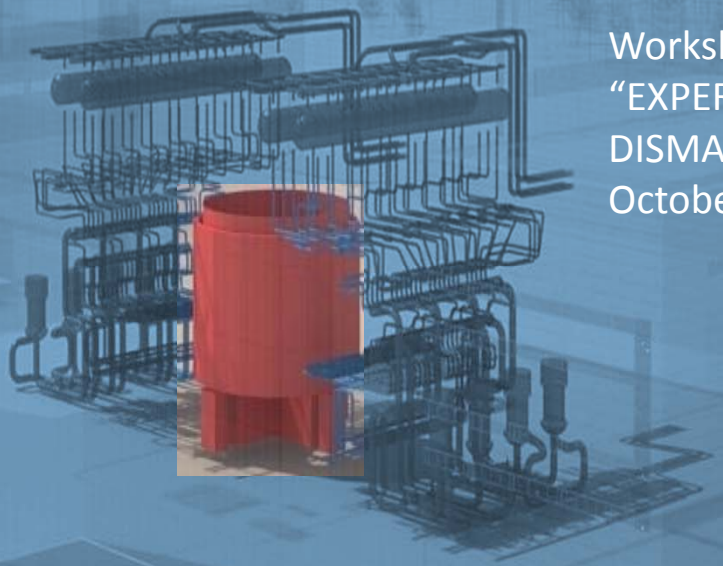
Overview of Zone R3 and Reactor Interim Waste Storage issues

SE Ignalina NPP



Workshop
"EXPERIENCE OF REACTORS DISMANTLING"
October – November 2018, Visaginas

Decommissioning of Ignalina NPP is co-financed by the European Union

Content

Content

1 Introduction (1)

Design: 2 RBMK-1500 water-cooled, graphite-moderated channel-type power reactors.

Capacity: Intended to supply North West region of former USSR (not Lithuania). After independence, one unit could produce 80% of Lithuanian electricity needs.

Operation:
Unit 1 commissioned Dec 1983 / closed Dec 2004
Unit 2 commissioned Aug 1987 / closed Dec 2009

Early closure: Required to facilitate EU accession. **First decommissioning of RMBK-type NPP**

Decommissioning approach:
Immediate Dismantling

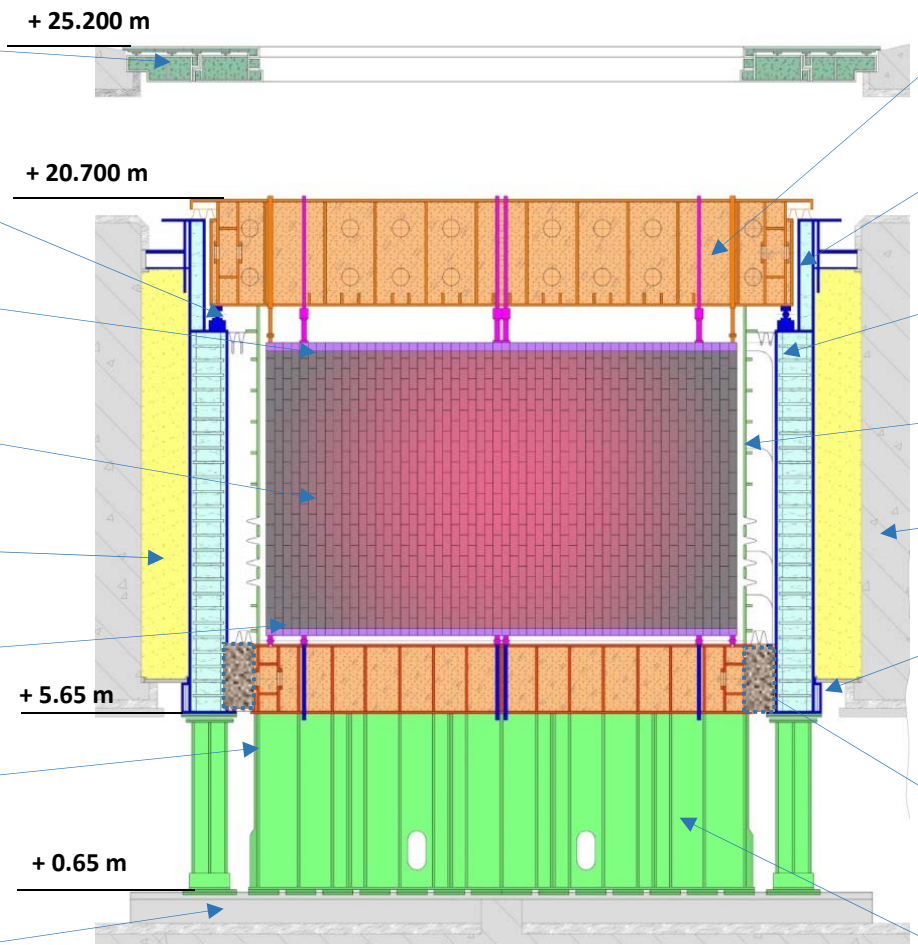
Content

2 **Key features**

2 Key features (1)

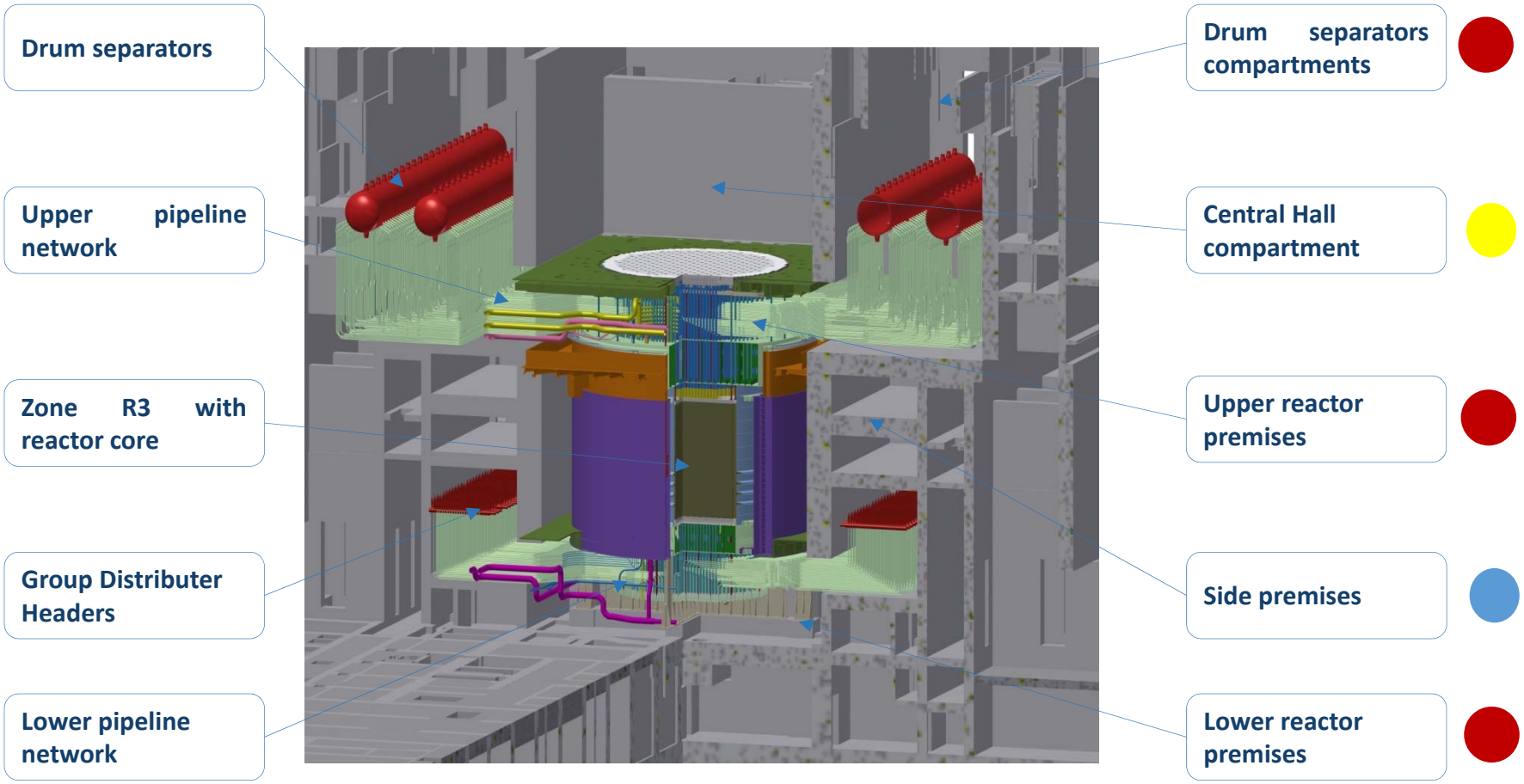
Parameter	Value
Coolant	water (steam-water mixture)
Heat cycle configuration	single circuit
Power, MW:	
• thermal (design)	4800
• thermal (actual)	4200
Graphite stack dimensions, m:	2488 graphite columns ~ 1760 t per Unit
• height	8
• diameter	~ 14
Lattice pitch, m	0.25 x 0.25
Number of channels:	To be retrieved from the core before Zone 3 dismantling
• fuel	
• control and shutdown system/reflector-cooling	
Fuel	
Maximum graphite stack temperature ^{O}C	750

2 Key features (2)



- Top shield cover, Scheme G
- Roller supports of Scheme E
- Upper protective slabs
- Graphite stack
- Sand-gravel filled radial aperture
- Bottom support slabs
- Scheme OR (serpentinite filled)
- Foundation plate of heat-resistant reinforced concrete
- Scheme E (serpentinite filled)
- Scheme D (with water)
- Scheme L (water-filled)
- Scheme KZh
- Concrete walls
- Scheme X (Э in Russian)
- Scheme OR auxiliary cavities (serpentinite, cast-iron/steel shot, crushed stone layers)
- Scheme C

2 Key features (3)



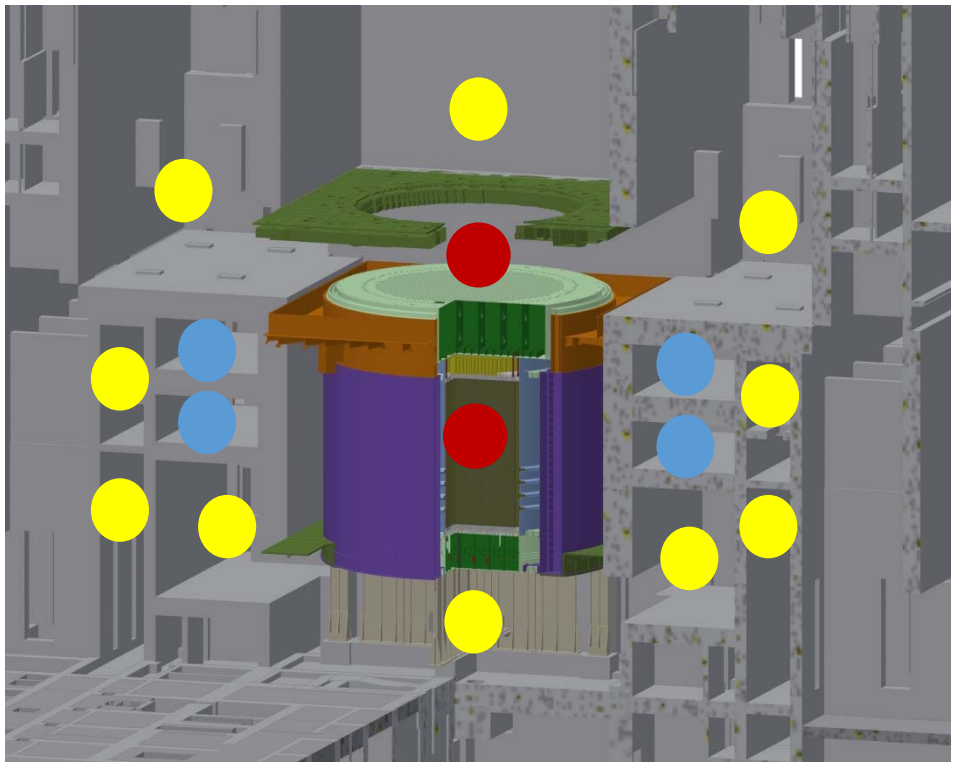
Redundant equipment and compartments by September 2018

2 Key features (4)

Controlled Parameters	Premise's categories for radiation safety/margins (by September 2018)			
	III	II		I
	below	from	below	from
Gamma radiation dose rate, µSv per hour (Pɣ)	12	12	56	56
Surface contamination of alfa-particles, Bq/cm2	4	4	20	20
Surface contamination of beta-particles, Bq/cm2	40	40	266	266
Volumetric activity of short-lived aerosols (after 30' decay), Bq/m3*	185	185	1110	1110

safety, taking into account controlled radiation parameters.

2 Key features (5)



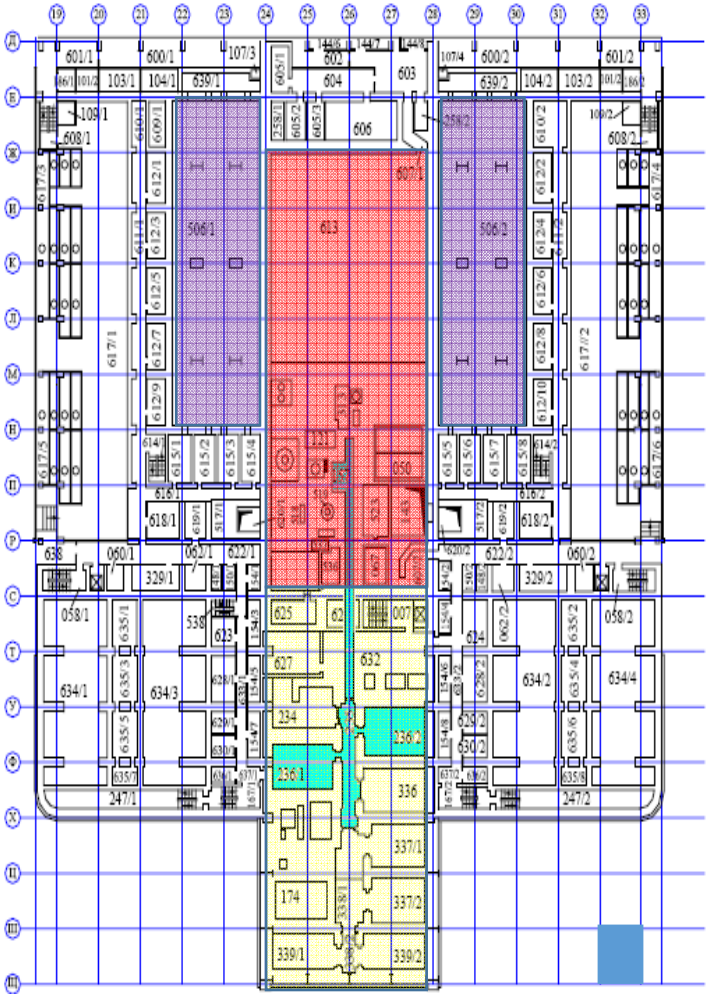
Expected Initial State before Zone 3 dismantling

Neighbouring compartments may be used for:

- **gaining access,**
- **maintaining engineering barriers,**
- **waste processing,**
- **waste accumulation;**
- **waste packaging.**

- **It is expected that Premise's categories for radiation safety/margins remain the same or slightly improved (as result of predecessor's dismantling works by 2027).**

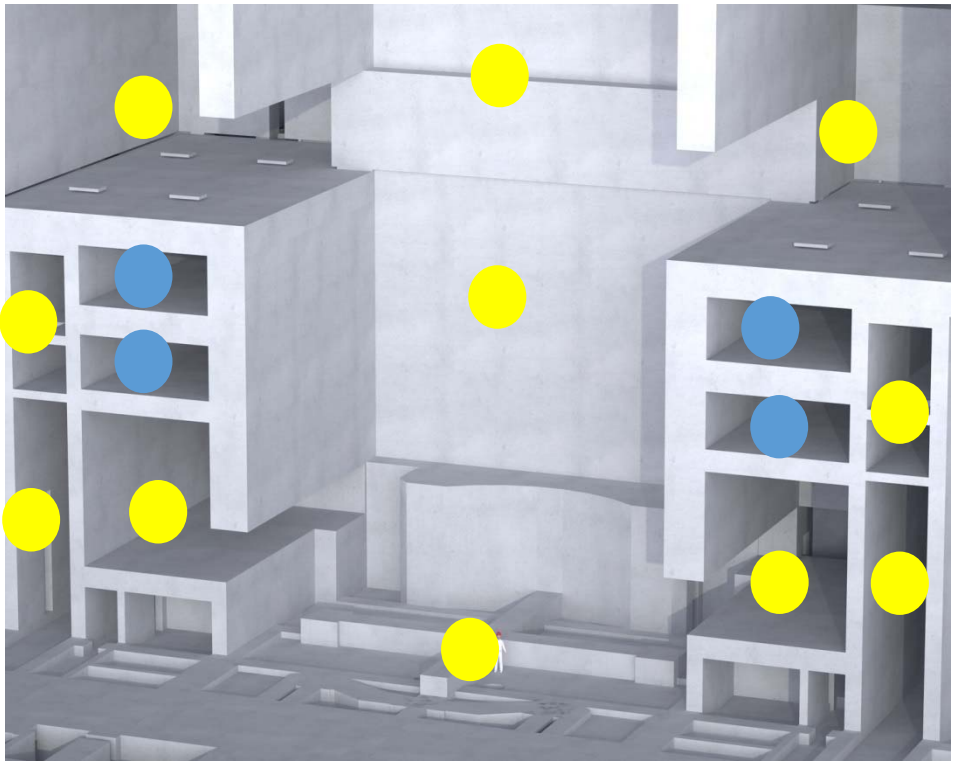
2 Key features (6)



- Central Hall - for possible in-air and underwater operations (in red)
- former Spent Fuel Basins - for possible underwater operations (in blue)
- former Spent Fuel Hall for possible in-air workshops (in yellow)
- former Drum-Separators compartments for possible in-air operation (in purple).

Plan of Unit 1 bld. A1, level +25.20 – each "cell" is about 6 m × 6

2 Key features (7)



Expected Final State after Zone 3 dismantling

All re-used compartments, new engineering barriers, equipment, tools, etc. shall be decommissioned/dismantled and clean up.

Content

3 **Material inventory and radiological characterization forecasts**

3 Waste classification at INPP site

Radioactive waste class	Definition	Abbrevi-ation	Surface dose rate, mSv/h	Final conditioning option	Disposal method* (according current Decom Plan)
0	Exempt waste	EW	-	Not required	Free release norms
Short-Lived Very low, Low and Intermediate Level Waste **					
A	Very low level waste	VLLV	<0.2	Not required	Very Low Level Waste Repository **(Landfill, B19 project)**
B	Low level waste	LLW-SL	0.2–2	Required	Near Surface Repository **(NSR, B25 project)**
C	Intermediate level waste	ILW-SL	>2	Required	Near Surface Repository **(B25 project)**
Long-Lived Low and Intermediate Level Waste ***					
D	Low level waste	LLW-LL	<10	Required	Only STORAGE option
E	Intermediate level waste	ILW-LL	>10	Required	

Solid Radioactive Waste Classification (BSR-3.1.2-2017)

* Disposal method is determined considering the radioactive waste package conformity to the acceptance criteria set for a specific radioactive waste disposal facility.

** Containing alpha emitters with half-life longer than the half-life of ^{137}Cs and the specific activity, measured and (or) calculated by using approved methods, is less than 4000 Bq/g in an individual waste package on the condition that the calculated average specific activity of these alpha emitters is less than 400 Bq/g after averaging of all waste packages. Activity of alpha, beta and (or) gamma emitters shall not exceed the values set for the **waste acceptance criteria for the Near Surface Repository.**

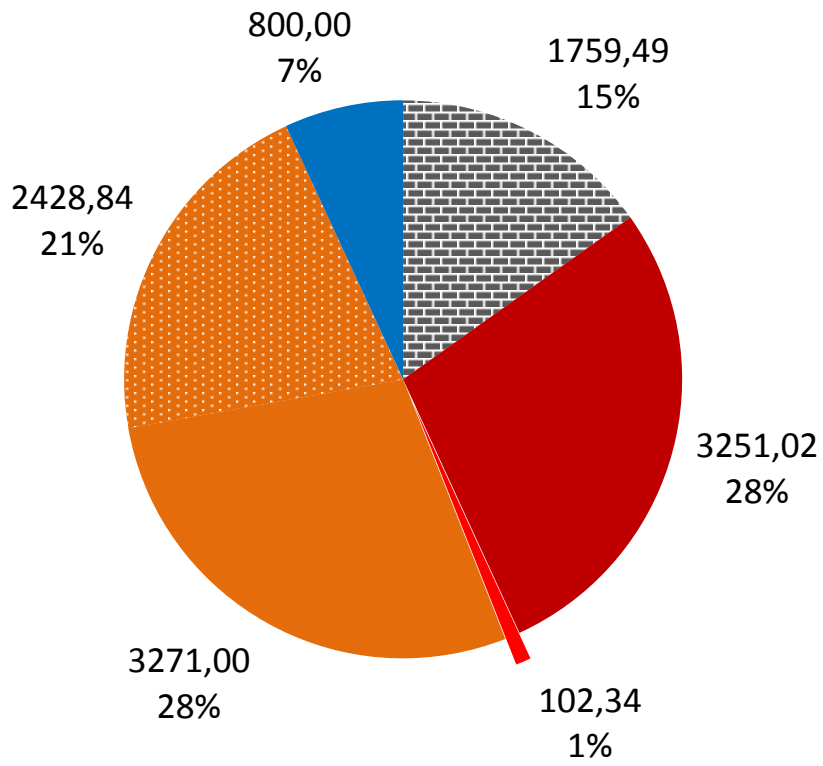
*** Containing alpha emitters with half-life longer than the half-life of ^{137}Cs and the specific activity, measured and/or calculated by using approved methods, is more than 4000 Bq/g in an individual waste package, also if after averaging of all waste packages the average calculated specific activity of these alpha emitters exceeds 400 Bq/g and (or) activity of alpha, beta and (or) gamma emitters exceeds the values set for the **waste acceptance criteria for the Near Surface Repository.**

3 Material inventory and radiological characterization forecasts (1)

- **Current Zone 3 radiological characterization forecast (by August 2018)**:
  - change of waste classifications limits (class A waste)
  - completion of Near Surface Repository (B25) Waste Acceptance Criteria (class B+C waste) with the prohibition of any activated waste disposal in B25 near-surface repository (class D+E).
  - Unit 1 preliminary nuclide vectors (includes hard-to-measured nuclide concentration) are developed on the basis of modern models and associated validation/verification (FTMC, Lithuania), taking into account INPP samples. At the moment – under regulator's (VATESI) consideration.
  - Change of project scope.
  - Short-lived nuclides (esp. Co60) decay consideration.
  - "Unit 1 Zone R3 = Unit 2 Zone R3" assumption in force.
  - **Several materials from different locations are classified as Class D+E waste.**

3 Material inventory and radiological characterization forecasts (2)

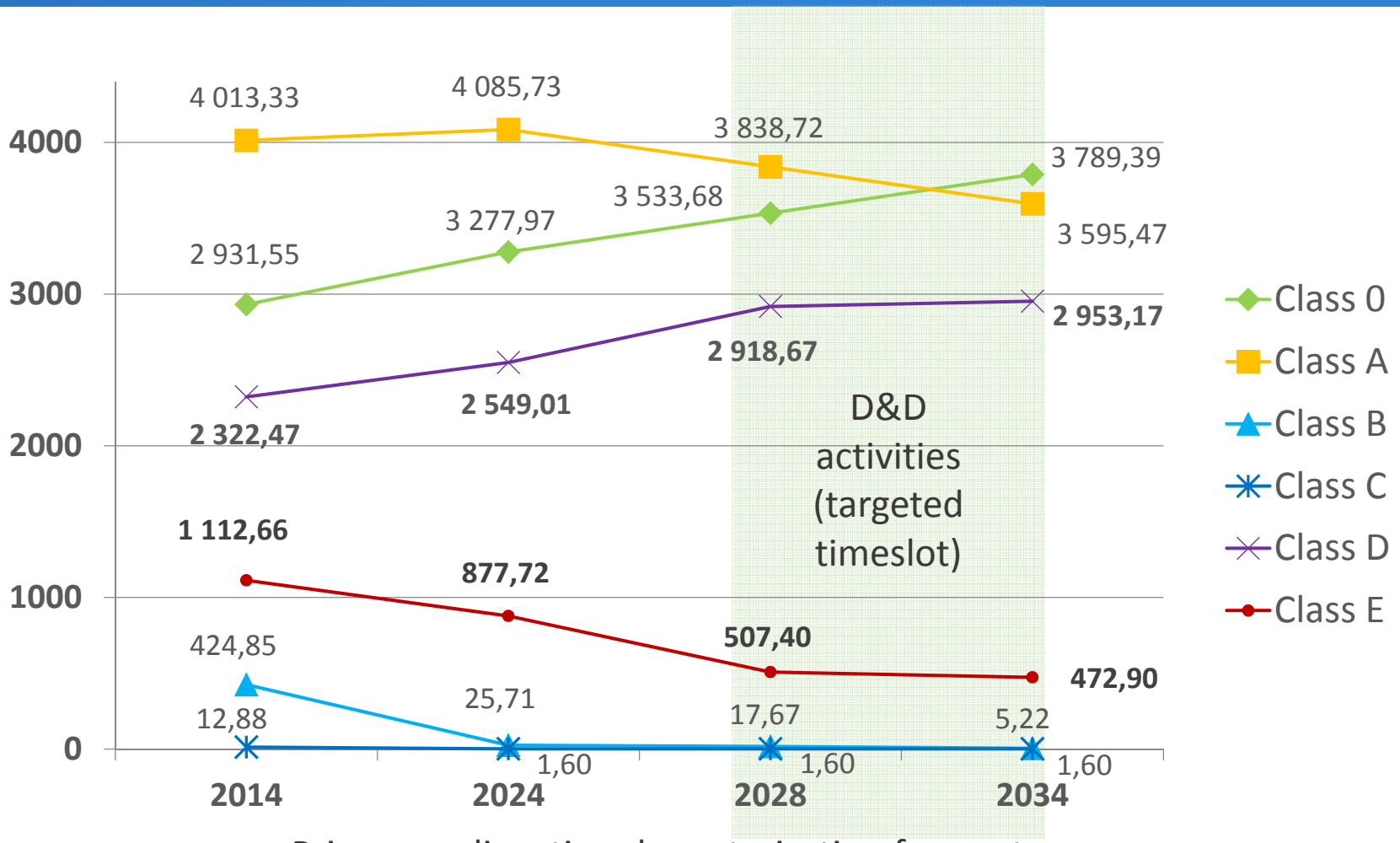
- Graphite
- Carbon steel
- Stainless steel
- Apertural filling (mainly sand and gravel)
- Structural filling (mainly serpentinite)
- Water filling



Not shown in the figure, there are also small amounts of other materials, in particular, ~1.85 tonnes of copper.

Material inventory data of Zone R3 of Unit 1 (tonnes), by August 2018

3 Material inventory and radiological characterization forecasts (3)



Primary radioactive characterization forecast for Zone R3 of Unit 1 (tonnes), by August 2018

3 Material inventory and radiological characterization forecasts (4)

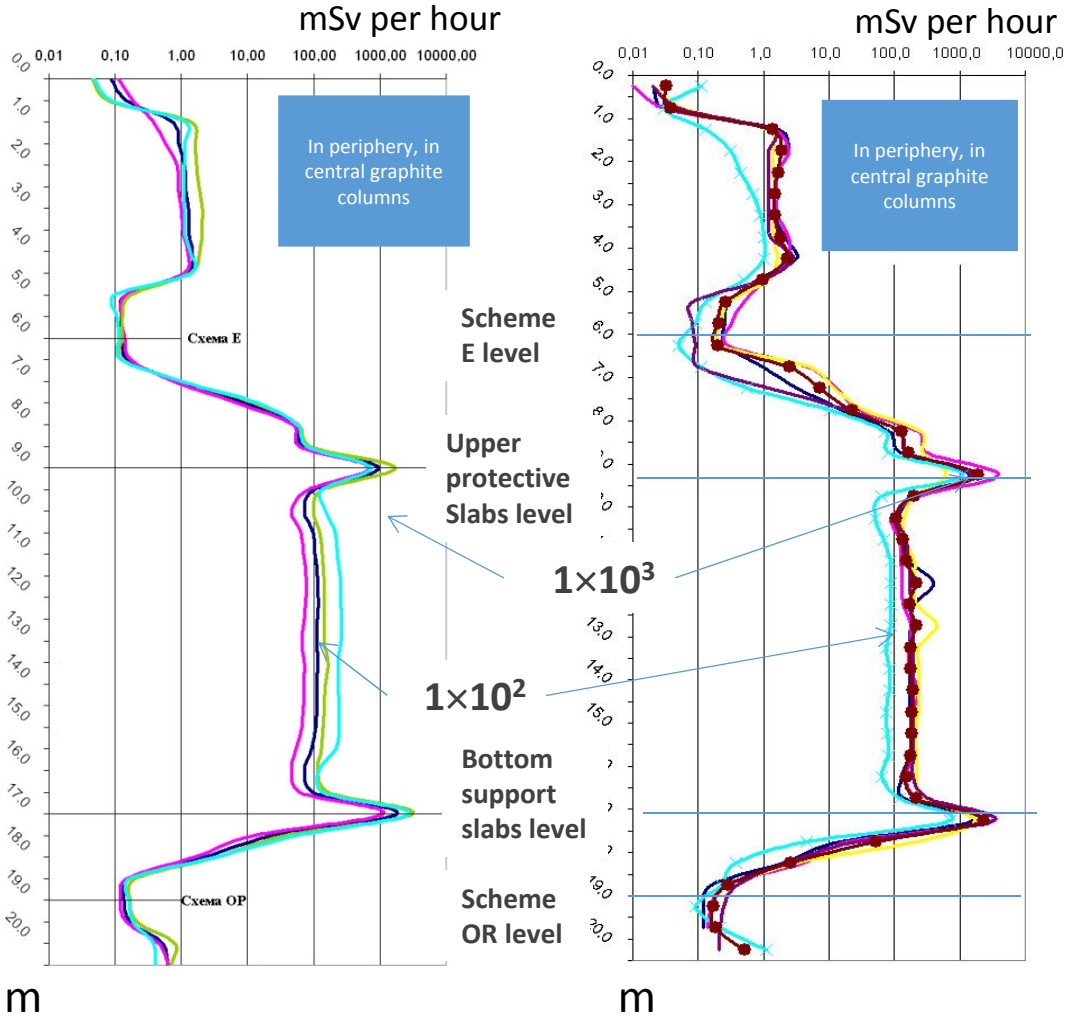
Material	Class 0 (Free Release)	Class A (Landfill)	Class B or C (NSR)	Class D or E (RWISF)
Irradiated graphite				✓
Steel	✓	✓	✓	✓
Solid Fillings	✓	✓	✓	✓
Water Filling			✓ (cemented waste)	

At least 10 waste streams must be considered.

3 Material inventory and radiological characterization forecasts (5) – comparative measurements of Unit 1 and Unit 2 characteristics

Dose rates scanning of Zone R3. Specifics:

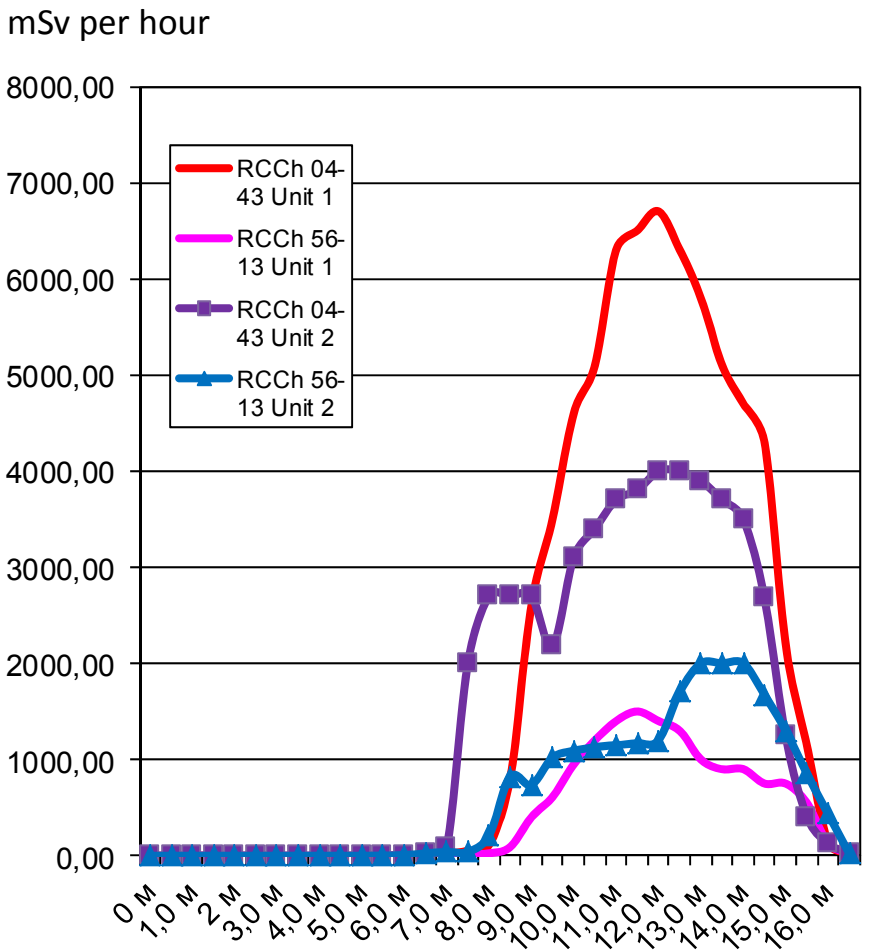
- Level 0 = level of Central Hall floor +25.200;
- “top-to-bottom” scanning inside graphite columns after several channels retrieval ;
- Approx. 9 years after RFS of Reactors;
- Peak dose rates levels correlates with main steel components layout.
- Cumulative dose rate measurement



3 Material inventory and radiological characterization forecasts (5) – comparative measurements of Unit 1 and Unit 2 characteristics

Dose rates scanning of retrieved Reflector Cooling Channels. Specifics:

- Retrieved channels in dry shaft. Distance ~ 10 cm;
- "top-to-bottom" scanning. Distance ~ 10 cm;
- Material – stainless steel Ch18N10T (close to AISI 304, 321)
- Unit 1 – April 2012, Unit 2 – September 2018;
- Considerable margins of dose rates (activation susceptibility and impurities)



3 Material inventory and radiological characterization forecasts – the nearest activities

- **Clarified Zone 3 radiological characterization forecast (by the middle of 2019)**:
  - change of Near Surface Repository (B25) Waste Acceptance Criteria (class B+C waste) with the possibility of low activated waste disposal in B25 near-surface repository (class B+C waste). **Under consideration to clarify class D+E STORAGE options.**
  - Unit 1 nuclide vectors (includes hard-to-measured nuclide concentration) (to be completed).
  - **Comparative engineering studies and radiological surveys are on-going, on the basis of Unit 1 experience.**
  - **Additional clarifications (for example,** Unit 1 nuclide vectors applicability for both Units)

CONCLUSION – SPECIAL REACTOR WASTE INTERIM STORAGE MUST BE CONSIDERED.

Content

4 Ruling Framework (1)

- **International Conventions:** Nuclear Safety Convention; Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention).
- **Laws:**
  - on Decommissioning of State Enterprise Ignalina NPP Unit 1 (2000)
  - on Nuclear Energy;
  - on Nuclear Safety;
  - on the Management of Radioactive Waste;
  - on Radiation Protection;
  - on Environmental Impact Assessment of the Proposed Economic Activity;
  - on Construction.
- **Governmental Resolutions:** on the State Enterprise Ignalina NPP Unit 1 Decommissioning Method (2002); Rules of Issuing Permissions to Construct, Reconstruct, Capital Repair or Demolish Building of Nuclear Facility (2015), etc.
- **Obligations** – for decommissioning funding and scheduling.

4 Ruling Framework (2)

- **State Nuclear Power Safety Inspectorate (VATESI) regulations - Nuclear Safety Requirements BSR.**
  - BSR-2.1.2-2010 General requirements on assurance of safety of nuclear power plants with RBMK-1500 type reactors.
  - BSR-1.5.1-2015 Decommissioning of Nuclear Facilities.
  - BSR-3.1.2-2017 Pre-disposal Management of Radioactive Waste at the Nuclear Facilities.
  - BSR-1.1.5-2017 Rules of Procedure for Public Participation in Decision-making in the Area of Nuclear Energy.
- **Ministry of Environment regulation - Technical Construction Regulation STR.**
- **Ministry of Health - Hygiene Norm HN.**

All applied regulations and norms will be selected and listed in Technical Specification.

http://www.vatesi.lt/index.php?id=545&L=1.

4 Services' Scope planning

Ruling Framework and Stakeholders opinions for each case are decisive!

4 Project packages and tasks (1)

Data, constraints and assumptions (their substantiation) for each case are decisive!

engineering studies and radiological surveys

- ***Engineering Studies.***
- ***Radiological characterizati on forecasts.***
- ***Initial planning.***
- ***Preliminary costs estimates.***
- ***Specification (s) for development.***
- ***etc.***

development of the D&D and Waste Facilities design documentation

Engineering Services for R3 Optioneering, Concept Design and EIAR development of D&D of Unit 1 and Unit 2 reactor Zone R3 equipment and RWISF storage (2103.026S)

- *development of the D&D Technological Design and D&D SAR based on the Conceptual Design and EIAR;*
- *design and fabrication of any complex tools or new waste containers;*
- *relevant design activities for the RWISF (according to the Construction Law) and SAR*

preparatory works

RWISF – Reactor Waste Interim Storage Facility

Reactor dismantling

Processes, i.e.

- ***gaining access;***
- ***dismantling/ retrieval;***
- ***processing/ packaging;***
- ***dispatch***

RWISF – Reactor Waste Interim Storage Facility

Ruling Framework and Stakeholders opinions for each case are decisive!

4 Gaining access

1. Gaining access
2. Dismantling/retrieva
3. Processing/packaging
4. Dispatch
5. Reactor Waste Interim Storage Facility (RWISF)

- **Option 1.1: Access from the top compartments.**

(1) No dismantling of top metal structure Scheme E – access through former assembly DN800 hatches

(2) Limited dismantling of top metal structure Scheme E – access through new penetrations of metal structure Scheme E

(3) Total removal of top metal structure Scheme E.

- **Option 1.2: Access from the side and bottom compartments.**

(1) No dismantling of top metal structure Scheme E – access through new penetrations of metal structures Schemes KZh, L and D and concrete walls.

(2) No dismantling of top metal structure Scheme E – access through new penetrations of metal structures Schemes X, L and D and concrete walls.

- **Option 1.3: Combination of Option 1.1 and Option 1.2**
- **Option 1.4: Any other options of the consultant**

4 Dismantling/retrieval

1. Gaining access
2. Dismantling/retrieval
3. Processing/packaging
4. Dispatch
5. Reactor Waste Interim Storage Facility (RWISF)

- **Option 2.1: Techniques identified by INPP**

(1) Irradiated graphite capture/retrieval (in-air, limited crushing)

(a) brick-by-brick; (b) multi-brick; (c) column-by-column

(2) Steel cutting/retrieval

Cutting: (a) mechanical cutting; (b) thermal cutting; (c) alternative cutting

Retrieval: (a) final cutting *in-situ*; (b) pre-cutting and retrieval as large items

(3) Solid fillings

(a) Suction; (b) mechanical retrieval ; (c) solidification and cutting

(4) Water filling

Discharge by: (a) top-installed pump; (b) bottom-installed drain.

- **Option 2.2: Techniques identified by the consultant**
- **Option 2.3: Combination of fit-for-purpose Option 2.1 and 2.2.**

4 Processing/packaging

1. Gaining access
2. Dismantling/retrieval
3. Processing/packaging
4. Dispatch
5. Reactor Waste Interim Storage Facility (RWISF)

- **Option 3.1: Container for Irradiated waste (long-lived waste, Class D & Class E)**

(1) LLWC
(2) F-ANP
(3) KTZ-3.6
(4) Other existing design
(5) Bespoke design

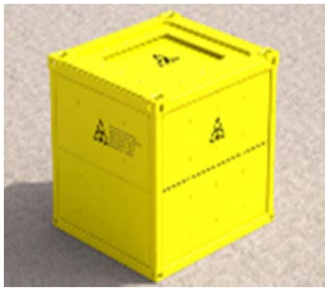
- **Option 3.2: Processing and packaging workshop (all classes of waste)**

(1) Only Central Hall compartments
(2) Central Hall and former Drum-Separator compartments
(3) Central Hall and former Spent Fuel Pools Hall compartments
(4) Other options identified by the consultant

Containers, accumulation areas and storage, other facilities for "free-release" and "short-lived waste" (Class 0, A, B, C) shall be available from predecessor's projects.

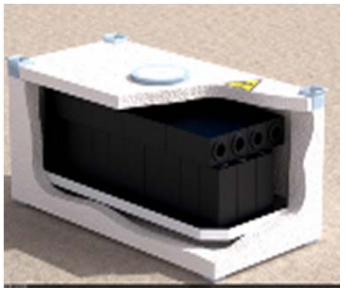
Packaging: possible options for storage containers

Use of “ILW-LL” containers for operational
- 2-wall carbon steel storage container, lifetime 50 years
- Outside dimensions, mm - 1700×1530×1570

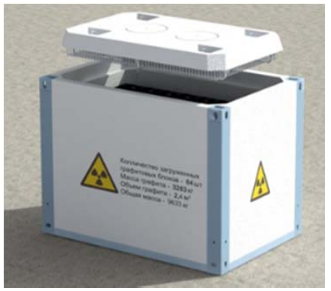


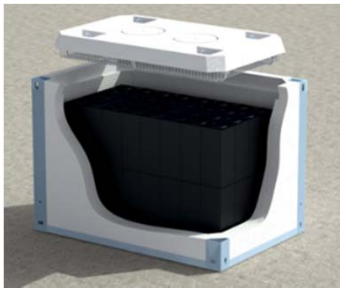
Storage and Containers for R3 LL waste

Use of LILW-SL FRAMATOME containers for operational SL waste
- Reinforced concrete storage/NSR disposal container
- Outside dimensions, mm - 3000×1500×1288



Use of LILW-SL KTZ-3,6 containers for SL waste
- Reinforced concrete storage/NSR disposal container
- Outside dimensions, mm - 2400×1620×1650





4 Dispatch

1. Gaining access
2. Dismantling/retrieval
3. Processing/packa
4. Dispatch
5. Reactor Waste Interim Storage Facility (RWISF)

There are no options for dispatch.
The consultant is required only to identify the route/means by which the respective waste streams are transferred ensuring that sufficient movement capacity exists to prevent any disruption of Zone R3 dismantling.

For example:

- **Class 0** waste transport packages to Building 159B or to Facility B10
- **Class A** waste disposal packages to the Landfill Buffer Storage Facility (B19-1)
- **Class B, C waste** KTZ-3.6 disposal packages to the Cementation Facility of the Near Surface Repository (B25)
- **Class D and Class E** (long-lived waste) waste storage packages to be dispatched to the **Reactor Waste Interim Storage Facility** to be defined under this project.

4 Reactor Waste Interim Storage Facility (RWISF) options

1. **Gaining access**
2. **Dismantling/retrieval**
3. **Processing/packaging**
4. **Dispatch**
5. **Reactor Waste Interim Storage Facility (RWISF)**

- **Option 5.1: an existing facility of INPP**
  - (1) Building 158/2*
  - (2) Facility B4-S / B4-L
- **Option 5.2: the pre-designed extension of an existing facility**
  - (1) Facility B4-S (additional module)
  - (2) Facility B4-L (extension)
- **Option 5.3: new construction**
  - (1) a new building
  - (2) a new open storage yard
- **Option 5.4: combination of the above**

4 Reactor Waste Interim Storage Facility (RWISF) options

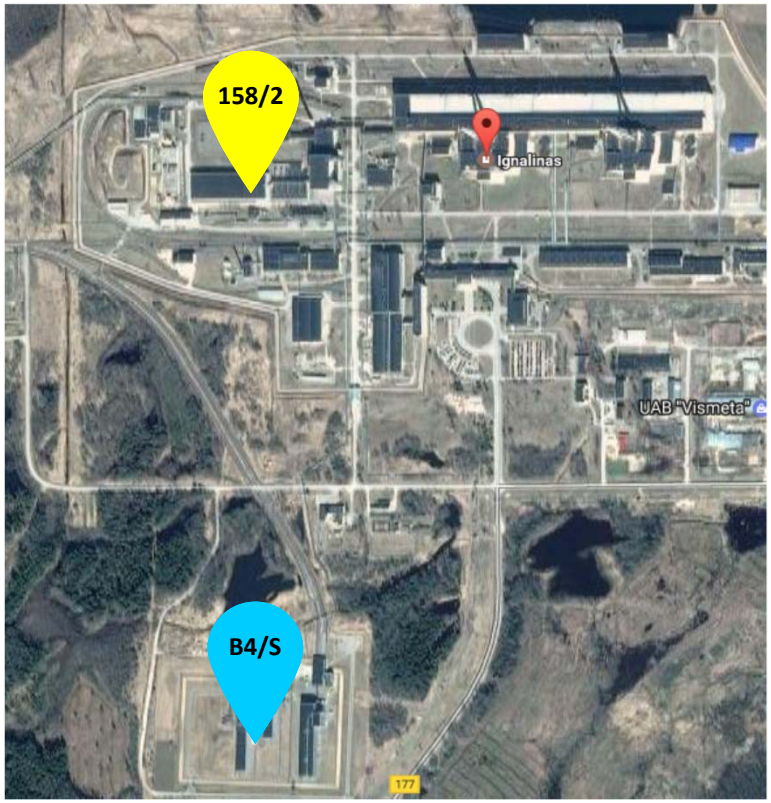
INPP site - https://www.google.lt/maps/place/IAE+-+Ignalinos+atominė+elektrinė

Option 5.1: an existing facility of INPP

(1) Building 158/2*

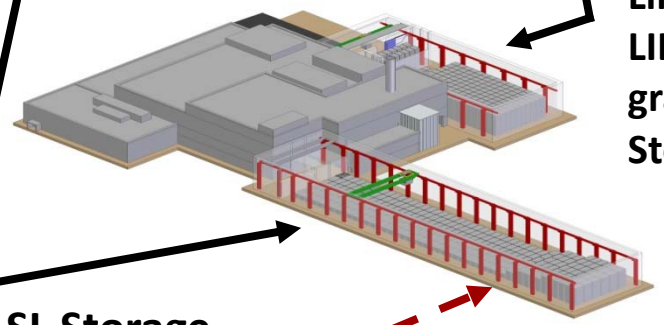
4 Reactor Waste Interim Storage Facility (RWISF) options

INPP site - https://www.google.lt/maps/place/IAE+-+Ignalinos+atominė+elektrinė



Option 5.1: an existing facility of INPP

(2) Facility B4-S



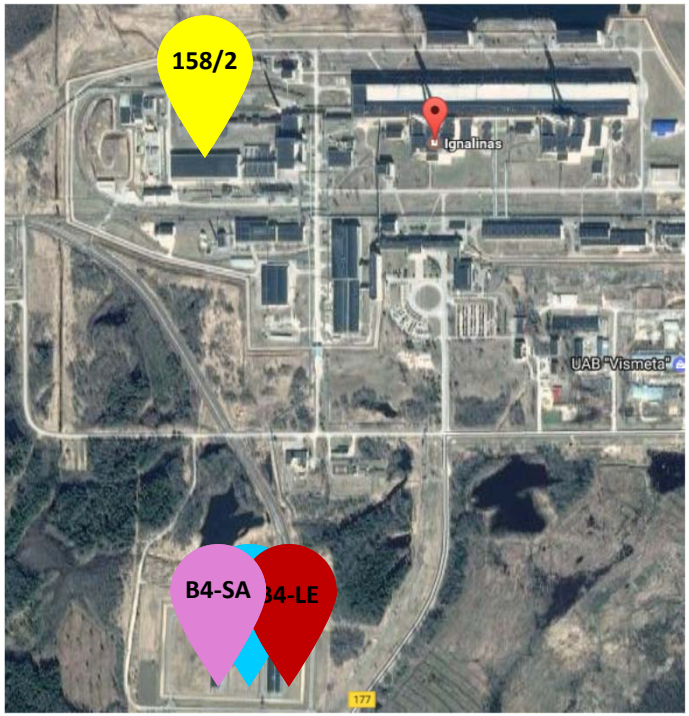
Limited LILW-LL graphite Storage

LILW-SL Storage

And/or LILW-LL Storage (after LILW-SL disposal)

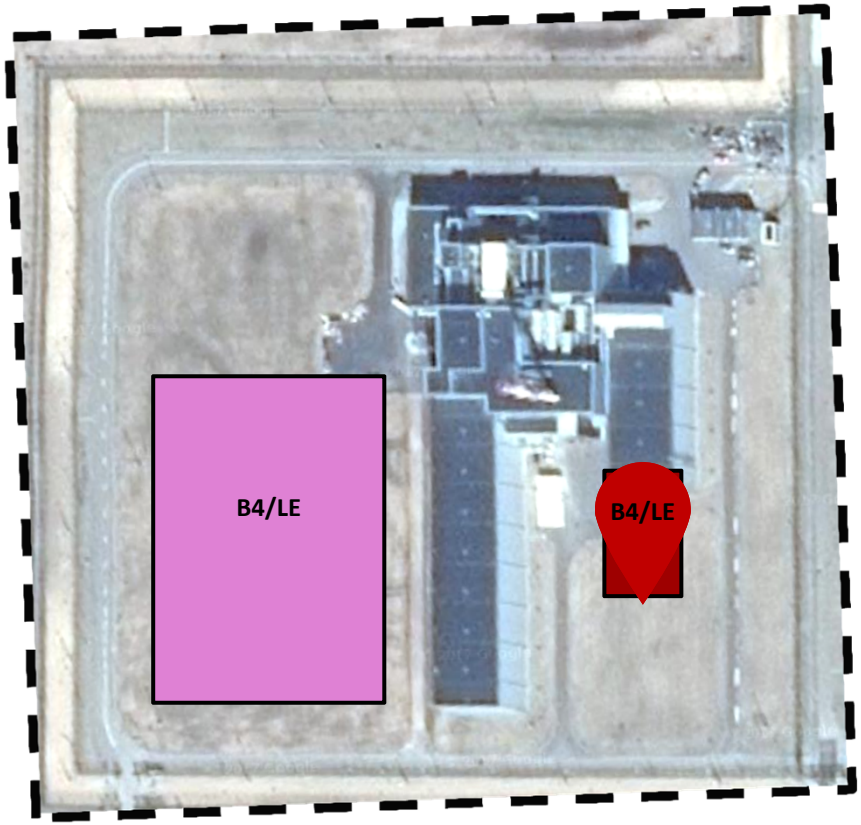
4 Reactor Waste Interim Storage Facility (RWISF) options

INPP site - https://www.google.lt/maps/place/IAE+-+Ignalinos+atominė+elektrinė



Option 5.2: the pre-designed extension of an existing facility

- Facility B4-SA (additional module)
- Facility B4-LE (extension)



Option 5.3: new construction

(1) a new building ?

(2) a new open storage yard ?

Option 5.4: combination of the above ?

4 Planned Tasks under Engineering Services for R3 Optioneering, Concept Design and EIAR development (2103.026S)

The activities in the project are subdivided into the following tasks under a single contracted:

Task 1: Development and submittal of contract implementation methodology;

Task 2: Optioneering and optimal solution.

Task 3: Conceptual design and Gap Analysis development;

Task 4: Environmental Impact Assessment Report (EIAR) development;

Task 5: Support to INPP during coordinating Tasks outputs with the regulatory bodies and financial stakeholders; during EIAR national approval and under Espoo convention.

Content

5 **Technical Specification Structure**

5 Technical Specification Structure (1)

Main part:

1. Purchase Type
2. Objective
3. Description of Services and Scope of Supply
4. Codes and Standards
5. Requirements for Purchase of Safety Important Products or Services/Works in Controlled Area of Nuclear Facility
6. Activity Schedule
7. Requirements for Service Provider's Staff (Experts) and Organization of Provision of Services
8. Place of Activity Performance
9. Deadline of Service Provision
10. Other Expenses
11. Reports
12. Supervision and Evaluation
13. Quality Control
14. Other Requirements

5 Technical Specification Structure (2)

Annexes:

- **Annex 1. Description of the Dismantling Object for Both Units.** Amongst others
  - Reactors site description, including Initial State of components, system and constructions to be dismantled, assumptions, boundary conditions and constraints; Final State of components, system and constructions after dismantling, decommissioning and clean-up.
  - Characteristics of components, system and constructions to be dismantled (on the basis available data)
  - Characteristics of existing systems and components remaining in operation (i.e. ventilation, power supply, compressed air supply, water supply, draining, fire extinguishing, lighting, radiation control and monitoring, cranes and transportation of reactor buildings, security, communication, etc.
  - Characteristics and lessons learnt from other dismantling designs (drum-separator dismantling, refueling machine dismantling, channels and upper/lower pipeline network dismantling, Spent Fuel removal from Units).

5 Technical Specification Structure (3)

- **Annex 2. Interactions of Activities on the Structures, Systems and Components Dismantling and Decontamination Waste Management with Free-Release Measurement Facility** (in particular, class 0 waste management)
- **Annex 3. Interactions of Works on Handling of Waste of Dismantling and Decontamination of Structures, Systems and Components with Buffer Storage of Landfill Facility** (in particular, class A waste management)
- **Annex 4. Interactions of Waste Management, Dismantling and Decontamination of Structures, Systems and Components with Solid Waste Treatment and Storage Complex B3/4 and Repository for Short-Lived Low and Medium Level Radioactive Waste B25** (in particular, class B+C, D+E waste management)
- **Annex 5. Interaction of Works Related to Management of Waste Originated due to Dismantling and Decontamination of Structures, Systems and Components with Storage Facility Located in Bld. 158/2** (as candidate for future reactor waste interim storage facility – class D+E)

5 Technical Specification Structure (4)

- **Annex 6. Requirements for Radiation Protection and Control**
- **Annex 7. General Requirements for Technical Specifications Dedicated for Procurement of Tools, Equipment and Devices**
- **Annex 8. Data for Assessment of Performance and Cost Effectiveness**
- **Annex 9. Requirements and Interaction with Physical Security Organization Service**
- **Annex 10. Health and Safety Requirements.**
- **CDs with selected design documentation** (i.e. main captures of constructions, technological drawings).
- **Additional Annexes** or Exclusions (if needed, for successful tendering)

SE Ignalina Nuclear Power Plant

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Thank you for attention!

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