A METHODOLOGY TO IMPROVE THE SAFETY OF TAILINGS MANAGEMENT FACILITIES

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Introduction

- Dramatic growth of wining waste amount in the world last decades.


The TMF at Ajkai (Hungary) after the dam failure (2010)

The river after dam failure at the TMF of Ridder in East Kazakhstan (2016)
Last TMF accident in Brazil (Vale dam, Jan 2019)
Incidents at TMFs in XX-th century (ICOLD Bulletin No. 121)

- Dramatic increase in the mid 1960s due to the intensive development of mining industry and construction of a large number of TMFs,
- Reducing the number of incidents since 1990s due to the introduction of stricter safety standards, contraction of mining production in some countries, the introduction of new technologies of sustainable mining.
Growing risk of TMF failures last decades

Between 2007 and 2017, there were at least 10 very serious mine tailings dam failures around the world. These involved multiple loss of life, approximately 20 lives per incident and/or the release of at least one million m³ of water. The waste in some of these cases travelled 20 km or more.

https://www.unenvironment.org/fr/node/21331
The base for the projects

Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities (UBA project, 2013-2015)

Methodology to improve the safety of tailings management facilities (TMF Methodology) as a practical tool for the implementation of the UNECE Guidelines with minimum requirements to tailings safety

TMF Methodology

Method of Evaluation “Tailings Hazard Index” (THI)

is intended for prompt and preliminary evaluation of tailings hazard for the large amount of TMFs on the national/regional level

TMF Checklist

is developed for evaluation of the safety level for a TMF using the test question method
Tailings Hazard Index (THI)

\[ \text{THI}_{\text{Extended}} = \text{THI}_{\text{Cap}} + \text{THI}_{\text{Tox}} + \text{THI}_{\text{Manag}} + \text{THI}_{\text{Site}} + \text{THI}_{\text{Dam}} \]

- **THI\text{Cap}** is the hazard caused by the amount of tailings materials (TMF capacity).
- **THI\text{Tox}** is the hazard caused by toxicity of substances contained in tailings.
- **THI\text{Manag}** is the hazard caused by improper management of facilities.
- **THI\text{Site}** is the hazard induced by siting the TMF in the area with specific geological and hydrological conditions.
- **THI\text{Dam}** is the dam failure hazard (weaknesses in structural and component integrity and functionality).
TMF Checklist is based on minimum safety requirements adopted in the UNECE «Safety guidelines and good practices for tailings management facilities»

- **Questionnaire**: the identification of incompliances with safety requirements
- **Evaluation Matrix**: the evaluation of the TMF safety level
- **Measure Catalogue**: recommendations to address the incompliances by short-, medium- or long-term measures
<table>
<thead>
<tr>
<th>Question group</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Group A**  
“Basic Check”               | Preliminary and prompt evaluation of the safety level of TMFs aimed to prioritize the following detailed check |
| **Group B**  
“Detailed Check”             | Comprehensive and detailed evaluation of the TMF safety level aimed to identify the need for taking measures |
| **Group C**  
“Check of Inactive Sites”  | Evaluation of the safety level of an inactive TMF aimed to identify the need for taking measures |
Evaluation Matrix. Overall evaluation

- **“MSR” rank** ("Meeting Safety Requirements") quantifies how the TMF meets the minimum set of requirements of environmental and industrial safety (the UNECE “Safety Guidelines and good practices for TMFs”).
- **“Credibility” rank** within the TMF Checklist quantifies the sufficiency and consistency of data used for calculating the “MSR” rank.
Evaluation Matrix. Categorical evaluation.

Spider diagram
includes the list of actions to be taken in case of establishing incompliances of TMF conditions to applicable safety requirements/regulations.

includes the measures from the UNECE “Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities” and national practices in post-mining environment restoration.

<table>
<thead>
<tr>
<th>#</th>
<th>Problem to be solved</th>
<th>Measures prescribed</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design documentation is incomplete</td>
<td>1A. Update design documentation made by a licensed company</td>
<td>Short-term</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1B. Update design documentation involving licensed and skilled staff</td>
<td>Short-term</td>
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<td></td>
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<td>1C. Perform expert analysis of design documents for authorities</td>
<td>Short-term</td>
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<tr>
<td></td>
<td></td>
<td>1D. Prepare or complete design documentation according to regulatory requirements</td>
<td>Short-term</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1E. Prepare a detailed map of the TMF site and the surrounding area</td>
<td>Short-term</td>
</tr>
</tbody>
</table>
Completed and on-going projects on TMF Methodology application

1. Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities (UBA, 2013-2015).


5. The project to strengthen the safety of mining operations, in particular tailings management facilities (TMF), in Kazakhstan and beyond in Central Asia (UNECE, 2018-2019).
First project (UBA). Testing TMF Methodology. The site of Kalush (Western Ukraine)

**Location.** Ivano-Frankivsk region 0.85 km from the city of Kalush,

**Name.** TMF No. 2 of State Enterprise “Potassium Plant” JSC “Oriana”

**Constructed in 1984**

**Tailing materials.** Solid waste of potassium production including halite, sludge, gypsum and brines

**Waste volume.**
- Solid phase 9 x10⁶m³,
- liquid phase 1.7×10⁶m³

**Kalush TMFs threat to**
- Safety of population (66,500 people),
- local aquifers,
- and rivers in the Dniester basin
Safety Evaluation for the TMF site in Kalush

Overall evaluation

Credibility, 58.2%
Overall Safety evaluation 51.7%

Categorial evaluation

- Geological, climate, and terrain risks GCR
- Closure and rehabilitation strategy CRS
- Facility inspection, documenting and reporting INR
- TMF Deposition Plan TDP
- Substances (Tailings Capacity, Toxicity) STC
- Dam and screens DSC
- Transportation and infrastructure TRI
- Water management WTM
- Emergency Plan EMP
- Monitoring MON
- Environment Impact Assessment EIA
- Trainings and personnel TRP
Second project (UBA). Addressing the TMF problem in Ukraine at the educational and legislative levels

- Raise the knowledge in the TMF safety among Ukrainian students in environmental and mining sciences and young university teachers dealing with education on environmental protection.
- Develop an educational course based on the TMF methodology

- Improve the TMF safety level by addressing this issue on the legislative level in terms of how Ukraine fulfils its obligations under the EU-Ukraine Association Agreement, Directive 2006/21/EC on the management of waste from the extractive industries

Education

Legislative area
Trainings on tailings safety with TMF Methodology application

First Training 3–7.10.2016
TMF of the Thermal Power Plant, city of Dnipro

• Lectures on the TMF Methodology
• Site visit to the TMF, filling in the TMF Checklist
• Presentation on TMF safety level evaluation by students

Training results
• Safety evaluation
• Testing of the Methodology
• Safety improvement program
• The on-line education course on TMF safety in the Moodle platform

Credibility 85%
Overall safety evaluation 77%
The map of 344 tailings facilities ranked by their hazard (tailings capacity and toxicity) has been created in Google Map and presented at Round Table for competent authorities (Kyiv, February 7, 2017) as a practical tool for implementation Directive 2006/21/EC provisions.

Waste classification

- Highly hazardous
- Very hazardous
- Hazardous
- Low hazardous

https://www.google.com/maps/d/viewer?amp%3Busp=sharing&mid=1RFomCn9uKponcHnFrK3XG997AEU&ll=48.74972991354911%2C30.694941406249995&z=6
Third project (UBA). Training on TMF safety in Armenia

TMF Nahatak of Akhtala ore dressing plant (Armenia)

The training at Tsaghkadzor (Armenia) on 3-6.09.2018 includes
- Theoretical studies,
- Site visit to the TMF,
- Safety evaluation and selection of safety improvement measures.

The participants’ feedback was taken into account in improvement of the TMF Methodology.

52 participants and experts from 13 countries
THI av = THI average for all TMFs in the country,
THI av (5 top haz. TMFs) = THI average for top 5 hazardous TMFs in the country (for 3 top hazardous TMFs in Georgia).
Mapping the TMFs for the participating countries

23 TMFs in Armenia,
5 TMFs in Georgia,
16 TMFs in Kyrgyzstan,

THI from ..to
5.5 .. 9.4
9.5 .. 13.4
13.5 .. 17.5
Fourth project (ICPDR). TMF hot-spot identification in the Danube River Basin (DRB)

Identified TMFs in the DRB. Total TMF number >300
On-going TMF hazard identification and TMF mapping in the DRB

119 TMFs in Romania,
39 TMFs in Hungary,
23 TMFs in Serbia.

Total in the DRB >300 TMFs

THI from ..to

5.5 .. 9.4
9.5 .. 13.4
13.5 .. 17.5
Strengthen the safety of mining operations, in particular tailings management facilities (TMF), in Kazakhstan and beyond in Central Asia (UNECE)

Project objectives
• Training at a TMF site to apply the Checklist (to be held in 2019)
• The national TMF database (under construction)

Currently identified
76 TMFs in Kazakhstan,
16 TMFs in Kyrgyzstan.
TMF mapping in the UNECE region (under development)

- Tailings Hazard Index (THI) and TMF mapping are powerful tools to prioritize their environment hazard and improvement interventions at national and regional levels.
- One of the objectives is to create the THI-based map of TMFs in the UNECE region.
Outlook for further developments

1. Identification and prioritization of TMFs in UNECE countries
2. Development of a methodology for land-use planning
3. Development of a methodology for contingency planning
Thank you for your attention!

Learn more about the TMF Methodology and project activities on our websites


http://ecopeace.am

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