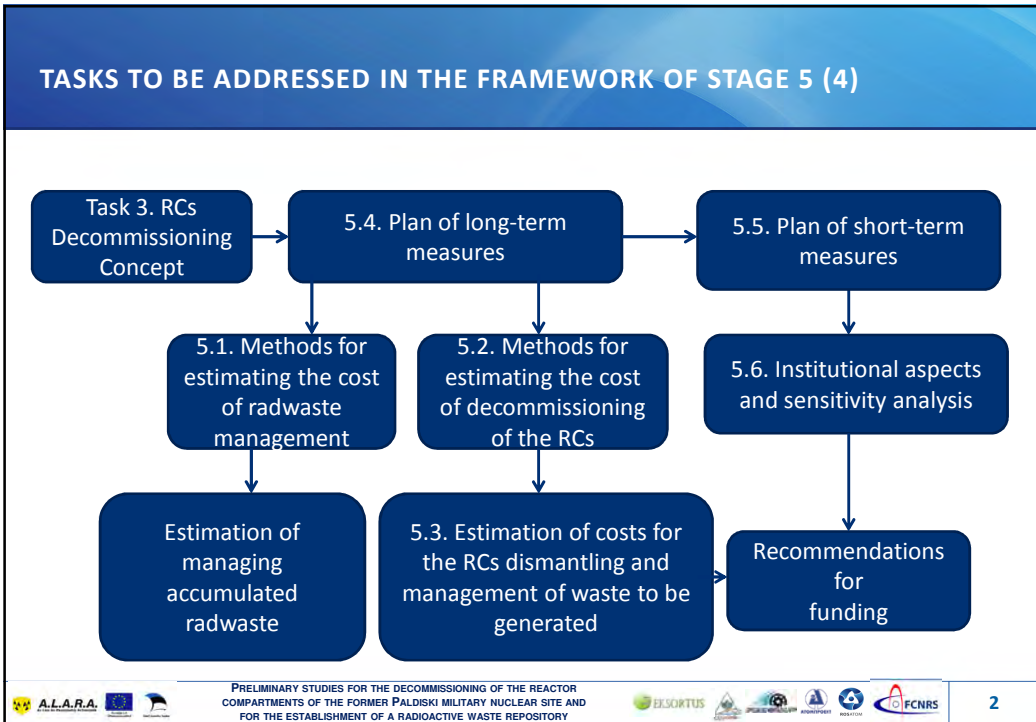


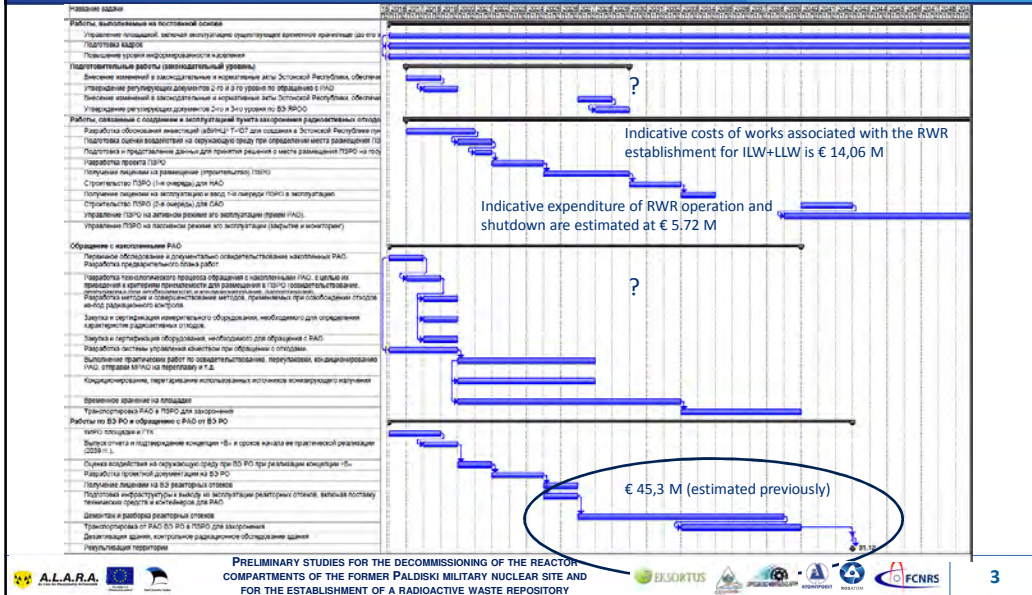
PROJECT
Preliminary studies for the decommissioning of the reactor compartments of the former Paldiski military nuclear site and for the establishment of a radioactive waste repository

TECHNICAL MEETING
TASK 5. COST OF WASTE MANAGEMENT, DECOMMISSIONING OF THE REACTOR COMPARTMENTS AND DISPOSAL

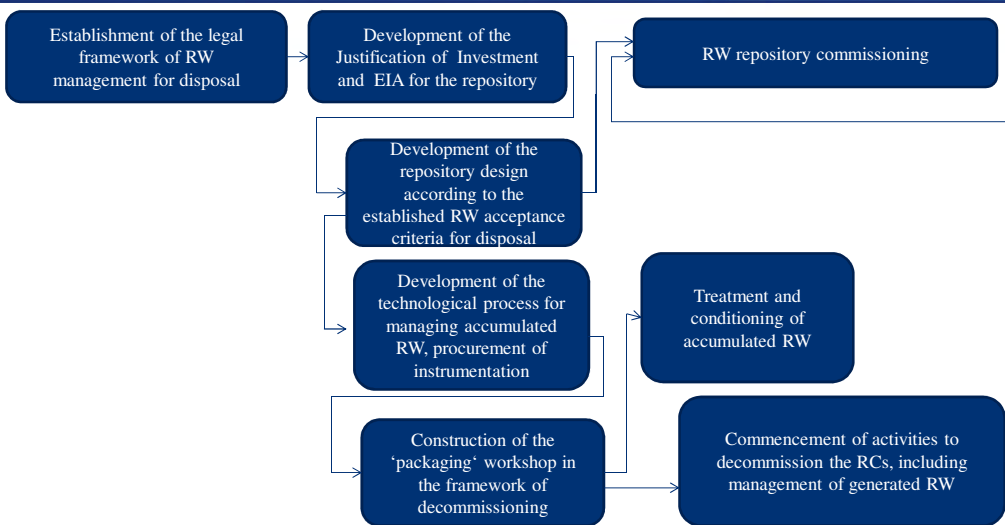
V.Y. Kitaeva
 Industrial and Technical Export Department
 JSC FCNRS
 Estonia, 7-9 December 2015

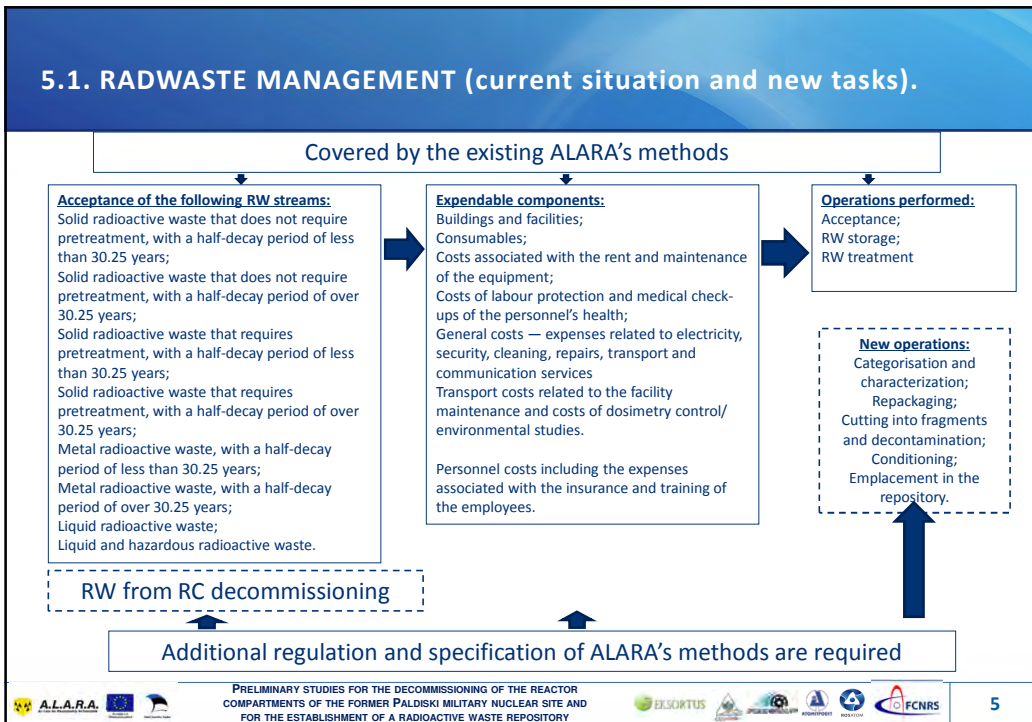


5.4. The recommended plan of long-term measures considers all stages of infrastructure preparation and implementation of the RCs decommissioning and RW management



5.4. Interconnection between the key events in the plan of long-term measures





5.1. Specification of ALARA's current methods.

Description	Used to be	Changes	Comments
Final disposal of radwaste	€2 900 / cub.m.	-	Excluded since these expenses will be distributed when breaking down the costs
Radwaste repository (RWR)	-	CAPEX + DEC Capacity: ≤ 3 000 m ³	Commissioning of new facility
TOTAL	€2 900 / cub.m.	9 082,5 Euro per m ³ for near-surface 12 450 Euro per m ³ for sub-surface	

Specific costs are higher as the Repository is a small-scale by the European standards < 3 000 m³ (Republic of Estonia) comparing to > 150 000 m³ (France, Spain, Russia).

PRELIMINARY STUDIES FOR THE DECOMMISSIONING OF THE REACTOR COMPARTMENTS OF THE FORMER PALDISKI MILITARY NUCLEAR SITE AND FOR THE ESTABLISHMENT OF A RADIOACTIVE WASTE REPOSITORY

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5.1. Specification of ALARA's current methods.

Description	Used to be	Changes	Comments
Labour costs associated with the management of radioactive waste	€1 369.04 to €5 476.17 Per m ³	<u>OPEX + DEC</u> Annual production rate	These will include labour costs of the packaging workshop
TOTAL	4 106,96 Per m ³	3 700,00 Per m ³	

Specific costs reduced, because the efficiency of the packaging shop is higher if to compare with the current section.



PRELIMINARY STUDIES FOR THE DECOMMISSIONING OF THE REACTOR
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5.2. HIGH LEVEL LIST OF THE RCs DECOMMISSIONING WORKS UNDER CONCEPT B WAS ESTABLISHED IN THE COURSE OF STAGE 3 IMPLEMENTATION

Ref No.	Description
1	Preparation for dismantling activities (arrange sanitary and access control, install active ventilation, manufacture a shielding shelter etc.)
2	Construction and equipment of a 'packaging workshop'
3	Dismantling of the RCs and reactor equipment using remotely controlled dismantling equipment
4	Cutting reactor equipment into small fragments in the 'packaging workshop'
5	Decontamination of radioactively contaminated equipment and structures, radwaste loading/ packaging into shielded containers
6	Transportation of shielded containers with RW to the repository
7	Disassembly of the building structures of the sarcophagi and MTB on the Paldiski site



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Methods for building up a supplement to the basic pay to cover material costs, operation of machine and equipment (M&E), overheads and estimated profit (Kper)

In order to estimate the supplement to the basic pay, process chains (PCs) have been analysed at the following companies: Novovoronezh NPP, Belyarsk NPP, NIIAR, DNR Centre, VNIINM, NITI as well as commercial contracts for services.

An example of estimating a supplement for cutting of the reactor equipment

TOTAL, EURO		11 396.60	Calculation of supplement to pay
Pay (salaries and wages)		3 053.33	Supplement to pay = (Mat. costs + operation of M&E+ Overhead costs + Estimated profit) / Pay (salaries and wages)
Material costs and operation of M&E		3 427.42	
Overhead costs	101%	3 083.86	Supplement to the basic pay for cutting of the reactor equipment will make 273.3%
Estimated profit	60%	1 832.00	

Source: Novovoronezh NPP

The calculation of prices, taking into account Kper and Kpaд, stealing by the following formula:

Methods for assessing cost rise for radiation (Krad)

Depending on the degree of potential radiological impact on the personnel, all controlled access areas are split into three categories / zones based on average annual permissible and reference values of the ambient dose equivalent rate at NPPs:

Contamination of work surfaces	Category III		Category II	
	Reference level	Permissible level	Reference level	Permissible level
α - particles/cm ² ×min	5	20	50	200
β - particles/cm ² ×min	100	2 000	2 000	10 000

Dose rate in Category I premises is not limited.

Assessment of cost rise for the category of premises	Free access area	Category III	Categories I,II
Number of working hours per day	8	8	4
Number of working days per year	261	213	213
Number of working hours per year	2088	1700	850
Krad. (Coefficient for annual dose limits)	0.81	1.00	2.00

The share of salaries and wages in the estimate has been calculated for the purposes of application to the consolidated cost index. This share has been afterwards adjusted for the access area.

Methods for assessing cost rise for radiation (Krad)

The following Krad is to be applied in case of gamma radiation

	Work categories				
	I	II	III	IV	V
γ dose rate (μSv/hr)	<12	12-120	120-1 000	1 000-10 000	>10 000
Krad value	1.15	1.2	1.25	1.5	2

5.2. Methods for estimating the cost of decommissioning of the RCs

$$\text{Cost of decommissioning} = \Sigma (\text{S\&W} \cdot (\text{Krad} + \text{Social tax rate} \cdot (\text{Krad} - 1)) + \text{S\&W} \cdot \text{Kper})$$

S&W= salaries and wages (pay) Cost rise for radiation Remuneration of labour+ expenses

Description	Preparation for dismantling operations. Establishment of the packaging workshop.	Dismantling of the reactors in Stands 346B and 346A.	Cutting reactor equipment into small fragments in the 'packaging workshop'.	Equipment decontamination	Demolition of the sarcophagi
Manhours	125 752,0	43 020,0	91 760,0	22 570,0	12 640,0
Average rate, Euro/hr. excl. taxes and insurance	8,46 – 8,56	8,4	8,4	7,8	8,85
Krad	нет	29,1	60,8	10,6	нет
Kper	277 – 313 %	338%	412%	402%	250%
Total, Euro, k	4 275,7	1 667,1	4 316,3	964,2	375,6

5.3. Indicative cost of decommissioning the RCs and RW management, thousand EURO

Permissive activities		Dismantling and disassembly of the RCs	
CERS, design, license	3 560,9	Breaking of concrete and dismantling of the reactors	1 667,1
Infrastructure preparation		Cutting the reactor equipment into small fragments in the 'packaging workshop'	4 316,3
Works	1 724,3	Decontamination of equipment and facilities,	964,2
'Packaging' workshop	2 551,4	Radwaste transport and final disposal	1 342,8
Equipment procurement	3 285,5	Demolition of the sarcophagi building structures	375,6
Containers for RW	18 130,0		

The costs of decommissioning the reactor compartments + costs of managing generated RW during RCs dismantling equal **37.9 million EURO** (2015), final disposal of RW – from 1.1 million EURO

TOTAL: 39.0 million EURO

5.3. Indicative cost of decommissioning the RCs and RW management, thousand EURO

TOTAL	67 012,8
Activities carried out on a permanent basis	Not estimated
Preparatory activities (legislative level)	Not estimated
Activities associated with the establishment and operation of a radioactive waste repository	14 570,4
Management of accumulated radwaste	7 055,1
RCs decommissioning and managing of RW (as a result of RCs decommissioning)	37 918,2
RW Disposal (accumulated RW and generated RW during decommissioning)	7 469,12



5.3. Major uncertainties

Timelines	Scope of work	Cost
Key factor: Taking decision with regard to the RW repository (RWR) including identification of waste acceptance criteria	RWR type, RWR siting/location, remoteness from the Paldiski site	€14 million indicative cost

- Longer duration of interim storage
- Refusal from the commencement of decommissioning the RCs
- Boundary conditions: a possibility to extend the service life of the MTB, sarcophagi, interim storage facility and containers for radwaste.
- Negative scenario: MTB demolition and construction of a new shelter over it.

5.3. Comparison of costs against various implementation options

Names of scenarios	Duration of implementation	Total cost, €, million (measured in 2015)	Total cost, €, million (measured for corresponding year)
Baseline	2016-2050	67,0	90,0
Baseline pessimistic	2016-2050	73,1	-
Negative	2016-2100	117,0	-
Negative pessimistic	2040-2100	-	146,2

5.4. Plan of short-term measures

1.	Preliminary work (legislative level)	
1.1.	Alteration of legislative and regulatory acts of the Republic of Estonia to ensure both ecologically and economically feasible approaches to safe radwaste management	2017-2018
1.2.	Approval of level 2 and 3 regulatory documents on radwaste management	2018-2019
1.3.	Alteration of legislative and regulatory acts of the Republic of Estonia to ensure both ecologically and economically feasible approaches to safe RC decommissioning	2027-2028
1.4.	Approval of level 2 and 3 regulatory documents on nuclear facilities decommissioning	2028-2029
2.	Works associated with the radioactive waste repository (RWR) establishment and operation	
2.1.	Development of the Justification of Investment (OBIN) for the radioactive waste repository establishment in the Republic of Estonia.	2017-2020
2.2.	Development of the Environmental Impact Assessment during the repository siting, public hearings	2019-2021
2.3.	Preparation and submission of data for the decision making on the repository location at government level	2021
2.4.	RWR design, including development of acceptability criteria	2022-2024
2.5.	Obtaining the construction license for the RWR	2025-2029
2.6.	RWR construction (stage 1) for LLW	2030-2032
2.7.	Obtaining the construction license and commissioning of RWR Stage 1.	2033-2034
2.8.	RWR construction (stage 2) for ILW	2040-2042

Critical path

Establish legal and regulatory framework

Take decision on the RWR siting

Develop acceptability criteria

Build the 'packaging' workshop

Build RWR Stage 1

5.6. Institutional aspects and sensitivity analysis

Areas considered and

- Responsibility for funding the activities
- Staff reserves and scientific basis
- Development of technologies associated with RW management
- Study of potential technologies with regard to RW management in the Republic of Estonia
- Technical needs for infrastructure development
- Changes in the cost of programme due to inflation and other macroeconomic parameters

Conclusions:

- there are no prerequisites for sharp shift (changes) in RW volumes generated in the Republic of Estonia (except NPP construction) or emergence of technologies capable of amending the plans and work programme considered;
- the key factor that influences the plans considered (except taking decision on the RWR siting) is inflation processes and possibilities of the budget of the Republic of Estonia with regard to funding the activities.

Institutional Establishment of funds for funding RW management activities and decommissioning of the RCs

- A prerequisite for establishing funds for commercial users of nuclear power is the need in funding of future expenses, when income from the nuclear facility might have stopped;
- The specific circumstances in the Republic of Estonia are an extremely low volume of commercially generated RW (less than 5%) compared to the accumulated volumes and RW to be generated as a result of decommissioning the RCs;
- In this case the prerequisite for establishing funds is an inequality of expenditure that will arise in the course of time;
- Long timeframes of programme implementation will lead to increase in the cost of activities due to inflation;
- A fund accrued with budgetary contributions, funds from international organisations, contributions from commercial RW producers, is deemed a feasible solution.

Model of the fund and annual payments

Methods for establishing the amount of contributions:

- Based on the average indicator of the cost of programme measures (on the whole or for a certain period);
- Based on the estimation of cost of liabilities of RW management and decommissioning, as a single or stage-by stage contribution.

Fund balance

Income	Expenditure
Balance of funds at the beginning of the period:	
Revenues in the form of earmarked contributions	Funding of measures in compliance with annual programme
Interest gained	
Balance of funds at the end of the period:	

The amount of contributions is subject to adjustments as the measures in the programmes are implemented



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Thank you!

phone: +7 (495) 780 74 83
e-mail: info@fcnrs.ru

Joint Stock Company Federal Center for Nuclear and Radiation Safety
www.fcnrs.ru