, second paragraph
Existing text	No releases of activity (above clearance level) by water path from proposed economic activity under normal operation conditions are expected.
Supplemented text	There will be no uncontrolled discharges of radioactive effluents into the environment from the proposed economic activity under normal operation

	conditions.