Strategic Approaches and Challenges when Developing the Comprehensive Program of the Nuclear Facilities Decommissioning in the Russian Federation

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### Types of NRHF to be decommissioned

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMB</td>
<td>2</td>
</tr>
<tr>
<td>VVER</td>
<td>15</td>
</tr>
<tr>
<td>EGP</td>
<td>4</td>
</tr>
<tr>
<td>RBMK</td>
<td>11</td>
</tr>
<tr>
<td>RR</td>
<td>50</td>
</tr>
<tr>
<td>RW storage facilities</td>
<td>40</td>
</tr>
<tr>
<td>SNF storage facilities</td>
<td>39</td>
</tr>
<tr>
<td>Testing areas</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Storage facilities</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Mining facilities</td>
<td>3</td>
</tr>
<tr>
<td>Metal industry</td>
<td>2</td>
</tr>
<tr>
<td>Radiochemistry</td>
<td>4</td>
</tr>
<tr>
<td>PPR</td>
<td>13</td>
</tr>
<tr>
<td>Scientific facilities</td>
<td>7</td>
</tr>
</tbody>
</table>

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Prime Tool of the Decommissioning Strategy is Transfer from «Hands-on Control» to the «Long-term Strategy»

Where Are We Going?

What Are We Doing?
Taking prompt actions
Implementing the long-term plans

How much we are paying?
As much as available
As stipulated in the plan

What is the planning time-frame?
5 years
50 - 70 years

Safe condition of all NRGFs

Long-term strategy is a new model of financing and interaction with the Government, as well as a tool for high-tech market development
There are about 2000 nuclear radiation hazardous facilities in the Russian Federation.

Input data acquisition — data base creation (~2000 NRGFs)

Determination of high-priority facilities (~300 facilities)

Scaled-up assessment of risks and ranking

Work planning for facilities (proposals generation)

Practical activities

Breakdown by NRHF types
Prioritizing in Decommissioning of the Nuclear & Radiation Hazardous Facilities

**PHSI** – **Potential Hazard Specific Indicators** characterizing specific parts of nuclear facilities to be decommissioned and subject to ranking.

**PHCI** – **Potential Hazard Cumulative Indicator** calculated based on certain PHSIs. Provides nuclear facility comparative estimate regarding nuclear and radiation safety.

- Particular Radionuclides Total Activity
- RS & RW Physical and Chemical Characteristics
- Population Number or Density within N&R Facility Emergency Planning Zone
- N&R Facility Number of Employees

**RS & RW Quantitative Characteristics**

**RS & RW Processing, Storage and Transportation Conditions**

**Human Health Effects**

**Safety Provisions**

**PHGI**

- Liquid vs. Total RS & RW regarding specific radionuclides
- Safety Measures
- Safety Barriers Degradation
Facilities by Potential Hazard

Variation in facility hazard change versus completed decommissioning activities.
1. A purpose of the modeling is – to build up system of valuation of decommissioning costs and costs of waste management

2. A structure of the valuation model

Similar structure of a model

- Decommissioned objects
- Liabilities for Contaminated areas
- RW Management Costs
- SNF Management Costs

General approach to strategy of Radioactive Waste Management
Valuation model of Decommissioning Costs

Representation of Information

Valuation models
- liability for nuclear facilities (Reactor Module, uranium-graphite reactors, nuclear installation, nuclear icebreaker fleet)
- liability for storage facilities
- liability for industrial areas
- liability for contaminated areas

Summary file for Organization
- Current value
- Present value
- Sensitivity analysis
- Accrued liabilities schedules

Summary file for State Corporation “Rosatom”
- Current value
- Present value
- Sensitivity analysis
- Accrued liabilities schedules

Capability of data analysis
Valuation model of Decommissioning Costs

Difference between a new model from the previous one

Valuation Model till 2014

- Integrated calculation of costs
- Only one conception is used
- High-level classification of activities
- High-level rates of activities
- Lack of flexibility in selection of duration of decommissioning stages and technologies
- One conception of RW management for all objects

New Valuation Model

- Detailed calculation of costs
- Capability of conception selection
- Detailed classification system on the basis of singular activities
- Detailed rates of activities
- Selection of technologies and duration of stages
- Selection of conception of RW management according to the specifics of an object
Long-Term Program Based on Nuclear Radiation Hazardous Facilities Ranking

PHCI / $$ = priority

Decommissioning Project 1
Decommissioning Project 2
Decommissioning Project 3
Decommissioning Project 4
Decommissioning Project 5
Decommissioning Project 6
Decommissioning Project 7
Decommissioning Project 8
Decommissioning Project 9
Decommissioning Project 10
Decommissioning Project 11
Decommissioning Project 12
Decommissioning Project 13
Decommissioning Project 14
Decommissioning Project 15
Decommissioning Project 16
Decommissioning Project 17
Decommissioning Project 18
Decommissioning Project 19
Decommissioning Project 20
Decommissioning Project 21
Decommissioning Project 22
Decommissioning Project 23
Decommissioning Project 24
Decommissioning Project ...

* Federal Target Program for Provision of Nuclear and Radiation Safety

** conventional unit
Informational Support of the Decommissioning Activities

Comprehensive survey

Planning of decommissioning activities

Utility lines

Estimate of RW generation
Centers of Competence in Decommissioning

Objective: Cost-cutting, centralization of the decommissioning experience

- **2011** — PDC UGR (SGChE) – Graphite reactors decommissioning
  - 2015 — decommissioning completion of the first production uranium-graphite reactor (EI-2)

2012 - **Pilot Demonstration Engineering Center** (Novovoronezh NPP, ROSENERGOATOM):
  - Decommissioning activities at VVER with further duplication of the technologies

**2014** – start of decommissioning activities at nuclear power units 1 & 2 of Novovoronezh NPP
Progress in RW Management

Creation of the unified national system for RW management

Federal law «On radioactive waste management ...» was enacted in 2011.
Basic regulatory documents were accepted in 2011-2013.
National operator was determined in 2012.
An inventory of radioactive waste was made which fall into «nuclear legacy» in 2013-2014 («primary record-keeping of RW and determination of their location areas»).
Rates were prescribed for radioactive waste disposal (Decree of the RF Ministry of Natural Resources in 2013).
All operating companies developed strategies on RW management in 2013.
Payment for RW disposal started in 2014.

Activities on «nuclear legacy»

Work is proceeded on safety improvement of RW disposal facility, including facilities under federal special purpose program (FSUE «PA «Mayak»), FSUE «MCC»), JSC «SGChE»), tailing facility «Almaz», JSC «ChMZ»).
Work is proceeded on RW retrieval and treatment (FSUE «RosRAO», «Rosenergoatom»).
Work on remediation of the underground nuclear explosion facilities for civilian purposes.
Site Selection for short-lived ILW, LLRW & very LLRW disposal

1. North-West Federal District (Leningrad Region, Arkhangelsk Region)

2. Central FD, Povolzhskiy FD, Southern FD (Republic of Kalmykia, Moscow Region at FSUE «RADON» site)

3. Urals FD, Povolzhskiy FD, – a site was determined at FSUE PA «Mayak» (Chelyabinsk Region)

4. JSC «UEIP» - phase 1 is completed (Sverdlovsk Region.)

5. Siberain FD – a site was determined at the JSC «SGChE» (Tomsk Region)
Building up an underground research laboratory to study a potential for highly radioactive waste (HRW) and long-lived intermediate level waste (ILW) disposal

**Principal characteristics of the facility**

- Depth of the underground structures location is 450-525 m
- Amount of disposed RW (net):
  - Vitrified HRW of class 1 – 4500 m³ (7500 canisters),
  - ILW & HRW of class 2 – 155 000 m³
- Disposal of class 2 ILW & HRW in stock-piles in horizontal workings at depth of 450 m & 525 m
- Class 1 HRW are located in vertical wells up to 75 m deep (depth range of 450-525 m) and 1,3 m in diameter
- Estimated cost of the facility construction is 23 billion rubles (in ten-years rubles)

**Layout of the underground research laboratory, Nizhne-Kansk solid mass**

- 3 vertical well bores up to 525 m deep and about 5,5-7,0 m in diameter
- Above-ground infrastructure including building and constructions at nearwellbore areas
- Horizontal capital mine roadways at depths of 450 m & 525 m, total length of 5000 m
- Underground structures of the research laboratory:
  - 4 horizontal roadways with the total length of 600 m and cross-section of 40-60 m².
  - 4 vertical wells up to 75 m deep
Location of RW («nuclear legacy») storage facilities for on-site disposal

<table>
<thead>
<tr>
<th>Company</th>
<th>Number of RW storage facilities</th>
<th>Amount of RW, mln. m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDC UGR</td>
<td>14</td>
<td>0,031</td>
</tr>
<tr>
<td>MCC</td>
<td>24</td>
<td>0,253</td>
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<tr>
<td>NCCP</td>
<td>1</td>
<td>0,956</td>
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<tr>
<td>ChMZ</td>
<td>2</td>
<td>4,180</td>
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<tr>
<td>SGChE</td>
<td>11</td>
<td>4,256</td>
</tr>
<tr>
<td>Priargynsky M&amp;CW</td>
<td>2</td>
<td>53,160</td>
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<tr>
<td>Mayak</td>
<td>13</td>
<td>406,334</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td>67</td>
<td>469,170</td>
</tr>
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</table>
Results by 2030. Dismantling of Nuclear & Radiation Hazardous Facilities

Rate of decommissioning activities ensures safe demolition of nuclear legacy:
- Decommissioning of 82 NRHF, including 7 PUGR, 2 atomic icebreakers, 16 nuclear maintenance ships;
- Remediation of contaminated area (4 259 m²)

RW repositories decommissioning

Reactor graphite stack dismantlement

Protective shield building-up
Results by 2030
Radioactive Waste Management

Excess of RW disposal over RW generation:

- operational commissioning of 4 subsurface RW repositories and 1 undersurface RW repository;
- operational commissioning of 6 regional complexes for RW treatment;
- disposal of more than 30% of solid RW which are in the federal ownership;
- cessation of use of open near-surface reservoirs for liquid RW.
THANK YOU FOR YOUR ATTENTION!