Developing Remediation and Infrastructure Reconstruction for Former Uranium Production Facilities in Ukraine – 16692

Kulchytska Svitlana
Deputy Director
Department of Nuclear Energy and Atomic Industry

Voitsekhovych Oleg,
Consultant
Ukrainian Hydrometeorological Institute,
Department of Radiation Monitoring

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“Pridneprovsky Chemical Plant” in Dneprodzerzhinsk is legacy of U-production facilities in Ukraine where remediation program is under development.

The Authorized Governmental Body is Responsible for Funding and Supervision of UPLS:
- Ministry of Energy and Coal Industry of Ukraine
- Nuclear Energy and Atomic Industry Department
- Regulatory Body - SNRI
- State Nuclear Regulatory Inspectorate of Ukraine

The Operator of UPLS is State Enterprise “Barrier” which is licensee of SNRIU.

Uranium Production Legacy at Dneprodzerzhinsk (1947-1991)

- Dneprodzerzhinsk industrial site
- Sukhachevskoe Legacy Site

Contaminated legacy site, 2 RW storage facilities, 7 U-residue tailings, 28 – contaminated building and engineering facilities used for U-production in past, which required clean-up technology application.

Potential risks for workers at the industrial site and for Public at surrounding areas – seems to be high.

LTS M is still not defined

Clean-up and Remediation – required significant financial resources.
Hazards at the site: Current understanding

- Two most heavy contaminated Buildings used for U-extraction in past (103 and 104), that have to be decontaminated and dismantled.
- Sedimentation ponds (used for storage of contaminated by NORM residues).
- Former Furnaces, and hot spots with contaminated soils by U-residues.
- Several tailings (no bottom clay floor, covers are not sufficient).
- Other U-production facilities that can be decontaminated for potentially re-use.
- The area to be finally cleaned-up according remediation objective (aprx. 100 ha).
- Largest tailings Dneprovskoe (12 mln ton) is covered by phosphogypsum that can be potentially re-cycled.
- Amount of radioactive waste to be generated is still not clearly estimated.
- Groundwater contamination is significant factor to be monitored.
- Significant portion of toxic materials are mixed with soils and U-residues.

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Main outcomes of the State Programs to support preparedness for Remediation

- Site Operator – enterprise was established, being responsible for site specific monitoring programs and safety management at the site.
- Significant portion of the planned Site characterization and Inventory studies, Borehole drilling programs at all tailings and radiological survey and initial assessment at the sites were carried out.
- Monitoring network and analytical capabilities of the laboratory have been created
- Preliminary Safety Assessment, Database, Engineering & Designs.
- Overall Remediation Strategy is under development in cooperation with EC and IAEA
- First priority remediation actions were implemented such as:
  - dismantling of some the milling equipment, contaminated pipelines, decontamination; new protective covers at the tailings, collect remained ore materials, mitigate actions, new fences, decontamination workshop, other.....

The total cost already paid (2003-2013) by Ukrainian Government estimated near 25-30 million USD

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Gamma-dose rate spatial distribution at the PChP
25-30% of Southern sector has gamma dose rate ≥ 0.5 μSv/h
(Data UHMI)

1 - Zapadnoe tailings
2 - Settling ponds №220, №230
3 - Central Yar (tailings); 4- Former U-extraction facilities Buildings №103-104, 2B
5 - Former U-ore raw storage
6 - Zirconiy

 µSv/ h
Radioactive “Hot spots”

The “hot spots” at the PChP former U-production legacy were identified during 2012-2013

1. Former U-extraction facilities (gamma dose rates in range 1µSv/h – 1 mSv/h)
2. Areas surrounding of most contaminated buildings (up to 30 µSv/h)
3. U-Tailings and waste storage facilities (Ra-226 from 1 to 100 Bq/g)
4. Sedimentation ponds for storage of the industrial slugs (Ra-226, U-238), Heavy metals
5. Remained infrastructure
Specific features of the tailings at the site

“Dneprovskoe” tailings covered with Phospogypsum

Western tailings (Zapadnoe). High contaminated groundwater

Wet type Sukhachivske tailings, Cell-1

“Techogenic” perched aquifer

Alluvial aquifer

Uranium plume
Tailing Central Yar (PChP legacy site)
Gamma-dose rate and borehole drilling surveys data were collected for period 1991-2012, allowing provide reliable data for characterization U- residues

![Gamma-dose rate survey map]

2012
Gamma-dose rate survey

<table>
<thead>
<tr>
<th>Gamma mSv/h</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Red</td>
</tr>
<tr>
<td>5</td>
<td>Orange</td>
</tr>
<tr>
<td>2</td>
<td>Brown</td>
</tr>
<tr>
<td>1</td>
<td>Dark Brown</td>
</tr>
<tr>
<td>0.8</td>
<td>Yellow</td>
</tr>
<tr>
<td>0.6</td>
<td>Light Yellow</td>
</tr>
<tr>
<td>0.5</td>
<td>Green</td>
</tr>
<tr>
<td>0.4</td>
<td>Light Green</td>
</tr>
<tr>
<td>0.3</td>
<td>Light Green</td>
</tr>
<tr>
<td>0.2</td>
<td>Green</td>
</tr>
</tbody>
</table>
High contaminated area is adjacent to U-extraction facility 103. Remediation Strategy has to be developed.

The highest Gamma dose rates reach 100-300 µSv/h on the top of the columns near building 103.
Condition inside of the former U-extraction facility (103)
Gamma dose rates in the Building №103 (third floor)

Safe technology to be applied for decontamination is under development

<table>
<thead>
<tr>
<th>Level 3</th>
<th>Specific radionuclide in the spilled materials, Bq·g⁻¹ dry, w</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U-238</td>
</tr>
<tr>
<td>mean</td>
<td>12,1-24,5</td>
</tr>
<tr>
<td>min</td>
<td>5,5</td>
</tr>
<tr>
<td>max</td>
<td>50-75</td>
</tr>
</tbody>
</table>
Preliminary dose assessment for workers at the different scenarios of exposure at the “Building 103 (ENSUE, 2013)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Receptor</th>
<th>Calculated Dose (mSv/a)</th>
<th>Main Pathway(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal Conditions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal Scenario 1</td>
<td>“Building 102” worker</td>
<td>1.6</td>
<td>Gamma, Radon</td>
</tr>
<tr>
<td>Normal Scenario 2</td>
<td>Characterization Worker</td>
<td>1.7</td>
<td>Gamma</td>
</tr>
<tr>
<td>Inside “Building 103”</td>
<td>D&amp;D Preparation</td>
<td><strong>1 µSv/h – 1 mSv/h</strong></td>
<td>Gamma</td>
</tr>
<tr>
<td><strong>Abnormal Conditions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal Scenario 1 - Strong Wind</td>
<td>“Building 102” Worker</td>
<td>0.041</td>
<td>Aerosols</td>
</tr>
<tr>
<td>Abnormal Scenario 2 - Tank Spill</td>
<td>PChP Worker (inside and outside)</td>
<td>0.1 to 1</td>
<td>Aerosols</td>
</tr>
<tr>
<td>Abnormal Scenario 3 - Intrusion</td>
<td>PChP Worker</td>
<td>1 - 2</td>
<td>Gamma</td>
</tr>
</tbody>
</table>
The program is developed to provide safe management at the legacy site, to support functions of the SE “Barrier” (Operator) ensure its functions such as:

- Site Safety management (radiological and non-radiological)
- UPLS – surveillance and monitoring
- Preparedness to further and ongoing remediation activities
- Provision security and Radiation protection at the site
- Coordination and support of the site investigation and actions for remediation strategy planning (national and international)
- Public communication and data management

State Program of Remediation of Uranium Production Legacy Site was approved by Cabinet of Minister of Ukraine 23 of December 2015 N 1091
Remediation Policy and Strategy

- **Special legal and regulatory frameworks** have to be developed to assist and stimulate financial and social support of the planned remediation activities.

- Site has to be remediated providing regulatory proved safety condition for **its further industrial use**.

- **Conventional enterprises have to be involved in remediation process** and safety management of the areas where their workplaces are located.

- Any national and international initiatives and projects helping to develop and implement remediation strategy to be welcome and kindly supported **expecting assistance from EC, IAEA, USA**.

- The overall remediation action plan for long-term site management currently is under development and expected to be ready for **international peer-review in Q-4 2016**.

- **The waste management should be carrying out according existing international practice.** National standards and regulations regarding Uranium legacy site management and remediation will be harmonized with IAEA Basic Safety Standards.
Expected results (Phase 2016-2017)

1. Safety management and site specific functioning of SE “Barrier” which are temporary terminated have to be renewed.

2. Coordination and cooperation between different institutions, Agencies and regulatory body regarding safety management and actions on preparedness of the site expected to be improved

3. The overall Remediation strategy for long-term remediation will be developed in cooperation between EC, IAEA and National experts

4. Conventional industrial enterprises, local businesses and other potential investors (stakeholders) will be involved in remediation planning and remediation program implementation, being motivated to provide safety conditions for its further economic development and supported be special Government decree;

5. State Remediation Program for 2018-2022 will be elaborated on a basis of Overall remediation Strategy and in agreement with potential Remediation plans to be supported EC and other International donors

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The Road Map suggests a graded cooperative five phases approach, allowing synergy of efforts of Ukraine and potential international donors, helping to solve problem.

**Phase 1**
- To complete site characterization and safety assessment. Enhancing Legal and regulatory framework
- Initiate and start implementation of the preparedness activities for further remediation.
- Initiate other international cooperation projects.....(EC, USA, Canada other partners)

**Phase 2**
- To justify and implement first priority actions for stabilization and conservation of the main hazard facilities and sources of exposure.
- Decontamination of the most contaminated buildings

**Phases 3 and 4**
- Preparedness actions and detailed remediation plans and designs can be developed for some of the first priority actions.

**Phase 5**
- Several pilot projects will be implemented with financial support of the international donors.
Emergency Measures needed to Improve Safety and Stability at the Site. Strategy and Objectives

To collect high contaminated dispersed materials in the buildings of the former U-extraction facilities (103 and 104)

To stabilize the objects requiring action, ensuring reduction of the non-radiological (including building engineering) hazards during the period until implementation of remediation actions

- To significantly reduce the immediate radiological risk until implementation of remediation actions (including establishment of boundaries)
- To raise awareness on and near the site about the conditions of the site and measures to mitigate the risk.
Specific tasks to be implemented during preparedness Phase

- Development of special enterprise for decontamination, recycling and possible re-processing of the wastes to be generated during remediation.

- **Vacuum and wet decontamination techniques** may be used and tested for its possible application for selected premises which high contaminated by dispersed residues and spills.

- Decontamination technologies used in EU and USA for clean-up and radioactive waste management of the high contaminated (U-Ra) dispersed materials.
Pilot Projects proposed for implementation

Preparedness activities (temporary RW storage facilities, significant development if infrastructure for the future remediation projects and waste management):

“Decontamination and dismantling of the most contaminated facilities and constructions in the Building 103 and 104”

“Reconstruction protective cover on the one or several of tailings facilities”.

“Create JSC for Decontamination, re-processing and re-use of the contaminated former industrial facilities (metals, tubes, construction materials at sat.)

Other activities to be justified and optimized within the framework of the national and international cooperation projects.

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If you have any questions or you need additional information, please contact: Tel/fax: + (380 44) 206 3608, fax: + (380 44) 206 3602 e-mail: svitlana@mev.energy.gov.ua