The use of the checklist methodology to improve the safety of tailings for UNECE countries, including in Ukraine, Armenia and Georgia

Prof. D. Rudakov
National Technical University “Dnipro Polytechnic”
Dnipro, Ukraine
Development of a methodology for improving the safety of tailings

The methodology, including the tailings hazard index and a checklist, was developed by the Ukrainian team within project of the Federal Agency of Germany on Environmental Protection "Improving the safety of industrial tailings on the example of Ukrainian objects" (2013-2015) with the participation of international experts as a tool for the practical implementation of the UNECE Guidelines on Tailings Safety.
Projects to develop and implement a methodology for improving the safety of tailings

1. Improving the safety of industrial tailings on the example of Ukrainian facilities (UBA, 2013-2015).
5. Improving the safety of mining facilities, including tailings, in Kazakhstan and Central Asia (UNECE, 2018-2019).
Methodology to improve the safety of tailings

Tailings Hazard Index

Designed for rapid preliminary risk assessment (ranking) of a large number of tailings at the national / regional level

Checklist

Designed for detailed assessment of individual tailings
Conducting training on testing methodology for improving the safety of tailings

1. Improving the safety of industrial tailings on the example of Ukrainian facilities (UBA, 2013-2015).
Application of the Checklist in Ukraine. 1. Tailing dump in Kalush

Evaluation in the framework of the first UBA project in Ukraine, 2014

**Location:** Ivano-Frankivsk region, 0.85 km from Kalush

**Title:** Tailing pond №2 GP “Potash Plant” LLC “Oriana”
Built in 1984

**Materials:** Potash Waste

**Waste volume.**
- **Solid phase** 9 x106 m3
- **Liquid phase** 1.7 x 106m3

**Environmental hazard**
- Groundwater
- The rivers in the basin of the river. Dniester
Application of the Checklist in Ukraine. 1. Tailing dump in Kalush

Tailing house No 2 in 2010

Tailing house No 2 in 2014

Saltwater seepage through dam
Application of the Checklist in Ukraine. 1. Tailing dump in Kalush

Overall rating

Categorical assessment

Veracity, 58.2%
Security Compliance 51.7%
Title: Ash and Pit Drainage Prydniprovska TPP PJSC "DTEK Dniproenergo"

Waste volume: 15.75 million tons

Composition: sludge, coal burning waste

Built 1970
Application of the Checklist in Ukraine. 2. Tailing dump in Dnepr

Assessment participants: 4 groups of environmental students under the guidance of teachers from 4 universities, as well as the developers of the Checklist.

The assessment was conducted during two trainings (October and November 2016) with the participation of international and national experts.
Application of the Checklist in Ukraine. 2. Tailing dump in Dnepr

Overall rating

Veracity, 85.5%
Security Compliance 74.1%
Application of the Checklist in Ukraine. Legislative consolidation

• A roadmap has been developed to implement Directive 2006/21 / EC through the UNECE Guidelines for the Safety of Tailing Pits within the framework of national legislation.

• At the Round Table with representatives of the competent authorities, the Methodology and interactive map of tailings sites were presented as a practical tool for the implementation of Directive 2006/21 / EC.

• The Ukrainian version of the methodology for tailing dumps is adapted for inspection bodies.
Training on the safety of tailings in Armenia. Location, participants.

Tailing dump "Nakhatak" Akhtala Mining Plant

Training in Tsakhkadzor 03-06.09.2018 included
Theoretical studies
Visit the tailings
Safety assessment and justification of measures.

Participants - representatives of the competent authorities of Armenia, Georgia, Kazakhstan, Kyrgyzstan, international experts, in total from 13 countries
Training on the safety of tailings in Armenia.

Evaluation results

Overall assessment of one of the groups of participants

<table>
<thead>
<tr>
<th></th>
<th>Security Compliance, %</th>
<th>Veracity, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual check</td>
<td>51.7</td>
<td>57.9</td>
</tr>
<tr>
<td>Documentation check</td>
<td>89.1</td>
<td>83.3</td>
</tr>
<tr>
<td>Overall rating</td>
<td>83.6</td>
<td>78.6</td>
</tr>
</tbody>
</table>
Inventory and mapping of tailings

- Georgia (2017-2019, 5 tailing dumps).
Tailings Danger Index (TDI)

\[ TDI_{Exsp.} = TDI_{Capacity} + TDI_{Tox.} + TDI_{Exc.} + TDI_{Location} + TDI_{Dam} \]

- **TDI\(_{Capacity}\)**: degree of hazard / risk associated with the volume of materials in the tailings
- **TDI\(_{Tox.}\)**: hazard / risk related to tail materials toxicity
- **TDI\(_{Exc.}\)**: degree of hazard / risk associated with improper management
- **TDI\(_{Location}\)**: degree of hazard / risk associated with geological and hydrological conditions
- **TDI\(_{Dam}\)**: degree of danger / risk of dam failure due to integrity deficiencies
Hazard Assessment of Tail Materials

\[ TDI_{\text{Capacity}} = \log_{10} [V_t] \]
where \( V_t \) — volume of tail materials, \( m^3 \).

Examples.

For a large tailing dump with \( V_t = 10 \text{ million} \ m^3 \)
\[ TDI_{\text{Capacity}} = 7 \]

For a small tailing dump with \( V_t = 0.01 \text{ million} \ m^3 \)
\[ TDI_{\text{Capacity}} = 4 \]
Toxic Hazard Assessment

<table>
<thead>
<tr>
<th>Classification</th>
<th>Value $^{TDI_{Tox}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(WGK)$^1$ KO$^2$</td>
<td></td>
</tr>
<tr>
<td>0 4 0</td>
<td>0</td>
</tr>
<tr>
<td>1 3 1</td>
<td>1</td>
</tr>
<tr>
<td>2 2 2</td>
<td>2</td>
</tr>
<tr>
<td>3 1 3</td>
<td>3</td>
</tr>
</tbody>
</table>

1. WGK = Water hazard class; WGK = Wassergefährdungsklasse, classification of the German Federal Agency for Environmental Protection.
2. KO = Hazard Class, classification according to SAUS 12.1.007-76 ССБТ
Assessment of hazard associated with tailing management

<table>
<thead>
<tr>
<th>Data to determine $TDI^{\text{Management}}_{\text{Management}}$</th>
<th>Size $TDI^{\text{Management}}_{\text{Management}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed or reclaimed tailings</td>
<td>0</td>
</tr>
<tr>
<td>Active or abandoned tailing dump</td>
<td>1</td>
</tr>
</tbody>
</table>
Assessment of geological hazards. Seismicity

\[ TDI_{\text{Location}} = TDI_{\text{Seis}} + TDI_{\text{Flood}} \]

Data to determine \( TDI_{\text{Seis}} \)

<table>
<thead>
<tr>
<th>Relative peak acceleration of soil ( aG ) with a repeatability period ( T_{\text{ret}} )</th>
<th>Value ( TDI_{\text{Seis}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 0.1 )</td>
<td>0</td>
</tr>
<tr>
<td>( &gt;0.1 )</td>
<td>1</td>
</tr>
</tbody>
</table>

Data can be identified by a global seismic hazard map. [http://gmo.gfz-potsdam.de/pub/download_data/download_data_frame.html](http://gmo.gfz-potsdam.de/pub/download_data/download_data_frame.html)
Flood hazard assessment

$TDI_{Flood}$ determined by the parameter $HQ_{500}$, which quantifies the frequency of flooding with a recurrence period of 500 years (flooding with a probability of 1: 500).

<table>
<thead>
<tr>
<th>Data to determine $TDI_{Flood}$</th>
<th>Value $TDI_{Flood}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tailings location</td>
<td></td>
</tr>
<tr>
<td>In the zone $HQ_{500}$</td>
<td>1</td>
</tr>
<tr>
<td>Out of zone $HQ_{500}$</td>
<td>0</td>
</tr>
</tbody>
</table>
Flood hazard assessment. Map example

Fragment of a map of zones with a probability of flooding of 1: 500 in Europe in the basin of the r. Danube.
World Health Organization Atlas flood hazard maps
Estimation of the risk of dam failure

Recommended Calculation Method

\[ TDI_{\text{Dam}} = TDI_{\text{Ky}} + TDI_{\text{Acs}} \]

<table>
<thead>
<tr>
<th>Range of slope stability factor $K_y$</th>
<th>Value $TDI_{Ky}$</th>
<th>The life of the tailings</th>
<th>Value $TDI_{Acs}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_y &gt; 1.35$</td>
<td>0</td>
<td>$\leq 30\text{ years}$</td>
<td>0</td>
</tr>
<tr>
<td>$K_y &lt; 1.35$ or unknown</td>
<td>1</td>
<td>$&gt; 30\text{ years}$</td>
<td>1</td>
</tr>
</tbody>
</table>
Application of the tailings hazard index in Ukraine

Map 344 of tailings, ranked by TDI, based on the volume of tailings and their toxicity, was built as part of the UBA project “Increasing the level of knowledge among students and teachers in tailing safety and its legislative review in Ukraine” (2016-2017)

https://www.google.com/maps/d/viewer?usp=sharing&mid=1RFomCn9uKponcHnFrK3XG997AEU&ll=48.74972991354911%2C30.694941406249995&z=6
Application of the tailings hazard index in Ukraine

35 most dangerous tailings (10% of the total)
Inventory and mapping of tailings in Armenia and Georgia (in progress)

23 tailing dumps in Armenia, 5 tailing dumps in Georgia
Findings

• As part of the methodology for improving the safety of tailings, a method of ranking them according to the degree of danger has been developed, which makes it possible to give a preliminary assessment of a large number of objects.

• Within the framework of the projects of the Federal Office of Germany for Environmental Protection in Ukraine, a database of tailing dumps (344 objects) has been created, a checklist has been tested, and the methodology has been introduced at the legislative level.

• Within the framework of the project, the departments in Armenia and Georgia are completing inventory and mapping of tailings. The training was conducted on the application of the methodology; it is being consolidated at the legislative level.
Thank you for attention!