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

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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.

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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.

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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.

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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.

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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.

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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.

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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))

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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.

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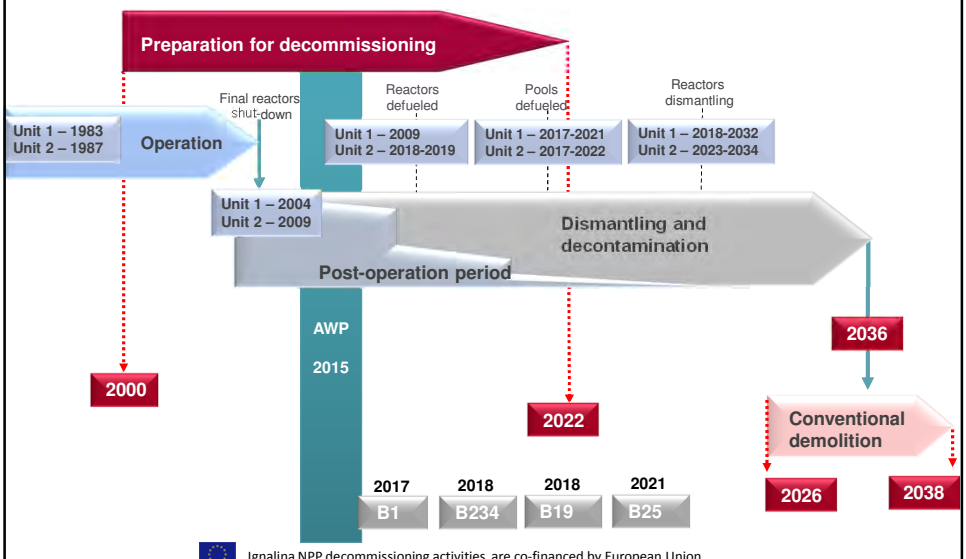
INPP Decommissioning Steps



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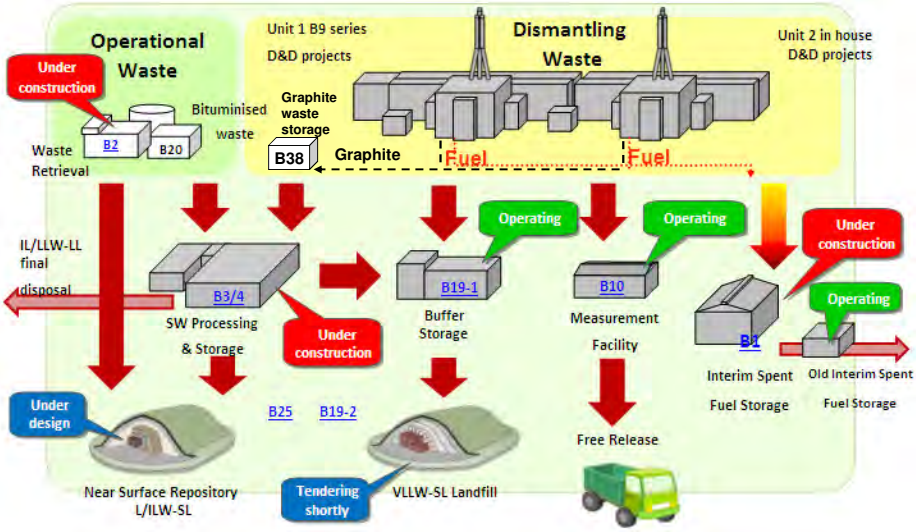
RAW management scheme at INPP



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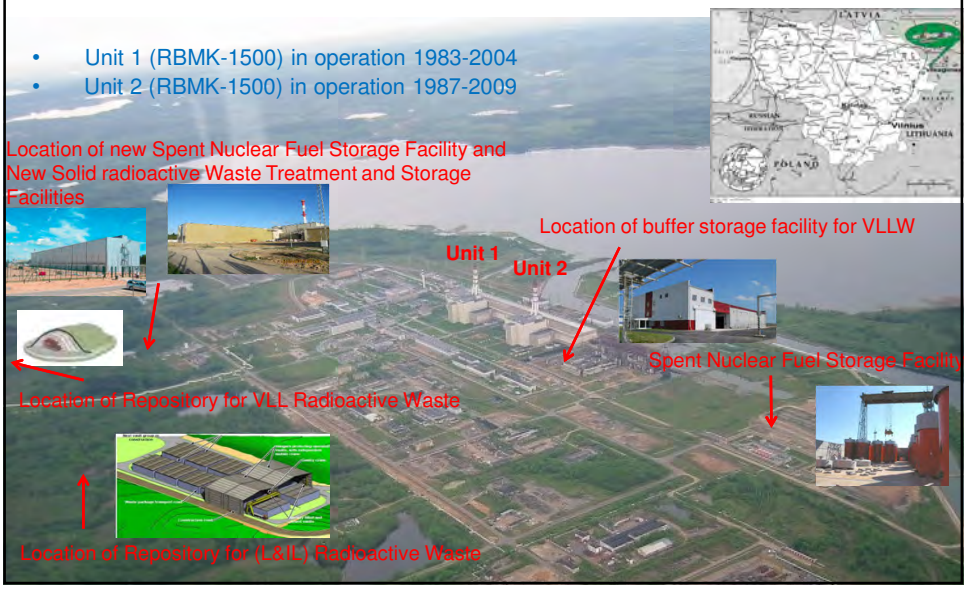
RAW management objects

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



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 151/1 – Storage of solid waste of group 1; 7 – "Poligon" – Storage of industrial waste.

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Radioactive waste quantities

Total amount of spent nuclear fuel at INPP as of 2015

Place of storage	Amount of SFA, pieces
SNF in DSFSF storage facility	6016
SNF SFP of Unit 1	7175*
SNF SFP of Unit 2	7246*
SNF in reactor of Unit 2	1134*
In total SFA at INPP	**21571**

*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.

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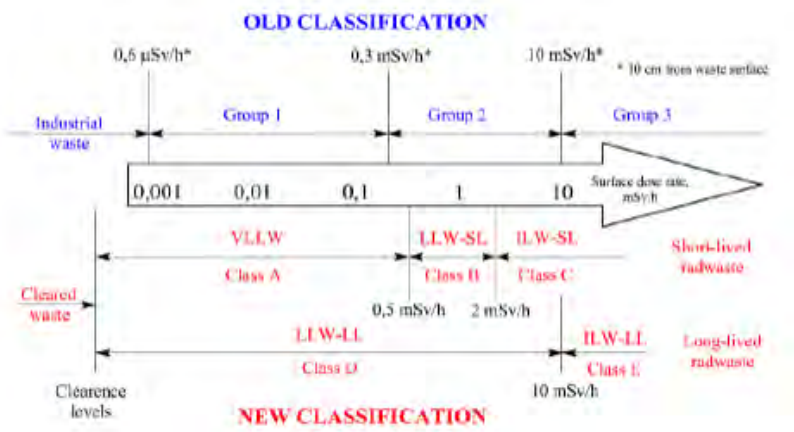
SRW classification



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Radioactive waste quantities

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

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

In addition about 200 m^3 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

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INPP radioactive waste management Program
Ignalina Nuclear Power Plant
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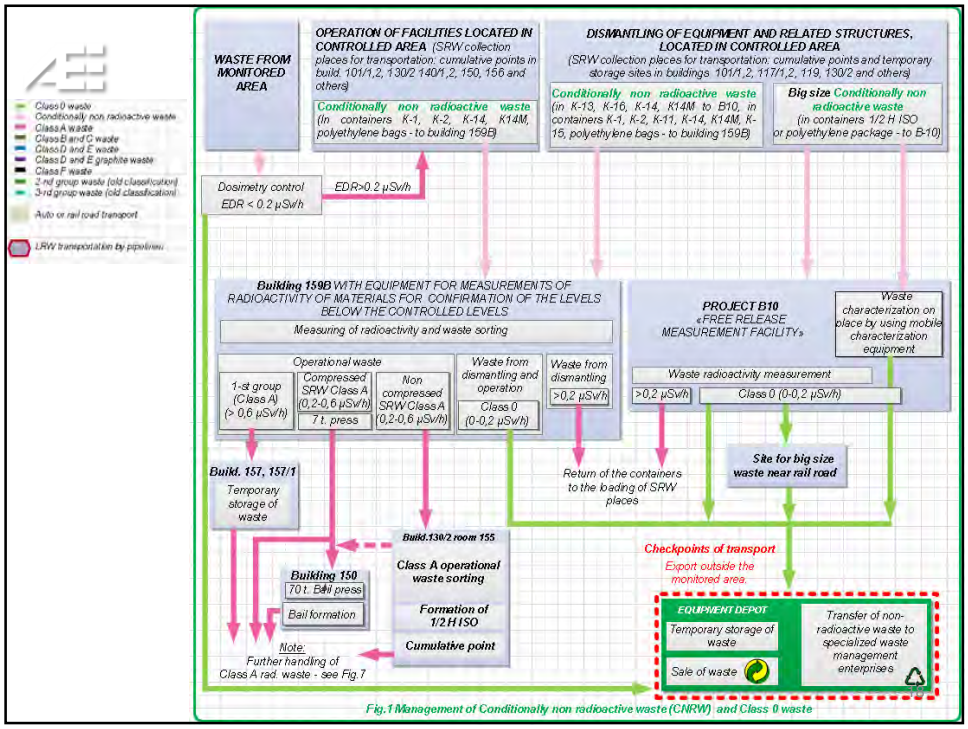
Class 0 waste
Conditionally non radioactive waste
Class A waste
Class B and C waste
Class D and E waste
Class D and E graphite waste
Class F waste
2-nd group waste (old classification)
3-rd group waste (old classification)
Auto or rail road transport
LRW transportation by pipelines
WASTE FROM MONITORED AREA
OPERATION OF FACILITIES LOCATED IN CONTROLLED AREA (SRW collection places for transportation: cumulative points in build. 101/1,2, 130/2 140/1,2, 150, 156 and others)
Conditionally non radioactive waste (in containers K-1, K-2, K-14, K14M, polyethylene bags - to building 159B)
DISMANTLING OF EQUIPMENT AND RELATED STRUCTURES, LOCATED IN CONTROLLED AREA (SRW collection places for transportation: cumulative points and temporary storage sites in buildings 101/1,2, 117/1,2, 119, 130/2 and others)
Conditionally non radioactive waste (in K-13, K-16, K-14, K14M to B10, in containers K-1, K-2, K-11, K-14, K14M, K-15, polyethylene bags - to building 159B)
Big size Conditionally non radioactive waste (in containers 1/2 H ISO or polyethylene package - to B-10)
Dosimetry control EDR < 0.2 µSv/h
EDR>0.2 µSv/h
Building 159B WITH EQUIPMENT FOR MEASUREMENTS OF RADIOACTIVITY OF MATERIALS FOR CONFIRMATION OF THE LEVELS BELOW THE CONTROLLED LEVELS
Measuring of radioactivity and waste sorting
Operational waste
1-st group (Class A) (> 0,6 µSv/h)
Compressed SRW Class A (0,2-0,6 µSv/h)
7 t. press
Non compressed SRW Class A (0,2-0,6 µSv/h)
Waste from dismantling and operation
Class 0 (0-0,2 µSv/h)
Waste from dismantling
>0,2 µSv/h
PROJECT B10 «FREE RELEASE MEASUREMENT FACILITY»
Waste radioactivity measurement
>0,2 µSv/h
Class 0 (0-0,2 µSv/h)
Waste characterization on place by using mobile characterization equipment
Build. 157, 157/1
Temporary storage of waste
Return of the containers to the loading of SRW places
Site for big size waste near rail road
Build.130/2 room 155
Class A operational waste sorting
Formation of 1/2 H ISO
Cumulative point
Buikling 150
70 t. Bail press
Bail formation
Note: Further handling of Class A rad. waste - see Fig.7
Checkpoints of transport
Export outside the monitored area.
EQUIPMENT DEPOT
Temporary storage of waste
Sale of waste
Transfer of non-radioactive waste to specialized waste management enterprises
Fig.1 Management of Conditionally non radioactive waste (CNRW) and Class 0 waste

Free release facility - Bld.159 B

Built and commissioned in 2005, funded by INPP

Output - 20 measurements per shift

missioning activities are co-financed

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.

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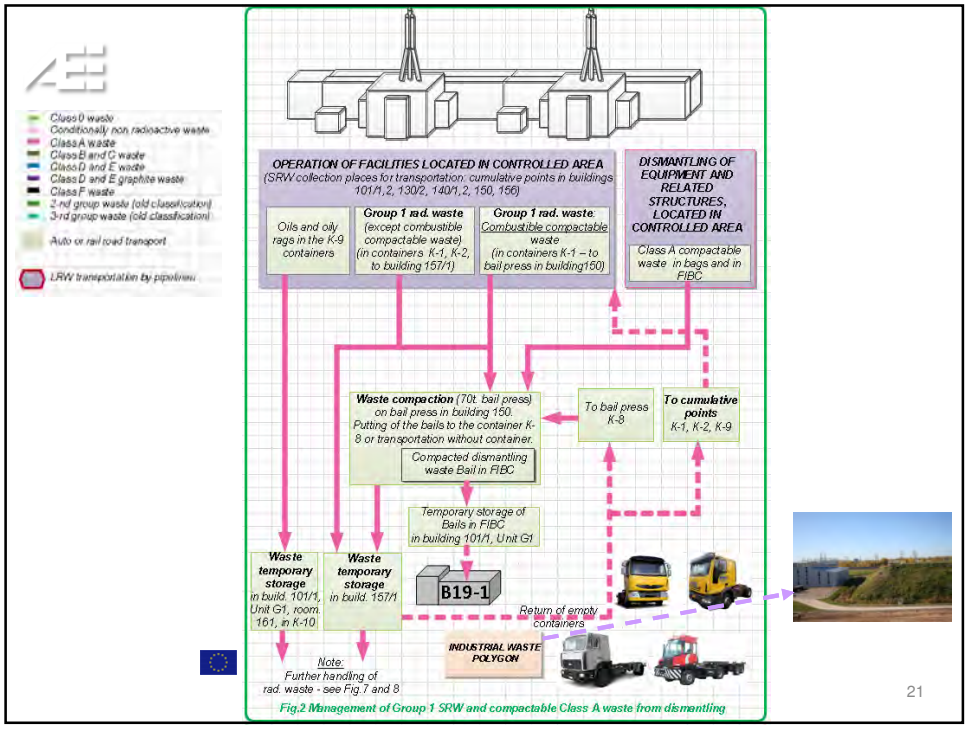

Operational waste Polygon (A class waste)

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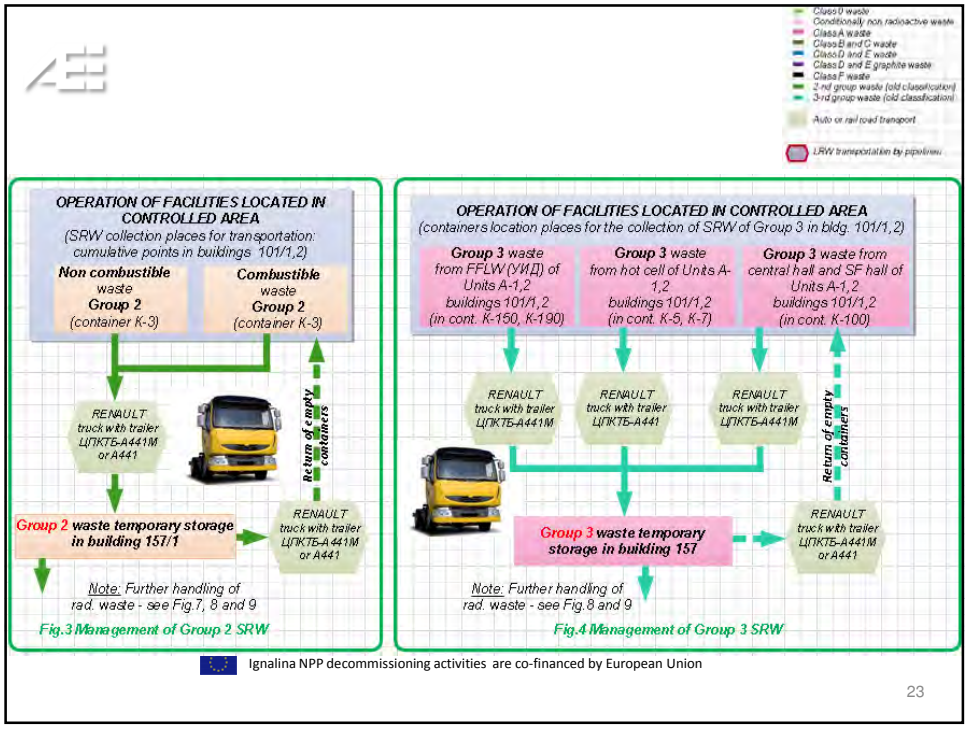
Class 0 waste
Conditionally non-radioactive waste
Class A waste
Class B and C waste
Class D and E waste
Class D and E graphite waste
Class F waste
2-nd group waste (old classification)
3-rd group waste (old classification)
Auto or rail road transport
LRW transportation by pipelines
OPERATION OF FACILITIES LOCATED IN CONTROLLED AREA
(SRW collection places for transportation: cumulative points in buildings 101/1,2)
Non combustible waste Group 2 (container K-3)
Combustible waste Group 2 (container K-3)
RENAULT truck with trailer ЦПКТБ-А441М or А441
Return of empty containers
Group 2 waste temporary storage in building 157/1
RENAULT truck with trailer ЦПКТБ-А441М or А441
Note: Further handling of rad. waste - see Fig.7, 8 and 9
Fig.3 Management of Group 2 SRW
OPERATION OF FACILITIES LOCATED IN CONTROLLED AREA
(containers location places for the collection of SRW of Group 3 in bldg. 101/1,2)
Group 3 waste from FFLW (УИД) of Units A-1,2 buildings 101/1,2 (in cont. K-150, K-190)
Group 3 waste from hot cell of Units A-1,2 buildings 101/1,2 (in cont. K-5, K-7)
Group 3 waste from central hall and SF hall of Units A-1,2 buildings 101/1,2 (in cont. K-100)
RENAULT truck with trailer ЦПКТБ-А441М
RENAULT truck with trailer ЦПКТБ-А441
RENAULT truck with trailer ЦПКТБ-А441М
Return of empty containers
Group 3 waste temporary storage in building 157
RENAULT truck with trailer ЦПКТБ-А441М or А441
Note: Further handling of rad. waste - see Fig.8 and 9
Fig.4 Management of Group 3 SRW
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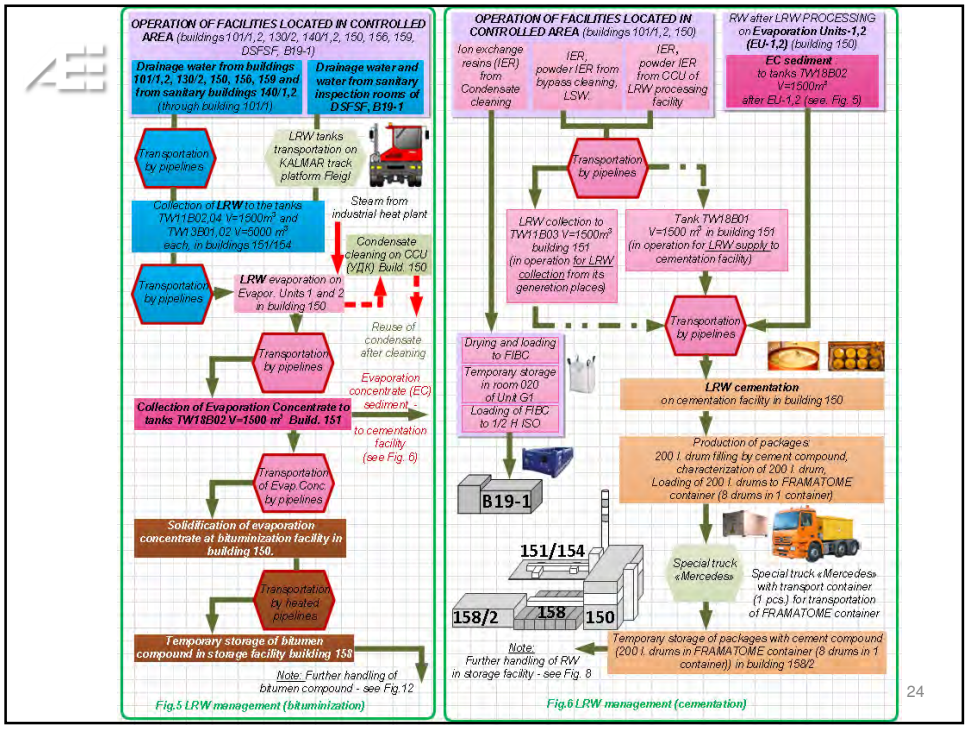
OPERATION OF FACILITIES LOCATED IN CONTROLLED AREA (buildings 101/1,2, 130/2, 140/1,2, 150, 156, 159, DSFSF, B19-1)
Drainage water from buildings 101/1,2, 130/2, 150, 156, 159 and from sanitary buildings 140/1,2 (through building 101/1)
Drainage water and water from sanitary inspection rooms of DSFSF, B19-1
Transportation by pipelines
LRW tanks transportation on KALMAR track platform Fleig!
Collection of LRW to the tanks TW11B02,04 V=1500m³ and TW13B01,02 V=5000 m³ each, in buildings 151/154
Steam from industrial heat plant
Condensate cleaning on CCU (УДК) Build. 150
Transportation by pipelines
LRW evaporation on Evapor. Units 1 and 2 in building 150
Reuse of condensate after cleaning
Transportation by pipelines
Evaporation concentrate (EC) sediment - to cementation facility (see Fig. 6)
Collection of Evaporation Concentrate to tanks TW18B02 V=1500 m³ Build. 151
Transportation of Evap.Conc. by pipelines
Solidification of evaporation concentrate at bituminization facility in building 150.
Transportation by heated pipelines
Temporary storage of bitumen compound in storage facility building 158
Note: Further handling of bitumen compound - see Fig.12
Fig.5 LRW management (bituminization)
OPERATION OF FACILITIES LOCATED IN CONTROLLED AREA (buildings 101/1,2, 150)
Ion exchange resins (IER) from Condensate cleaning
IER, powder IER from bypass cleaning, LSW.
IER, powder IER from CCU of LRW processing facility
RW after LRW PROCESSING on Evaporation Units-1,2 (EU-1,2) (building 150)
EC sediment to tanks TW18B02 V=1500m³ after EU-1,2 (see. Fig. 6)
Transportation by pipelines
LRW collection to TW11B03 V=1500m³ building 151 (in operation for LRW collection from its generation places)
Tank TW18B01 V=1500 m³ in building 151 (in operation for LRW supply to cementation facility)
Transportation by pipelines
Drying and loading to FIBC
Temporary storage in room 020 of Unit G1
Loading of FIBC to 1/2 H ISO
LRW cementation on cementation facility in building 150
Production of packages: 200 l. drum filling by cement compound, characterization of 200 l. drum, Loading of 200 l. drums to FRAMATOME container (8 drums in 1 container)
B19-1
151/154
158/2
158
150
Special truck «Mercedes»
Special truck «Mercedes» with transport container (1 pcs.) for transportation of FRAMATOME container
Temporary storage of packages with cement compound (200 l. drums in FRAMATOME container (8 drums in 1 container)) in building 158/2
Note: Further handling of RW in storage facility - see Fig. 8
Fig.6 LRW management (cementation)
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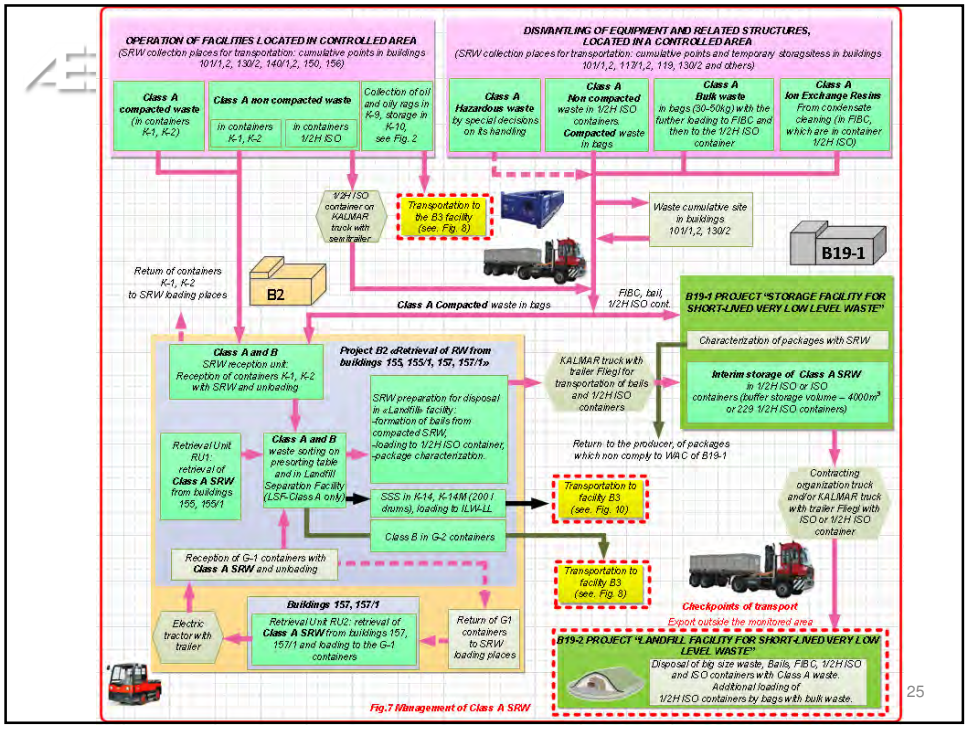

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Operational SRW retrieval facility B2 (1)

- 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, presort 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 m^3/h

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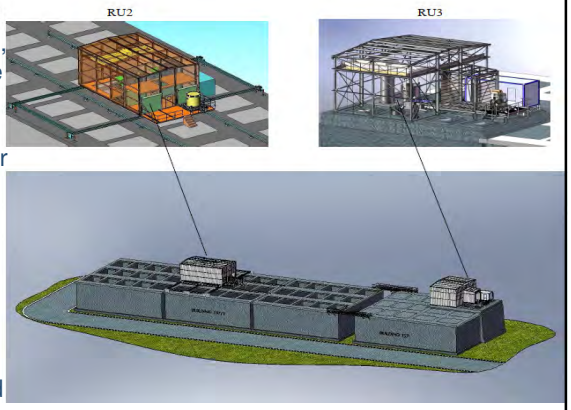
Operational SRW retrieval facility B2 (2)

- 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 will be prepared and agreed with VATESI.
- Planned start of operation - 2018.



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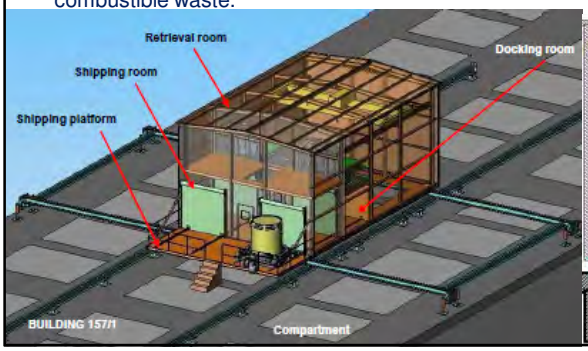
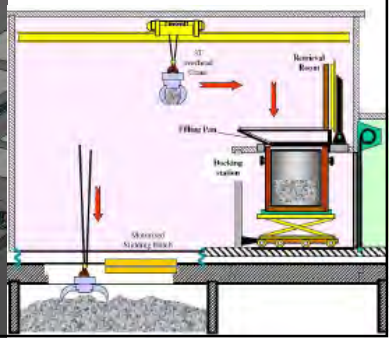
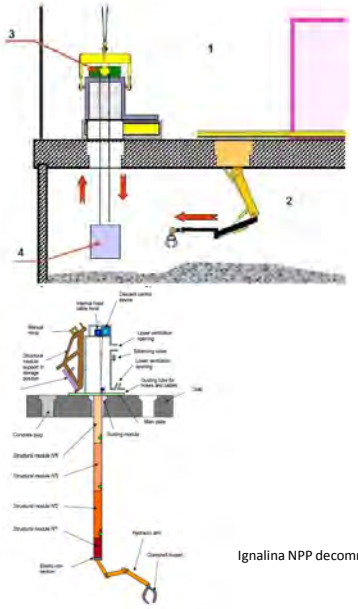
Operational SRW retrieval facility B2 (3)

- 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 m^3/day.

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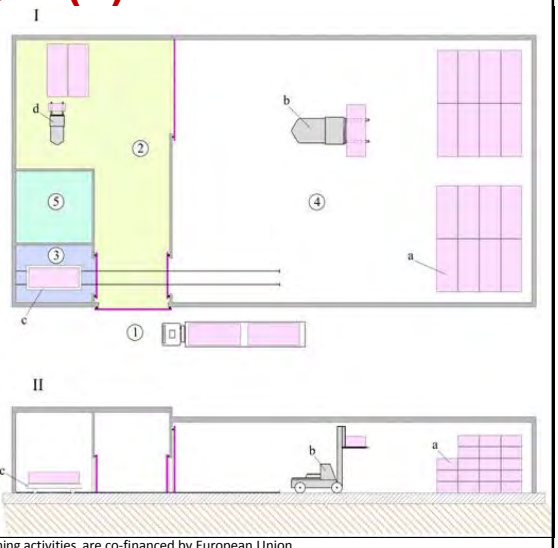
A class waste Buffer storage facility – B19-1 (1)

Buffer storage:

- Volume of 4000 м^3 (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



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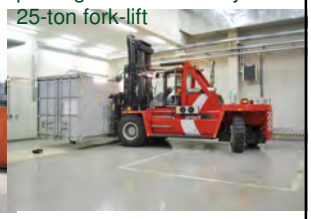
A class waste Buffer storage facility – B19-1 (2)

Transportation of packages is performed by the truck with a trailer

Within the buffer storage, packages are moved by the 25-ton fork-lift



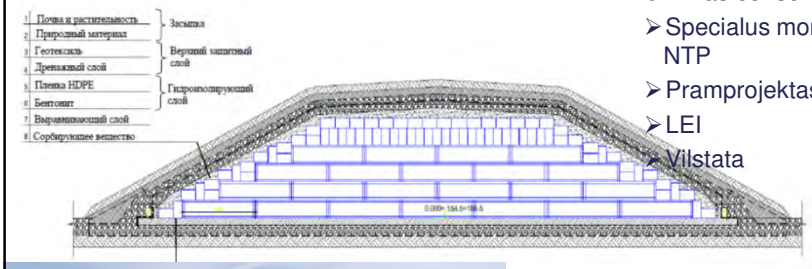
•Characterization unit for the measurements of activity of nuclides in the packages with the use of nuclide vector

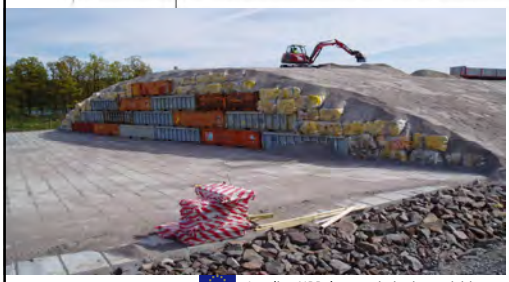
•Aimed at waste transportation into the measurements room and into the waste storage area, transport trolley is used, equipped with scales

A class waste disposal facility – B19-2

Contractor (2007) of B19-1 and B19-2 was consorcium of :

- Specialus montazas – NTP
- Pramprojektas
- LEI
- Vilstata





Conception of Landfill of Oskarshamn NPP, Sweden.

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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 1×1×1 m

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

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

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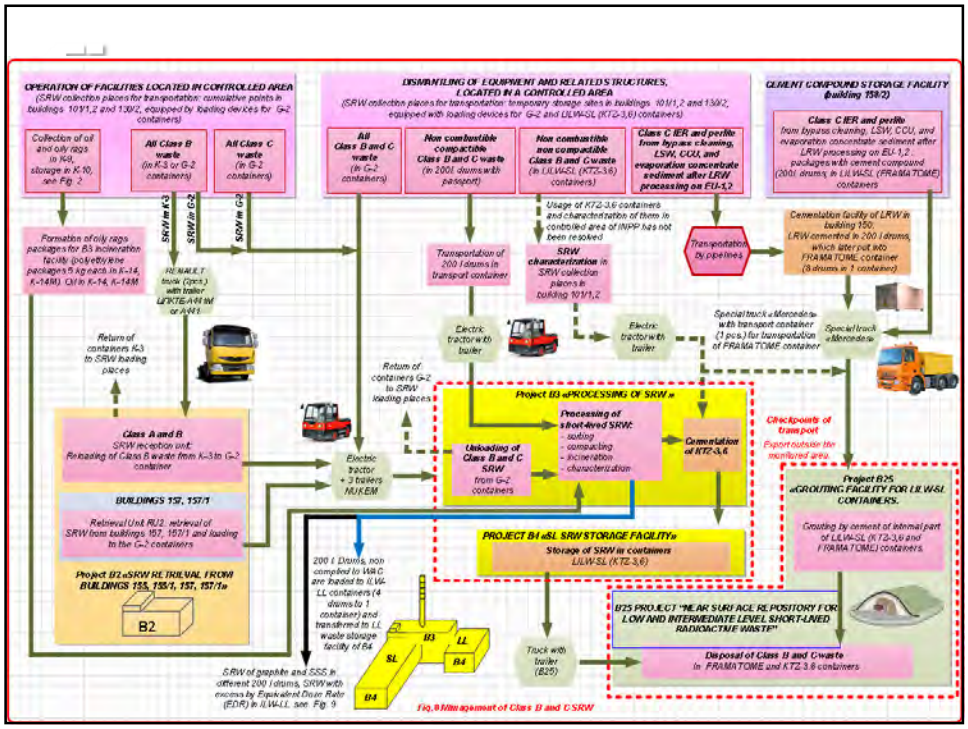

LRW (Class B+C) cementation and storage

- 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 filed 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.


Spent resins storage tank


Cement solidification facility


Cemented waste in drum


Storage container


Characterisation


Storage facility


Inside storage facility

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.

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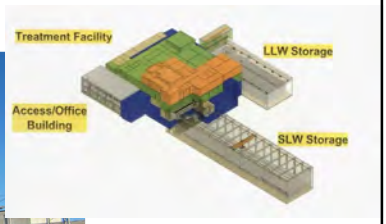
SRW treatment and storage facility – B3/4 (1)

- 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.

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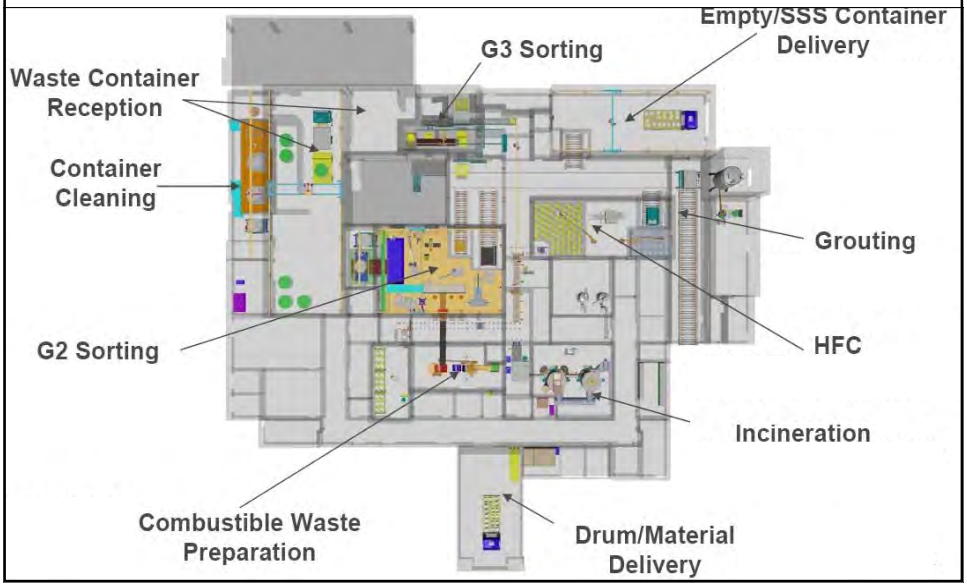
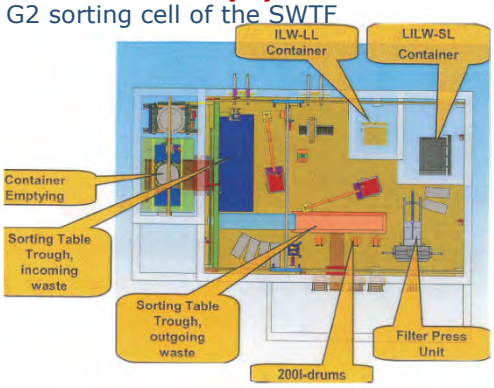
SRW treatment and storage facility – B3/4 (2)

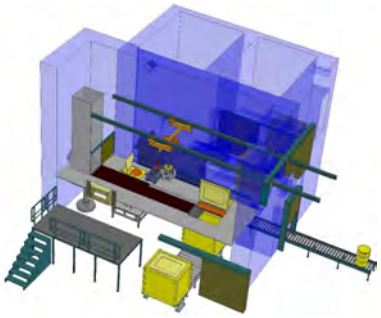


SRW treatment and storage facility – B3/4 (3)

G2 sorting cell of the SWTF



G3 sorting cell of the SWTF



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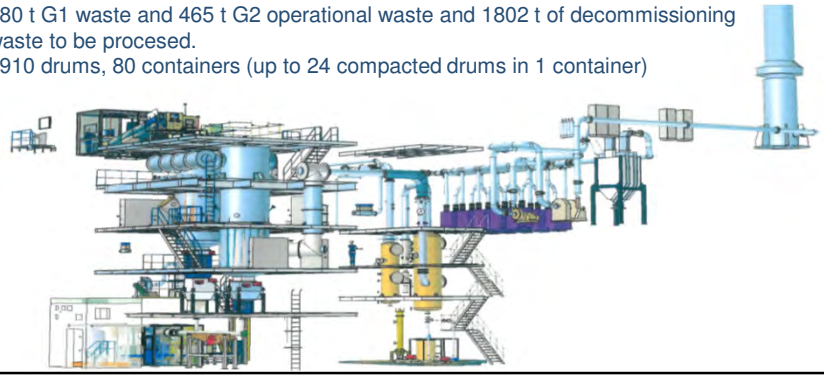
SRW treatment and storage facility – B3/4 (4)

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 100kg/h (approximately 2000kg/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 procesed.
1910 drums, 80 containers (up to 24 compacted drums in 1 container)



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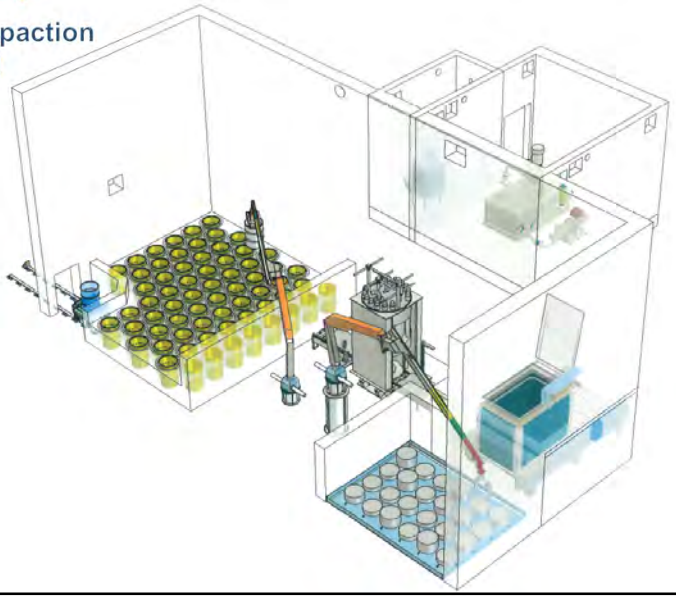
SRW treatment and storage facility – B3/4 (5)

High Force Compaction
15000 kN

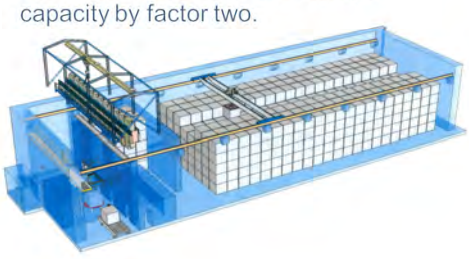


- Volume redaction ratio: from 4 to 7;
- Average processing rate: 32 drums/day.

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

LL Waste Storage

The LL storage facility is designed for the storage of 2000 m^3 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 m^3 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 m^3 can be provided.

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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 m^3 (internal 3.6 m^3)
- 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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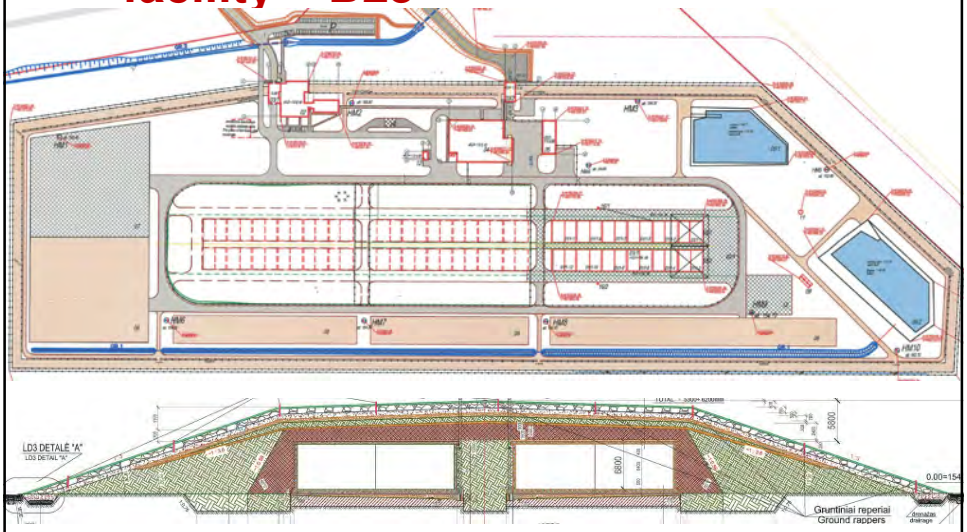
B and C class waste disposal facility – B25



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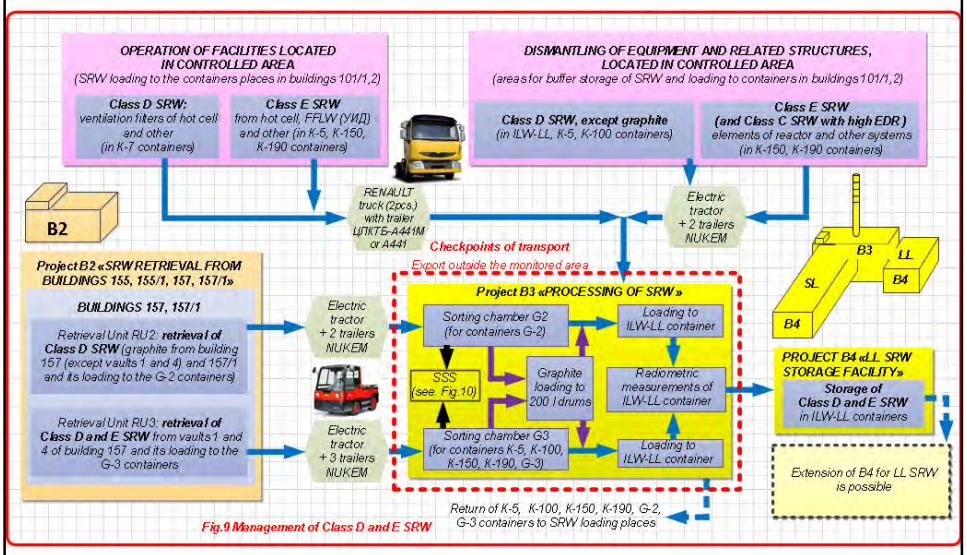

Fig.9 Management of Class D and E SRW

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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 m^3;
- Total weight: 8000 kg.

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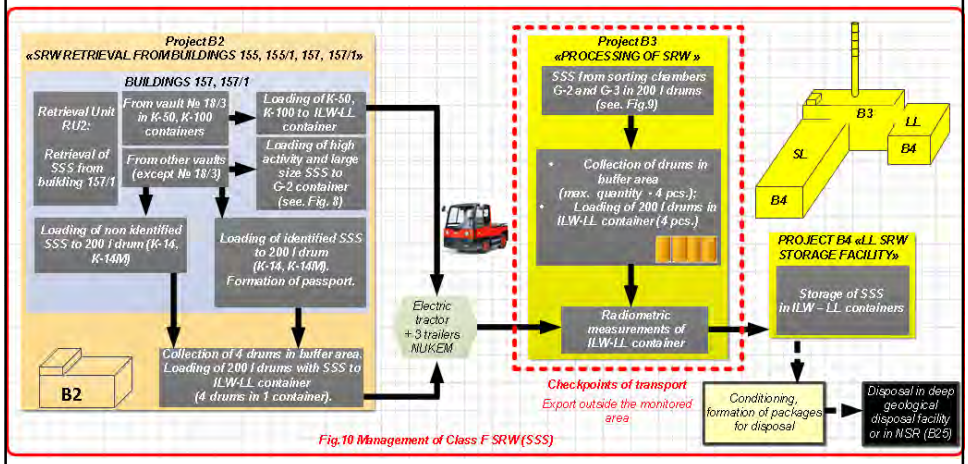

Fig.10 Management of Class F SRW (SSS)

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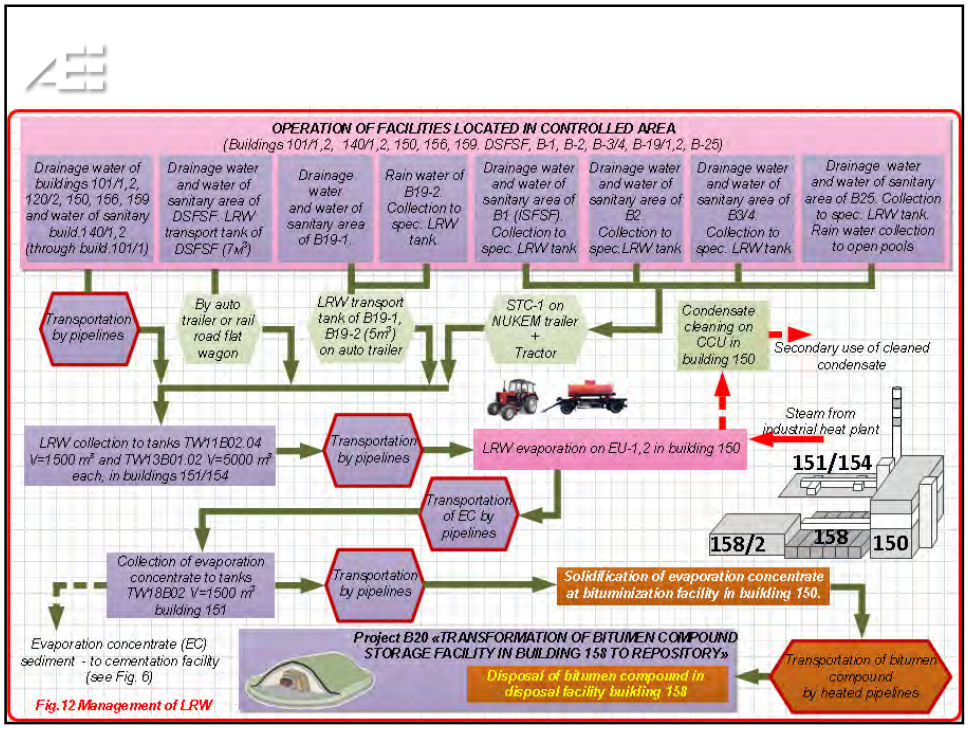
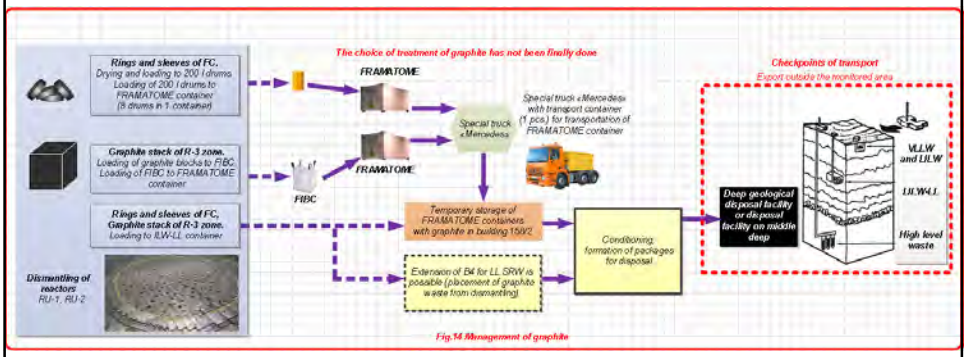


Fig.12 Management of LRW



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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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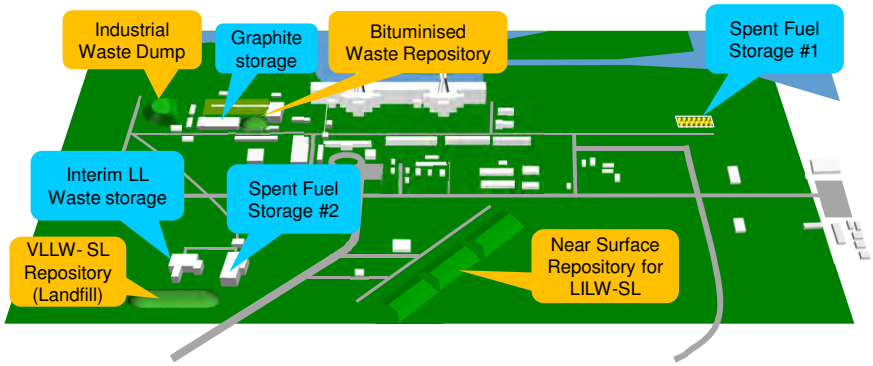
INPP is a “decommissioning island”

On completion of brown-field decommissioning (2038) the active residues of the entire plant will be disposed of, or in storage, on its own site.



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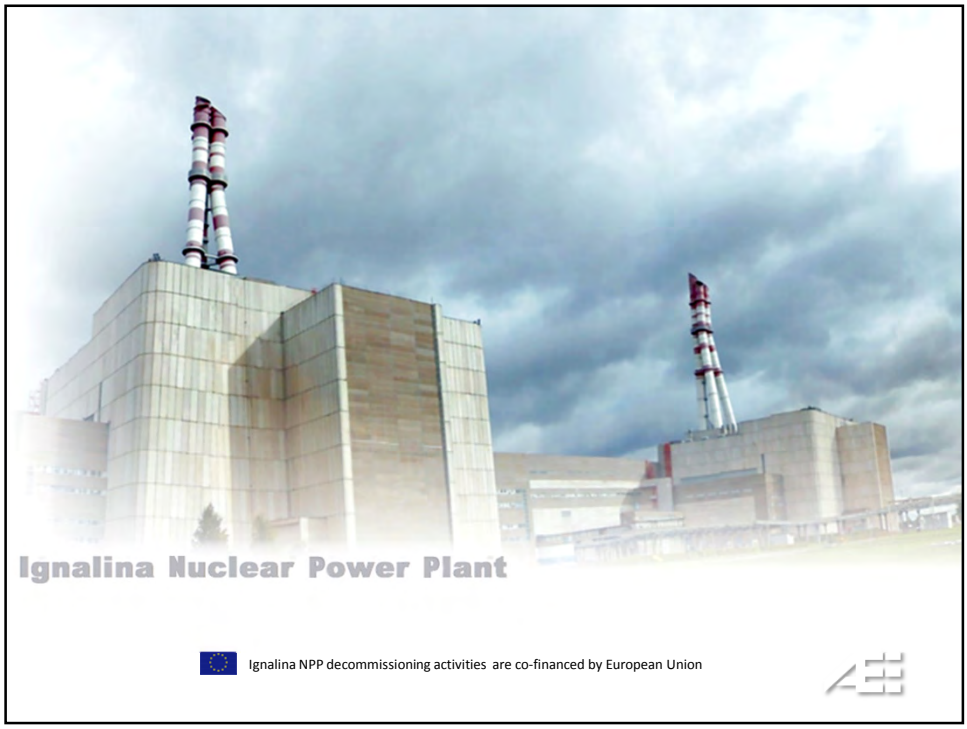

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