Environment Monitoring and Site Characterization Relative to Pridneprovsky Uranium Legacy Site in Ukraine

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The former State Industrial Enterprise Pridneprovskiy Chemical Plant (PChP) was one of the largest metallurgical facilities, where uranium ores were processed from 1948 until 1991.

There has been no regular surveillance of the Uranium residue and other toxic waste and releases from the tailing sites.

New monitoring programme launched in 2005 and founded by Ministry of Fuel and Energy of Ukraine
Uranium Production Legacy at Dneprodzerzhinsk (1947-1991)

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.

LTSM is still not defined

Clean-up and Remediation – required significant financial resources
CURRENT REMEDIATION ACTIVITIES.  Key Mile stones

• 1991-2000  U-Mill production at PChP was ceased. Decommissioning period of the Legacy site / No regulation. No strategy. Bed economical situation

• 2000-2003  SE “Barrier” was created to provide safe Legacy Site Management. First site characterization studies (2002) UkrNIIIPromtechnology develops the First Remediation Program to provide safe condition and remediation at the PChP Legacy Site. Only first priority Safety protection actions were taken in consideration

• 2003-2007  First priority actions done (decontamination, removal most contaminated facilities and pipe. The site specific Monitoring& Surveillance program were established.

• 2008-2009  Preliminary Safety Assessment has been carried. Government Commission was created to support Legal and Regulatory actions in assistance to the State Program. New State Remediation Program was developed (2010-2014) based on more realistic financial requests and SA results. Inventory studies and systematic site specific studies have been started.

• 2010-2011  State Remediation Program to bring PChP U-production legacy site to the ecological safe and sustainable State is launched.”

• 2012 – Need to modify the Strategy for Remediation Actions and Planning. Request for IAEA expert Mission for reviewing

The Main problem -- Lack of Regulatory Requirements for Project Planning and Safety criteria. Long-Term Remediation Strategy have to better justified and Approved.
Remediation Planning

- **Phase 0 (2009).** Tailing Inventory and Safety barrier characterisation. Safety Assessment. Monitoring and Surveillance network development


- **Phase 2 (2011-2015).** Implementation of the main set of engineering as a first priority action at territory of PChP (preparatory activity and decontamination of the most contaminated buildings).

- **Phase 3 (2016-2020).** Preliminary actions on possible removal of the tailing materials from the industrial site to the tailing “D”. Justification and partly relocation of the tailing materials at the surface of tailing “D”.

- Further remedial actions at a later phase have to be focused on the neighbouring areas

- **Phase 4. (2021-2025).** Stewardship and handover the re-profiled facilities to the basic enterprises and neighbouring areas of the town.
Identification and Characterization of the main hazards

A - tailing “Western” and “Central Yar”; Former U-extraction facilities B – (buildings №103, 104, 120 i 112) in operation of SE “Barrier”, C – in operation of private enterprises FERREXPO LLS; D – in operation of DZMU (Mineral Fertilizer Plant); E – “Polychimprom”
Inhomogeneous and High gamma-dose rates were identified around the tailing dumps and former Mill and U-extraction facilities.

High gamma dose and $^{222}$Rn are the main expose factors at the PChP site. Gamma-dose varies 0.2 - 10 µSv h$^{-1}$. At some locations – up to 30 µSv h$^{-1}$.

The hot spots with $^{238}$U and $^{226}$Ra were identified. Gamma-dose rates are in good correspondence with high contamination of some toxic metals in soils: Zn (72.9 - MAC), As (2-20), Fe (21.8), Cu (4.5), Ni (4.2), Cd (2 - MAC).
The surface cover of the tailing dumps “Zapadnoe”, “Central Yar” and storage facility Base C have to be replaced with new sufficient cover (0.2 - 15 μSv h⁻¹).
Rn-222 exhalation (up) and Rn-222 ambient activity concentration in air

Tailing cove is sufficient if Rn-222 exhalation rate less 1 Bq m² s⁻¹

Sufficient cover of the tailing is still cannot guarantee sufficient remediation effect, because high contamination of the areas adjacent to the tailing dump site.
South-Eastern sector of the PChP site and the tailing "Yugo-Vostoshnoe", with constructed new cover during 2008-2009

New cover still can not guarantee safety condition due remained high contaminated soils at the adjacent area (gamma dose rate 0,5-15 µSv h\(^{-1}\)), which is require to be cleaned-up.

The results of detailed gamma-dose survey were suggested as a basis for clean up planning according End status criteria to be achieved at the industrial site less 0,5 µSv h\(^{-1}\).
Inventory studies have been carried out during 2009-2010, based on drilling and laboratory studies of the tailing materials and existing covers. Additional drilling and Assessment have to be continued in 2012.
In some locations an existing cover are damaged due to creaking unacceptable steep slopes, and animals effects.
Experimental studies of Kd for radionuclides in the tailing materials allows to reduce uncertainties for the long-term radionuclide groundwater transport predictions from the tailing dump site.
The main radiological hazards at the Uranium production legacy sites

In some cases gamma dose rate are $10^1$ - $10^3$ $\mu$Sv h$^{-1}$, surface beta particle fluxes are $10^1$ - $10^3$ Bq cm$^{-2}$, U in dust dispersed at the floor up to $10^2$ g / m$^2$.

Challenges. A large number of the high contaminated buildings and equipment remained at the PChP Legacy Site have to be removed and decontaminated.
The typical Monitoring program for PChP Legacy Site is elaborated according to IAEA Recommendation SRS-27(2002) and SRS-64 (2010)

- Gamma-dose rate survey over the UPLS (ones 2-5 years);
- Rn-222 exhalation on the tailing covers (seasonally)
- Rn-222 ambient concentration survey at the Legacy sites territory and in the most contaminated premises and houses at the adjacent areas (seasonally) by installing track detectors
- The samples from surface waters (seasonally) and in the groundwater (ones a year) have to be taken for analyses of its radioactive and chemical contamination
- Aerosols to be taken at the defined locations and during remediation
- In the defined cases the water, soils, aerosol and biological samples have to be analyzed for $^{238}\text{U}$ - $^{234}\text{U}$ - $^{230}\text{Th}$ - $^{226}\text{Ra}$ - $^{210}\text{Po}$ - $^{210}\text{Pb}$, $^{230}\text{Th}$
- The typical set of toxic metals have to be also monitored: Pb, Co, Cd, Mn, Cu, Ni, Fe, Zn, As, V, Cr

Basic meteorological and hydrological parameters have to be measured
Analytical capacity of the Reference laboratory UHMI includes

High efficient gamma, alpha and LLC spectrometry devices as well as basic radiochemical and environment sample preparation facilities.
Methods of environmental samples measurement

**Gamma –spectroscopy**

- 4 HPGe Semiconductor Detectors
  Type - GEM, GWL, GMX – ORTEC,
  BE5030 - CANBERRA

Measurement - $^{234}$Th ($^{238}$U), $^{235}$U, $^{234}$U, $^{226}$Ra, $^{228}$Ra, $^{210}$Pb, $^{228}$Th, $^{40}$K, $^{137}$Cs, $^{241}$Am and ets.

- NaI(Tl) scintillation detector
  Measurement - $^{40}$K, $^{137}$Cs, $^{60}$Co and ets.
Simplified methods for U-Th series radionuclides determination in waters (UMF-2000, and LLC) are put in use at the Barrier Lab.

UHMI Lab. Becomes an international training centre. During recent 4 years

Tajikistan 4 people trained, Kyrgyzstan 6, Azerbaijan 2, Georgia 2, Ukraine 2
Regular participation in IAEA PT Inter-comparison exercise for all Labs can significantly improve quality of analytical measurement.

UUMI and Marzeev Inst. Labs is a partners of IAEA PT programs since 2005

Barrier Lab. Is measured all samples delivered in frame of RER/3/010 ICE
Fifty laboratories reported their results without any “not acceptable” score. Table 7 lists the codes of these laboratories. In this group there are three participants with codes 64, 92 and 186 reported the results of all requested analytes (17 results) without any “not acceptable” result.

It is recommended to this group of laboratories to maintain the statistical control of the analytical process and to monitor it. This group of laboratories reported satisfactory analytical results for the scope and evaluation criteria of this PT.
There are 4 different laboratories involved for Monitoring Program Implementation. All of them are annually take part in the inter-laboratories comparison exercise as part of established Site specific Monitoring Programs at PChP site and surrounding areas.

2010-2011

UHMI Internal QA/QC procedures, when U-238 in the tailing materials was measured by two different methods (Alpha and Gamma Spectrometry)
AEROSOL CONTAMINATION IMPACT

Relative values of U-238, Ra-226, Pb-210 in aerosol fallout at two different places

A - South-eastern tailing

B - near building 103

Former U-extraction Facility in comparison to aerosol fallout contamination at the Dneprodzershinsk (meteorol. station) at the distance 10 km from the legacy site.

Highest contamination in summer period
ECOLEGO modeling tool for Radionuclide transport and Dose assessment has been provided for RER/3/010 project partners and is currently in use for SA and EIA at PChP site.

- Tailings (gamma-dose expose, Rn)
- Aerosol fallout and Inhalation
- Groundwater transport module was developed and applied for long-term dose assessment via water pathways
- Assessment applied for the contaminated buildings and settlement
- Agriculture lands and irrigation

Adapted for all former U facilities and territory of PChP UPLS

- Inter-active matrix easy in use (LEGO)
- Open system for development and improvement and function extension
- Large Library for model parameters and simple screening models
- Module for statistic and Probability functions analyses
- Dose and Risk assessment modules to be extended for Chemo toxic risks
- Generation of Reports
Effective dose rate at the different location of the PChP Legacy Site (ECOLEGO modeling tool application)

The High potential Radiological Risks for workers at this territory required Strict Regulatory Control and IAEA Consulting on Remediation Strategy Development.
Comparison of the potential dose rates between PChP site and similar UP Legacy sites in Tajikistan and Uzbekistan. The highest potential doses are expected for workers in the buildings former U- extraction facilities.
Preliminary Assessment of the Cover effect for the Tailing dump Dnieprovskoe based on the Groundwater Pollution simulation with ECOLEGO Groundwater Module (by D. Bugai)

U-activity concentration in the aquifer at the groundwater inlet site for the different scenarios

- **base case**
- **waste removal**
- **soil cover**
Main constrains and needs for further development (1)

- The Legal and Regulatory framework should be significantly develop and provide clear safety criteria and regulatory requirements in support and implementation Remedial Actions. Licensing instruments have to be harmonized with EC and best international practice making Monitoring Programs as Decision Making Instrument more efficient.

- QA/QC programs have become normal regular practice for all participants of the Site specific Monitoring Programs

- Monitoring and radiation control devices, specially for Inhalation and Rn-222, working in the contaminated buildings and tailing sites has to be provided for site operator workers.

- Site specific Monitoring program has to be developed and optimized. Ecotoxicological studies regarding toxic metal in soils, water and aerosol, have to be extended. Specific monitoring studies are required for Most contaminated buildings.
Experimental site specific studies have to be developed such as lysimeters, AMAD and aerosol re-suspension parameters, solubility of tailing materials and erosion and hydraulic conductivity site specific factors

- There are many State and Private organization are still in operation at the PChP UPLS, they have to be involved for implementation the State Remediation Program. Site characterization and Assessment have to cover also territories and facilities operated by Private companies at the territory

- Technical capacity of the involved laboratories and in particular SE “Barrier” should be significantly improved

- Participation in the internationally organized training, and fellowship programs are important component of the Monitoring Programs sustainable development and optimization and all period of the remediation process
Thank you very much for sharing DOE and RSLS Unique Experience

Спасибо

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