Management strategy and methods applied at INPP for operational and decommissioning RAW

Ignalina Nuclear Power Plant

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Radioactive waste management main documentation

- Inventarization and pre-characterization of RAW at INPP.
- Evaluation of the total amount of radioactive waste.
- Preparation of Final decommissioning plan. (Decommissioning strategy).
- Preparation of different SAR’s and TD (dismantling activities, RAW storage and treatment facilities, disposal facilities)
- Preparation of Radioactive waste management program. (Strategy implementation description)
- Etc.
Predisposal Steps

- Pre-treatment
- Treatment
- Conditioning
- Storage
- Transportation.

Characterization of waste is also an essential predisposal activity that is common to all of the above steps.

Predisposal Steps (Pre-treatment)

**Pre-treatment** includes any operations prior to waste treatment, to allow selection of technologies that will be further used in processing of waste (treatment and conditioning):

- Collection
- Segregation
- Decontamination.
Predisposal Steps (Treatment)

**Treatment** of radioactive waste includes those operations intended to improve safety or economy by changing the characteristics of the radioactive waste. The basic objectives of treatment are:

- Volume reduction;
- Radionuclide removal from waste; and
- Change of physical and chemical composition.

Predisposal Steps (Conditioning)

**Conditioning** covers those operations that produce a waste package suitable for handling, transportation, storage and/or disposal. It may include:

- Immobilization of the waste
- Enclosure of the waste in containers; and, if necessary
- Provision of an overpack.

Immobilization refers to the conversion of waste into a waste form by solidification, embedding or encapsulation. Common immobilization matrices include cement, bitumen, polymers and glass.
Predisposal Steps (Storage)

Storage of RAW during storage period should ensure:
- retrievability
- confinement,
- isolation,
- environmental protection and
- monitoring.
Radioactive waste may be stored as:
- RAW,
- pre-treated,
- treated or
- conditioned waste.
The purpose and duration of storage depending on:
- decay of waste for free release or for clearance after decay;
- further processing and/or disposal at a later time.

Predisposal Steps (Transportation)

Transportation - physical movement of radioactive waste in specially designed packages:
- From RAW collection point to processing facility or centralized storage.
- Conditioned waste packages from processing or storage facilities to disposal facilities.
The most common modes of transport:
- trucks
- tankers
- trains
- barges
To protect people, property and the environment, transport is carried out in special packages in accordance with internationally accepted regulations. (IAEA Safety Standards: Regulations for the Safe Transport of Radioactive Materials (SSR-6))
Predisposal Steps (Characterization)

Characterization of radioactive waste is an important aspect at every stage of pre-disposal management.

Waste characterization - determination of the physical, chemical and radiological properties of the waste

Depending on RAW characteristics, it is established:
- pre-treatment,
- treatment,
- conditioning, or
- suitability for further handling,
- processing,
- storage or disposal.
Ignalina NPP decommissioning activities are co-financed by European Union.

RAW management objects

- Unit 1 (RBMK-1500) in operation 1983-2004
- Unit 2 (RBMK-1500) in operation 1987-2009

Location of new Spent Nuclear Fuel Storage Facility and New Solid radioactive Waste Treatment and Storage Facilities.

Location of buffer storage facility for VLLW

Location of Repository for LLC Radioactive Waste

Location of Repository for IL Radioactive Waste
RAW management objects

1 – Liquid waste treatment facilities (bituminization and cementation); 2 - Bldg. 158 – Bituminized waste storage; 3 - Liquid waste collection and storage tanks; 4 – Bldg. 158/2 – Cemented waste storage; 5 – Bldg. 157 and 157/1 – Storage of solid waste of groups 1, 2 and 3; 6 – Bldg. 155 and 155/1 – Storage of solid waste of group 1; 7 – “Poligon” – Storage of industrial waste.

Radioactive waste quantities

Total amount of spent nuclear fuel at INPP as of 2015

<table>
<thead>
<tr>
<th>Place of storage</th>
<th>Amount of SFA, pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNF in DSFSF storage facility</td>
<td>6016</td>
</tr>
<tr>
<td>SNF SFP of Unit 1</td>
<td>7175*</td>
</tr>
<tr>
<td>SNF SFP of Unit 2</td>
<td>7246*</td>
</tr>
<tr>
<td>SNF in reactor of Unit 2</td>
<td>1134*</td>
</tr>
<tr>
<td>In total SFA at INPP</td>
<td>21571</td>
</tr>
</tbody>
</table>

*up to 2022 their retrieval, placement into the casks and transportation for storage in ISFSF (Project B1) is planned. The amount of heavy metals in one SFA is 110-112 kg.
SRW classification

Radioactive waste quantities

<table>
<thead>
<tr>
<th>Class of wastes</th>
<th>Type of wastes</th>
<th>Amount of wastes, t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A (VLLW-SL)</td>
<td>Concrete</td>
<td>83466</td>
</tr>
<tr>
<td></td>
<td>Combustible</td>
<td>4156</td>
</tr>
<tr>
<td></td>
<td>Non-combustible</td>
<td>87989</td>
</tr>
<tr>
<td>Class B and C (LILW-SL)</td>
<td>Combustible</td>
<td>161</td>
</tr>
<tr>
<td></td>
<td>Non-combustible</td>
<td>7277</td>
</tr>
<tr>
<td></td>
<td>LRW bituminization **</td>
<td>19356</td>
</tr>
<tr>
<td></td>
<td>LRW cementation **</td>
<td>14000</td>
</tr>
<tr>
<td>Class D+E (Graphite) (LILW-LL)</td>
<td>Non-combustible</td>
<td>3819</td>
</tr>
<tr>
<td>Class D+E (LILW-LL)</td>
<td>Non-combustible</td>
<td>627</td>
</tr>
<tr>
<td>Class F (SSS)</td>
<td>Non-combustible</td>
<td>15,7</td>
</tr>
</tbody>
</table>

**planned amount of waste after processing and solidification of all liquid radioactive waste (LRW) up to 2038.

In addition about 200 m³ of RAW are stored in Lithuania in RADON type facility in Mašiagala temporary storage facility which will be retrieved and transferred to INPP for sorting, and packages formation for disposal or temporary storage.
INPP radioactive waste management Program

Ignalina Nuclear Power Plant

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Free release facility - Bld. 159 B
Built and commissioned in 2005, funded by INPP
Output - 20 measurements per shift

Free release facility – B10
Facility B10 in operation from 2010
Used for sorting and measurements of solid wastes from dismantling.
- 3 measurement options:
  - containers 1200x900x900mm,
  - 200 l drums,
  - large size objects < 6.0 x 2.0 x 2.5 m.
Output - 28 measurements per shift.
Measurement methodology for release of large size objects agreed with VATESI in 2010.
Operational waste Polygon (A class waste)
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Operational SRW retrieval facility B2 (1)

- The Solid Waste Retrieval Facility (SWRF) is built in connection with the existing INPP solid radioactive waste storage buildings inside the perimeter of the INPP.
- The purpose of the SWRF is to extract existing waste from its present storage location within INPP solid radioactive waste storage facility, present it and segregate adequate material (Class A waste) for VLLW repository, and package the rest waste for transfer to the Solid Waste Treatment Facility (SWTF).
- Planned start of operation in 2018.

- Licence for construction of RU1 for retrieval of G1 group radioactive waste from build. 155, 155/1, the Separation Facility (SF) and the Control Building was issued by VATESI in 2011.
- SF receive class A operational and decommissioning waste from INPP
- SF processing rate 1.87 m³/h
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Operational SRW retrieval facility B2 (2)

- RU2 and RU3 retrieval Units will be installations for retrieval of G1, G2 & G3 group radioactive waste from buildings 157, 157/1 within which the waste retrieval, pre-sorting and packaging for transfer to SWTF will take place.
- Technical design documentation and preliminary safety analysis report was prepared and submitted for VATESI review.
- After resolution of all comments, final version of the documents shall be prepared and agreed with VATESI.
- Planned start of operation - 2018.

Operational SRW retrieval facility B2 (3)

- RU2 will be:
  - used to retrieve, pre-sort and pack G1 and G2 waste from buildings 157 and 157/1;
  - able to move in 2 directions;
  - sealed to the waste storage building and with installed ventilation system to prevent spread of the airborne contamination.
- Waste will be retrieved remotely with a girder crane equipped with specific grabs.
- Waste will be loaded in G1/G2 transfer containers.
- In order to minimize retrieved waste volume and to fit large objects in to the transfer containers the oversized waste will be cut using fitted tools.
- RU2 designed for an average rate 2.5 m$^3$/h for G1 waste, 0.5 m$^3$/h G2 waste and 1 m$^3$/h G2 combustible waste.
Operational SRW retrieval facility B2 (4)

- RU3 will be:
  - used to retrieve the G3 waste from compartments 1 and 4 of building 157;
  - a fixed shed structure, which need to be placed one time only.
- Waste retrieval will be:
  - performed after removing the plugs from G3 waste compartments' roofs;
  - performed using inside compartment mounted remote tools carrier arm;
  - automatic and remotely controlled.
- The G3 waste transfer container will be equipped with a basket (situated inside the container), which can be lowered into the waste compartment.
- Once loaded, the basket with waste will be lifted up into waste transfer container.
- Oversized waste will be treated appropriately by means of attached tools.
- RU3 design for an average rate 0.75 m³/day.

A class waste Buffer storage facility – B19-1 (1)

Buffer storage:
- Volume of 4000 m³ (about 200 HH ISO containers)
- Characterization of waste packages (HH ISO, 1x1x1 m packages (bails or FIBC))
- Waste transportation inside the buffer storage by fork lifters (1.5 t and 25 t)

Limitations of characterization
- not envisaged possibility of the large-size waste characterization
- homogeneity requirement for the filling regarding chemical and radiological content
- strict requirement for the geometry of small packages
A class waste Buffer storage facility – B19-1 (2)

Transportation of packages is performed by the truck with a trailer. Within the buffer storage, packages are moved by the 25-ton fork lift.

- Characterization unit for the measurements of activity of nuclides in the packages with the use of nuclide vector.
- Aimed at waste transportation into the measurements room and into the waste storage area, transport trolley is used, equipped with scales.

A class waste disposal facility – B19-2

Contractor (2007) of B19-1 and B19-2 was consortium of:
- Specialus montazas – NTP
- Pramprojektas
- LEI
- Vilstata

Conception of Landfill of Oskarshamn NPP, Sweden.
A class RAW packages

Spent ion exchange resins after decontamination and drying will be packed in FIBC (Flexible Intermediate Bulk Containers) containers with dimensions of about 1 x 1 x 1 m.

Compactable wastes (cloths, plastics, papers etc.) are pressed by 70-t compactor in bales with dimensions of about 1 x 1.2 x 0.7 m.

Non-compactable waste (dismantled equipment, construction waste) are placed in 20-feet half-height ISO containers.

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\[ 08/10/2015 \]
Ignalina NPP decommissioning activities are co-financed by European Union LRW (Class B+C) cementation and storage

- Spent ion-exchange resins, filter aid (Perlite) and part of evaporator concentrate with solid particle sediments from 2006 are solidified in cement solidification facility with processing capability 450 m$^3$/a
- 200-litre drums are filled with the use of cementation unit and packaged in sets of 8 into containers.
- Cemented waste storage facility capacity is to store 6300 containers vol. 5.6 m$^3$.

![Cemented waste in drum](image)
![Storage container](image)

Ignalina NPP decommissioning activities are co-financed by European Union LRW (Class B+C) bitumen compound storage facility

PROJECT B20. Bituminized waste repository. It is planned to change purposes of the existing storage facility (Bld 158) into repository

- Bituminised waste storage facility capacity 22 800 m$^3$.
- At the end of 2014 filed in 14384 m$^3$ of bitumen compound.
- Build. 158 is not designed and constructed to contain radionuclides for long time.
Ignalina NPP decommissioning activities are co-financed by European Union SRW treatment and storage facility – B3/4 (1)

- The SWTSF is designed for sorting, treatment, packaging, characterization and storage of Short-Lived and Long-Lived solid radioactive waste currently stored at the INPP and produced by decommissioning of INPP and treatment of combustible liquid radioactive wastes.
- Licence for construction of SWTSF issued by VATESI in 2009.
- Waste processing rates: 2.8 m$^3$/day for G1 and G2 waste; 0.9 m$^3$/day for G3.
- Volume of waste to be treated and packaged: ~ 63 500 m$^3$ SL RW; ~ 6100 m$^3$ LL RW; 63 000 disused sealed sources.
- Volume of the storage for SL RW – 2500 m$^3$.
- Volume of the storage for LL RW – 2000 m$^3$.
- Design lifetime of storage facilities – 50 years.

Start of operation - 2018.

SRW treatment and storage facility – B3/4 (2)
Ignalina NPP decommissioning activities are co-financed by European Union SRW treatment and storage facility – B3/4 (3)

G2 sorting cell of the SWTF

SRW treatment and storage facility – B3/4 (4)

Incineration system of the Solid Waste Treatment Facility

- The Incineration Facility is intended to incinerate both, solid and liquid combustible waste.
- The solid waste that is to be incinerated is delivered in specific containers filled with bags with pre-sorted and shredded solid waste, with a weight of approximately 5 kg.
- Processing rate for solid waste is 100 kg/h (approximately 2000 kg/day).
- Liquid waste will be fed into the incinerator rate at a maximum of 40 kg/h.

980 t G1 waste and 465 t G2 operational waste and 1802 t of decommissioning waste to be processed.
1910 drums, 80 containers (up to 24 compacted drums in 1 container)
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High Force Compaction
15000 kN

- Volume redaction ratio: from 4 to 7;
- Average processing rate: 32 drums/day.

SRW treatment and storage facility – B3/4 (6)

LL Waste Storage

The LL waste storage facility is designed for the storage of 2000 m³ waste (836 containers for G3 waste; 10 containers for graphite; 30 containers for disused sealed sources). Potential extension of the storage capacity by factor two.

SL Storage

The volume of SL storage facility is capable of containing 2500 m³ of processed waste (1190 containers). It can be extended by the addition of up to 3 similar modules, so that a total storage volume of 10000 m³ can be provided.
B and C class RAW packages

Reinforced concrete container KTZ-3.6 will be used to:

- package of pellets from supercompaction, class B and C waste;
- package of not treated decommissioning waste, class B and C (non compactible and non combustible waste)

- Volume of container - 6.42 m³ (internal 3.6 m³)
- Dimensions – 2400x1620x1650 mm
- Weight of container and lid, not more than 6250 kg
- Gross weight, not more than 15000 kg
- Containers are designed following the IP-2 standard.

Reinforced concrete container FRAMATOME will be used to:

- Storage and disposal of Cemented LRW in drums (8 drums in one container)
- Dimensions – 3000x1500x1288 mm
- Weight of container and lid, not more than 5950 kg
- Gross weight, not more than 15000 kg
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**D and E class RAW packages**

Steel container ILW-LL for LL RAW and disused sealed sources:

- Sealed sources in transport containers K-50, K-100 (dia 1000 mm, h-1200 mm) or four 200-litre drums are placed in ILW-LLS container.
- The difference between ILW-LL and ILW-LLS container is only in the opening width (ILW-LLS containers have bigger opening than ILW-LL containers).
- Outer dimension: 1700 x 1530 x 1570 mm;
- Inner dimension: 1600 x 1400 x 1450 mm;
- Inner volume: ~3.24 m³;
- Total weight: 8000 kg.
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Main challenges

**Short term challenges:**
- Ensuring of knowledge transfer in time.
- Damaged SFA handling.
- Transformation of bitumen compound storage facility to repository.
- Ensuring of financing of INPP closure and construction of Deep geological repository.

**Long term challenges:**
- Decommissioning of INPP and treatment of specific RAW in accordance to schedule until 2038.
- Treatment of SF and LL waste and formation of packages for disposal.
- Construction of Deep geological repository and LL waste disposal.
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