



## 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

### STAGE 4. COST OF WASTE MANAGEMENT, DECOMMISSIONING OF THE REACTOR COMPARTMENTS AND DISPOSAL

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## OBJECTIVES OF STAGE 4. COST OF WASTE MANAGEMENT, DECOMMISSIONING OF THE REACTOR COMPARTMENTS AND DISPOSAL

- **DEVELOPMENT OF METHODS FOR ESTIMATING THE COST OF RADIOACTIVE WASTE MANAGEMENT**
- **DEVELOPMENT OF METHODS FOR ESTIMATING THE COST OF DECOMMISSIONING THE REACTOR COMPARTMENTS**
- **ESTIMATED COST OF DECOMMISSIONING THE REACTOR COMPARTMENTS**
- **PLAN OF LONG-TERM MEASURES AND THE RELATED COSTS IN WASTE DISPOSAL**
- **PLAN OF SHORT-TERM MEASURES AND THE RELATED COSTS IN WASTE DISPOSAL**
- **INSTITUTIONAL ASPECTS AND SENSITIVITY ANALYSIS**

## SUBSTAGE 4.1. DEVELOPMENT OF METHODS FOR ESTIMATING THE COST OF RADIOACTIVE WASTE MANAGEMENT

- **Methods for estimating the cost of radioactive waste management**
- **Possible mechanisms of financing works on radioactive waste management**
  - Fundamental economic parameters
  - Review of international practices in terms of financing works
  - Possible variants of financing works in the Republic of Estonia
- **Parameters influencing the cost of radioactive waste management**
  - Inflation
  - Used currency
  - Date when waste begin to arrive for disposal
  - Difficulties of accumulated waste management
  - Unexpected expenditures and risks
  - Financial examination

## SUBSTAGE 4.1 METHODS FOR ESTIMATING THE COST OF RADIOACTIVE WASTE MANAGEMENT

- **The Procedure considers the cost of radioactive management only in respect of radioactive waste stored at Paldiski site, generated as a result of enterprise activities, and received annually for storage by A.S. ALARA**
- **The costs of radioactive waste management generated as a result of reactor compartments decommissioning is described in methods for estimating the cost of decommissioning the reactor compartments**
- **The transportation and disposal costs for packed radioactive waste are estimated solely based on contract prices, actual expenses and expert appraisals**
- **Methods for estimating the cost of radioactive waste management is based on enlarged cost estimation**
  - Assessment of costs of obligations on radioactive waste management generated during the year - cost of works on the RW preparation for disposal and RW disposal
  - Determination of changing the cost of radioactive waste management operations in the course of year
  - Estimation of obligations on radioactive waste management at the end of concerned year
  - Discounting procedure - determination current cost of works on RW management at the end of year

## SUBSTAGE 4.2 DEVELOPMENT OF METHODS FOR ESTIMATING THE COST OF DECOMMISSIONING THE REACTOR COMPARTMENTS

### •Methods for estimating the cost of decommissioning the reactor compartments

- Aggregate activity types for final disposal of reactor compartments
- Cost of preparatory works
- Cost of research works
- Cost of design works
- Cost of dismantling metal structures and concrete of reactor compartments
- Dismantling metal RW and sarcophagi
- Containerization of metal RW
- Cost of metal RW for disposal
- Cost of radwastes landfill for VLLW
- Cost of shafts for disposal of SRW (ILW and LILW)
- Cost of finish works

### •Methods of calculating changed cost of works on decommissioning in time span (2014-2040)

## SUBSTAGE 4.3 ESTIMATED COST OF DECOMMISSIONING THE REACTOR COMPARTMENTS . Indicative cost estimation for dismantling the reactor compartments

#	Position	Cost, thousand EURO	Item of report
1	Cost of preparation works	6380	3.1.1
2	Cost of reactor compartments dismantling	4060	3.1.2
3	Cost of cutting for reactor compartments equipment	810.7	3.1.3
4	Cost of sarcophagus dismantling	1435	3.1.4
5	Cost of final works at construction area	760	3.1.5
	<b>TOTAL</b>	<b>13445.7</b>	

**SUBSTAGE 4.3 ESTIMATED COST OF DECOMMISSIONING THE REACTOR COMPARTMENTS . Indicative cost estimation for treatment of generated radioactive waste (RC 346A/ 346B)**

#	Position	Cost, thousand EURO	Item of report
1	CERS	70/150	3.2.2.1/ 3.2.3.1
2	Unsealing of reactor compartment and extraction of RW	17/35	3.2.2.2/ 3.2.3.2
3	Incoming radiation monitoring and radwaste segregation	38/17	3.2.2.3/ 3.2.3.3
4	SRW fragmentation	2710/5700	3.2.2.4/ 3.2.3.4
5	RW fragments characterization	38/46	3.2.2.5/ 3.2.3.5
6	RW containerization	9968/8077	3.2.2.6/ 3.2.3.6
7	Packing certification	4/6	3.2.2.7/ 3.2.3.7
8	Cost of RW temporary storage at site	91/91	3.2.2.8/ 3.2.3.8
9	Cost of RW disposal	2466/3810	3.2.2.9/ 3.2.3.9
10	Cost of RW transportation from temporary storage area to radwaste landfill	123/190,5	3.2.2.10/ 3.2.3.10
11	Cost of containers packing	123/190,5	3.2.2.11/ 3.2.3.11
	<b>TOTAL</b>	<b>15648/18313</b>	3.2.2.12/ 3.2.3.12

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**SUBSTAGE 4.4 PLAN OF LONG-TERM MEASURES AND THE RELATED COSTS IN WASTE DISPOSAL**

**Long-term schedule of works for radioactive waste disposal**

No.	Aggregate activity types	Time period
1	The implementation of a set of RW measurements in Paldiski storage with a view to their characterization	2018-2022
2	Taking inventory of RW in the storage	2021-2022
3	Environmental Impact Assessment	2017-2027
4	Construction of RWL (radwaste landfill) for LLW (low-level radwaste) and VLLW (very low-level waste)	2038-2039
5	Construction of RWL for ILW (medium-active waste), ILW+LLWLLW	2039
6	Handling with RW when reactor blocks dismantling	2040-2050
7	Ecological monitoring of RWL for LLW and VLLW and RWL for ILW, ILW+LLW after RW disposal and closure of the disposal facilities	2050-2100

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## SUBSTAGE 4.4 PLAN OF LONG-TERM MEASURES AND THE RELATED COSTS IN WASTE DISPOSAL. Technological and economic aspects of management of radioactive wastes landfill (RWL)

### •Regular expenses

- watching charges
- physical examination personnel
- insurance and training

### •Overhead costs

- expenditures for electricity
- protective clothing
- protective equipment
- safety
- equipment rentals
- building renovation costs
- communications services
- metering control
- administration expenses
- maintenance
- technical supervision over the equipment



## SUBSTAGE 4.4 PLAN OF LONG-TERM MEASURES AND THE RELATED COSTS IN WASTE DISPOSAL. Technological and economic aspects of management of radioactive wastes landfill (RWL)

Indicative volume of radioactive waste generated during decommissioning reactor compartments is 1403 m<sup>3</sup> (according to the information at the Report Stage 2 )

No.	Operating expenses	Annual costs, thous. EURO	Expenses for the whole period (2.5 years), thous. EURO
1	Personnel expense (salaries and wages):		
	- SRW	1804.9	4512.4
	- metal	732.8	1831.9
	- management	100.0	249.9
2	Expenses associated with the employment of equipment:		
	- SRW	49.2	123.5
	- metal	70.7	176.8
	- management	37.0	92.5
3	Regular expenses	80.2	200.6
4	Overheads	36.6	96.5
<b>TOTAL:</b>		<b>2912.1</b>	<b>7287.8</b>

### SUBSTAGE 4.4 PLAN OF LONG-TERM MEASURES AND THE RELATED COSTS IN WASTE DISPOSAL. Technical and economic needs of RWL management after closing

#### The annual costs for execution of works after the closure of RWL

Type of expenditures	Annual receipts from the budget, euro
Metering control and environmental research	12480
Protective clothing	1750
Communications services	1840
Transportation expenses	6590
Maintenance of equipment	1600
Insurance	390
Training	1090
<b>TOTAL:</b>	<b>25740</b>

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### SUBSTAGE 4.5 PLAN OF SHORT-TERM MEASURES AND THE RELATED COSTS IN WASTE DISPOSAL Schedule of works for RWL creation

No	Stage name	Beginning	Ending	Expenses, thous. EURO
1	"Concepts of creation of permanent RW disposal post of low and average activity in the territory of the Republic of Estonia" was developed	01.01.2017	30.12.2018	860
2	Drawing up schemes of the master RWL lay-out	01.01.2019	31.12.2019	250
3	Search for potential sites (at least 3), suitable for RWL construction	01.01.2024	31.12.2025	800
4	Carrying out of set of studies and researches for final decision of RWL disposal	01.01.2026	31.12.2029	2400
5	RWL impact assessment on the population and the environment (EIA)	01.01.2030	31.12.2030	340
6	Carrying out a detailed discussion of the socio-economic aspects of the project with residents of nearby settlements	01.01.2031	31.12.2032	150
7	Carrying out the design works with the passing through the relevant expert investigations and obtaining a construction license	01.01.2033	31.12.2033	560
8	Civil and erection work execution	01.01.2034	31.12.2037	7500
9	Obtaining a license to RWL operate	01.01.2038	31.12.2038	100
10	RWL commissioning	01.01.2039	31.12.2039	400
11	Organization of environmental monitoring in the surrounding territory	01.01.2039	01.12.2039	700
<b>Total:</b>		<b>14,060 thousand EURO</b>		

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## SUBSTAGE 4.5 PLAN OF SHORT-TERM MEASURES AND THE RELATED COSTS IN WASTE DISPOSAL.

### RWL creation and operation, taking into account the uncertainties

#### Key negative factors of uncertainty affecting the execution of works when RWL creating

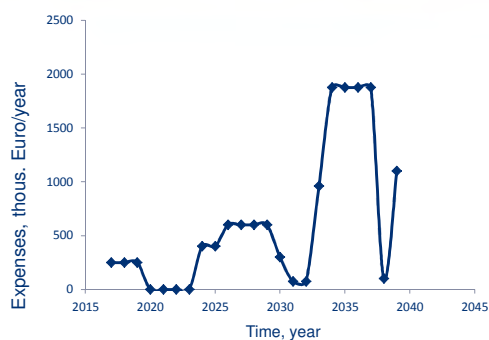
- The absence of the necessary legislative framework for dealing with RW in the Republic of Estonia
- The lack of financial resources for the implementation of planned activities due to bankruptcy of the financing sources or the development of the world crisis phenomena
- The deterioration of the socio-economic environment for the adoption of a final decision concerning RWL placements in the Republic of Estonia, including the refusal of residents of the nearest inhabited localities
- Negative search result of the potential sites suitable for RWL construction on the territory of the Republic of Estonia

#### Key negative factors of uncertainty affecting the execution of works during RWL operation

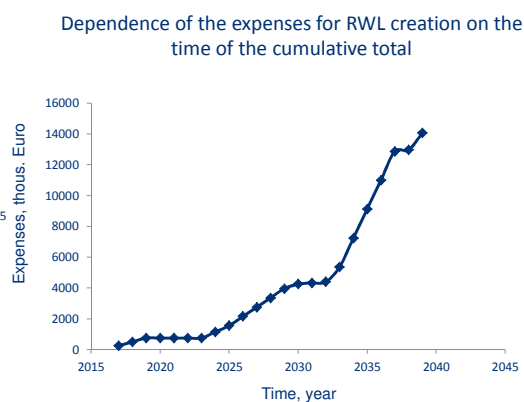
- Modification of RW planned volume
- Insufficient free volume of RWL for entering RW into it
- Change in long-term and short-term disposal rates, other than rates, the meanings of which are planned by National operator
- The tightening of acceptance criteria for RW packaging and RWL engineering protective barriers

## SUBSTAGE 4.5 PLAN OF SHORT-TERM MEASURES AND THE RELATED COSTS IN WASTE DISPOSAL

### Dependence of the annual costs for RWL timely establishment



Dependence of the annual expenses for RWL creation on the time



Dependence of the expenses for RWL creation on the time of the cumulative total



## SUBSTAGE 4.6 INSTITUTIONAL ASPECTS AND SENSITIVITY ANALYSIS

### •Analysis of the situation in the field of technology in the Republic of Estonia

- Personnel reserves and scientific base
- Technology

### •Analysis of possible technologies applied to RW in the Republic of Estonia

### •Technical needs for the infrastructure development

The main sources of radioactive waste formation in the Republic of Estonia are medical, industrial and research institutions.

Possible technologies for processing/disposal of the formed waste to the application were offered as a result of the analysis of the situation in Estonia in the direction of scientific and technical capacity in the field of RW handling and in accordance with the National program for RW handling



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