REPORT

from the on-site training and results of the application of the Checklists B.1 and B.2 of the tailings management facilities (TMF) Methodology

held during an on-site training and evaluation workshop (Penjikent, Tajikistan, 2-4 June 2021) under the UNECE projects on improving mining/tailings safety in Kazakhstan, Tajikistan and beyond in Central Asia

based on the safety evaluation of the TMF of JV «Zarafshon» (Penjikent, Republic of Tajikistan)

Contents

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– trainers for the on-site training –
in June 2021, with the support of UNECE

Introduction, background and site selection

This report has been prepared based on the results of the training held on June 2-4, 2021, in the city of Penjikent (Tajikistan). The training was held as a part of the UNECE project on strengthening the safety of mining operations, in particular tailings management facilities (TMFs), in Tajikistan and Central Asia, implemented under the auspices of the UNECE Convention on the Transboundary Effects of Industrial Accidents (Industrial Accidents Convention) and with the financial support of the Swiss Federal Office for the Environment.

The objective of the training was to enhance the capacity of participants to prevent accidental water pollution from TMFs, notably by supporting them in the application of the UNECE Safety Guidelines and Good Practices for TMFs [1] and a related TMF Methodology updated in 2020 after the project on tailings safety in Romania [2], developed under the leadership of the German Federal Environment Agency (UBA) based on the UNECE Safety Guidelines. Beneficiaries of the training were representatives from Tajikistan (on-site), Kazakhstan, Kyrgyzstan, and Uzbekistan (online). The training included a theoretical part, comprised of a briefing for all participants on the conduct of the on-site training and completion of the checklist, which included the outline of the basics of the above UNECE Safety Guidelines, the related TMF Methodology and their practical application, and a practical part, i.e. visit to the facility and conduct of a visual inspection. Mr. Dmytro Rudakov, the consultant of the UNECE Industrial Accidents Convention, supported by Mr. Dmytro Pikarenia, supervised the on-site training online, assisted in completing the checklist documentation by the operator and during the group work. Besides, he prepared this report with the support of the secretariat of the UNECE Industrial Accidents Convention.

The TMF site selection was undertaken by the Tajik competent authorities, led by the Service of the State Supervision over the Safe Conduct of Work in Industry and Mining Supervision under the Government of the Republic of Tajikistan (RT) and in close cooperation with the operators. Several aspects were considered in choosing an appropriate site for the training, including the scope of the UNECE Industrial Accidents Convention and, most notably, possible transboundary effects. In addition, the site selection criterion was the close location to the Zarafshon river that, in case of an accident, would have potential transboundary effects on Uzbekistan, which was also closely involved in the training. Therefore, following the careful evaluation of various aspects, the company Joint Venture "Zarafshon" was selected by the Tajik national competent authorities to conduct the on-site training. Regarding the selected TMF, the first (old) TMF of the gold processing plant JV "Zarafshon" began to be built in 1994, and it was put into operation in 1997 (see Annex 1 for more information about the company and its TMF).

1. Evaluation method

To evaluate the safety level of this facility, the Methodology for improving the safety of TMFs (hereinafter referred to as the TMF Methodology) was used. The TMF Methodology has been developed, tested and found useful in several projects implemented within the work plan of the UNECE Industrial Accidents Convention under the leadership of the German Environment Agency, including in Armenia, Georgia, and Ukraine[1]. It has also been successfully applied in the UNECE-led project on strengthening the safety of mining operations, in particular tailings management facilities (TMFs), in Kazakhstan and beyond in Central Asia (2018-2019).

[1] For further information, please see: www.umweltbundesamt.de/en/topics/sustainability-strategies-international/cooperation-eeca-centraleastern-european-states/project-database-advisory-assistance-programme/assistance-in-safety-improvement-of-tailings, www.umweltbundesamt.de/en/publikationen/improving-the-safety-of-industrial-tailings, www.umweltbundesamt.de/en/topics/sustainability-strategies-international/cooperation-eeca-centraleastern-european-states/project-database-advisory-assistance-programme/improving-the-safety-of-tailings-management, and https://www.umweltbundesamt.de/publikationen/safety-of-the-tailings-management-facilities-in-the

The TMF methodology includes the **Tailings Hazard Index (THI)** – for assessing the hazard of a large number of facilities at the national/regional levels – and TMF Checklists – for assessing the safety level of individual TMFs. The THI allows competent authorities to rank TMFs in their country according to their hazard, based on the collection of some basic information, such as the volume of the tailings and the toxicity of the hazardous substances. For example, the old TMF and TMFs nr. 1 and nr. 2 of the JV "Zarafshon" were ranked 1, 5 and 6 out of 13 identified TMFs in Tajikistan.

The **Checklists** in the TMF Methodology consist of Questionnaires which allow for the following: a general evaluation of the TMF safety level (Checklist A), a detailed evaluation of the TMF safety level (Checklist B), and a safety level evaluation of inactive facilities (Checklist C). Each Checklist includes two groups; the first one contains questions for a visual inspection, and the second one questions for a document check. Document check questions are mainly based on UNECE recommendations, while the questions and criteria for a visual inspection are largely based on the professional experience of the experts involved and the Checklist creators. Given the great importance of visual inspection, it would be reasonable to clarify how it had been performed (on-site inspection or using drones).

The TMF Checklists are accompanied by an Evaluation Matrix for quantifying answers to the questions and a Measure Catalogue that lists the protective and preventive measures recommended in case of non-compliance with the safety requirements. The Evaluation Matrix is included in an Excel file, automatically calculating the safety level based on the answers to the questions in the Checklist. The Measure Catalogue, also available in Excel, from which the user can select relevant measures, provides a number of possible actions to solve the identified safety issues. The developed Excel templates for the Evaluation Matrix and the Measure Catalogue were disseminated among all participants before the TMF safety evaluation started.

The Checklist questions are formulated in such a way as to cover a minimum set of requirements important to TMF safety and to assess the facility's condition reliably. The questions in all checklists are grouped according to the stages of the TMF life cycle (Pre-construction and construction, operation and management, closure and rehabilitation), and each group contains questions related to a particular issue, such as licensing, risk assessment, dam safety, management, training of personnel, monitoring, emergency planning, closure, etc. Some of the Checklist questions are considered critical because they relate to the vital functions of the TMF, such as dam stability, neutralization of toxic substances, monitoring, etc. Non-positive answers to these questions mean significant issues in tailings safety.

The **Evaluation Matrix** provides a quantitative assessment of the inspected TMFs in accordance with the current safety requirements formulated in the checklists. The Evaluation Matrix unifies the answers to the questions. It generates an overall and categorial evaluation based on the parameter "Compliance with safety requirements", which allows thorough checking of all TMF safety elements and identifying safety problems. In addition, the matrix enables estimating the uncertainty that arises in case of a lack of data about the facility being checked and the appearance of ambiguous answers by the "Credibility" parameter. A feature of the Evaluation Matrix is the criterion of an acceptable TMF safety level, according to which only meeting 100% of the minimum safety requirements [2] is considered acceptable; in all other cases, it is considered unacceptable.

The TMF Checklist application is completed with a **Measure Catalogue** containing a list of short-, mid- and long-term activities. Short- and mid-term measures should be based mainly on economic aspects, and long-term measures should be consistent with high international safety standards.

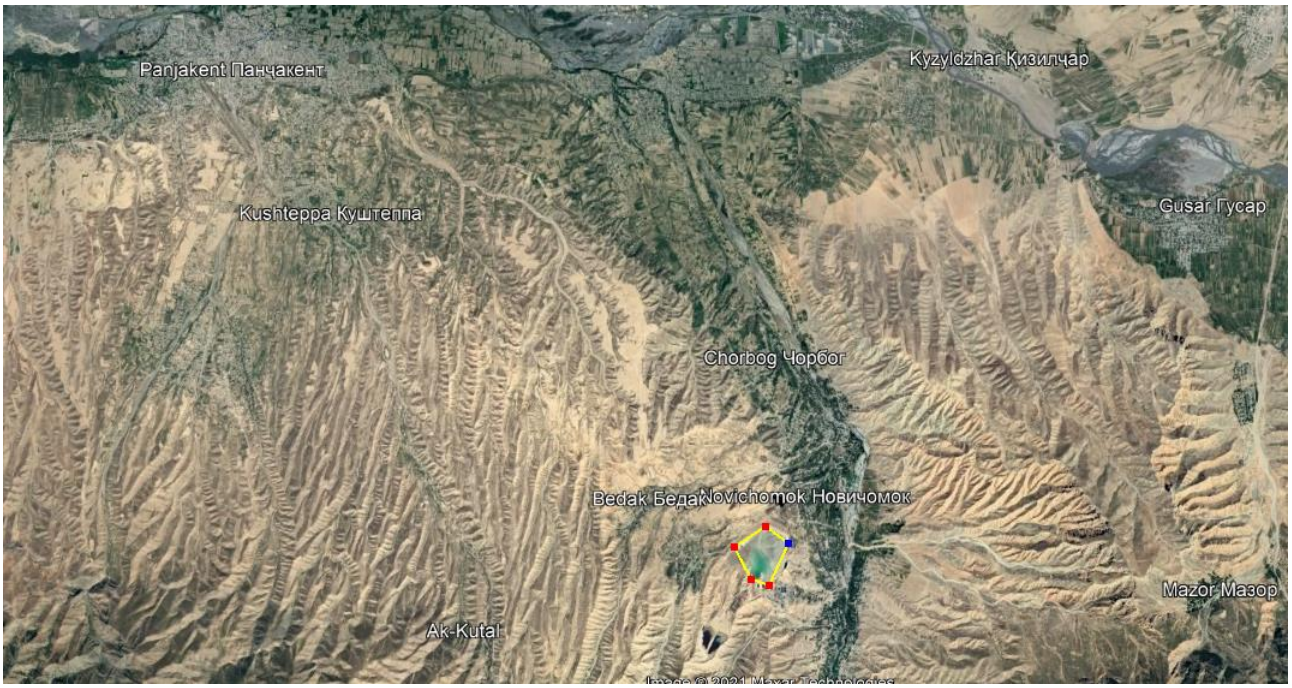
This report includes the results of checking the TMF by Group B "Detailed Check" including visual inspection carried out by Tajik participants during the on-site training (Checklist B Group 1 "Detailed visual inspection") and the check of the enterprise's documents (Checklist B Group 2 "Detailed document check"), performed by the trainers based on the company documents related to the TMF [3]. The other TMF checklists were irrelevant in this case because Checklist A is intended for

competent authorities, and Checklist C is designed for inactive sites. In addition, the TMF safety level has been evaluated using the last version of the TMF Methodology from October 2020 [2].

1.1.Visual inspection

The TMF is located in the Penjikent district of the Sughd region of the Republic of Tajikistan (Fig. 1). The views of the TMF (see Fig. 1,b) are shown in Fig. 2. General information on the facility and its production is prepared by the company personnel. Please see Annex 1 to this report.

Figure 1: TMF location on-site on a small scale (a) and large scale (b) inspected with using the drone during the training).



a)

b)

Figure 2: Views of the TMF from its northern side

The training participants visited the TMF on June 3, 2021, from 8:00 am to 12:00 pm. First, they briefly got acquainted with the enterprise activity and received safety instructions. Then they visited the TMF site by bus provided by the enterprise. Due to the proximity of key TMF elements, the allotted time was generally sufficient for a brief visual inspection. Besides, the participants used the drone to look at the whole TMF area. However, due to the large perimeter length, it was decided to inspect only critically important and closely located sections of the enclosing dams. Therefore, the following TMF elements were examined:

- a section of the dam crest of the TMF with the visible fragment of lining;
- a pumping station for pulp delivery to the tailings pond;
- checkpoints for water level monitoring in the dam.

Due to the close location of the critically important TMF elements and the possibility of travelling only by one bus provided by the company, the visual inspection was carried out by a single group accompanied by the enterprise staff. Afterwards, the participants worked in the office supervised by the TMF staff representatives. Taking into account the hybrid format of the event, filling in the Checklist and safety level evaluation were performed by one group of participants with the opportunity to get consultations from the trainers online.

Special attention was paid to the stability issues of dams and slopes, protective coating on the tailings surface, drainage facilities and water recycling systems, and monitoring systems for the technical condition of dams. The accompanying staff gave detailed answers to all clarifying questions.

The participants noted that almost all systems for ensuring the safe operation of the TMF are in satisfactory condition, maintained and operating without any evidence of accidents that might have occurred in the past. The dam's technical conditions are monitored regularly and, in general, sufficiently; however, the enterprise is introducing new control systems for individual parameters that were not previously recorded.

After the TMF inspection, the training participants answered all 38 questions of the TMF Checklist B Group 1 “Detailed visual inspection” in the office. In addition, the training participants took photos and recorded a video during the site visit, which was sent to the trainers for their independent study

and evaluation. Based on the submitted materials and conversations with the participants, the trainers slightly modified the evaluation results, as demonstrated in Fig. 1, Table 3 and 4.

1.2. TMF documents verification

The trainers filled out the answers to the Checklist B Group 2 questions "Detailed document check" using the technical documentation [3] provided by the TMF operator. The training's participants had the opportunity to check the correctness of the answers using the basic information provided by the TMF operator in advance (see Annex 1) and ask questions to the enterprise personnel who attended the training.

In general, the brief information provided by the operator on the TMF (see Annex 1) contains the data necessary to familiarize with the facility and its location. At the same time, it does not reflect some issues, in particular, the TMF impact on groundwater, hydrogeological regime on the TMF territory, detailed chemical composition of flotation tailings; monitoring of the groundwater and the parameters of the physical stability of dams.

Most of the questions in Checklist B Group 2 were answered positively. At the same time, the trainers did not have sufficient data and information to answer "Yes" to 10 out of 223 questions; these are listed in Annex 3 with the relevant justifications. These questions concerned mainly the aspects of environmental impact and risk assessment, design documentation, including the Environmental Impact Assessment and the closure/rehabilitation plan, and monitoring.

The results of the documentation check, with a short justification for each answer, were included in the Checklist in an MS Excel format, which was used in the safety evaluation in combination with the visual check. The general conclusions of the trainees are presented in the next section; the detailed evaluation results are contained in two MS Excel files, not available for public use. Photos and video materials recorded at the site are also attached in electronic form.

2. Evaluation results

The overall evaluation results (Table 1, Fig. 3) showed a relatively high level of compliance of this TMF with the safety requirements defined in the UNECE Safety Guidelines and Good Practices for TMFs [1]. As a result of the visual inspection, with the results of which the trainers agreed, the TMF safety level was rated very highly: the parameter "Compliance with safety requirements" was 98% and "Credibility" at 94,6%; the minor discrepancies in two evaluations are explained in Annex 2. The trainers estimated the same parameters for the Checklist B Group 2 at 98,8% and 97,3%, respectively.

Despite the sufficiently high degree of compliance with the safety requirements defined in the above UNECE Safety Guidelines, the overall TMF safety level has been identified as unacceptable, which follows from the criteria for the safety level evaluation recommended in the TMF Methodology [1, page 67]. According to the Methodology, a TMF can only have an acceptable safety level if 100% of the minimum safety requirements are met ("Compliance with safety requirements" (MSR) is 100%); the other option "Acceptable with conditions" is applied if all answers are "yes" or "mostly yes". The safety level is considered unacceptable in all other cases (MSR < 100%). Both training participants and trainers gave at least one answer, "mostly no" (see question 34 in Annex 2), thus, the conclusion on the "unacceptable safety level" has been drawn. This approach was adopted to encourage the operator to take measures to improve the TMF safety level until 100% of the requirements from the minimum set are met.

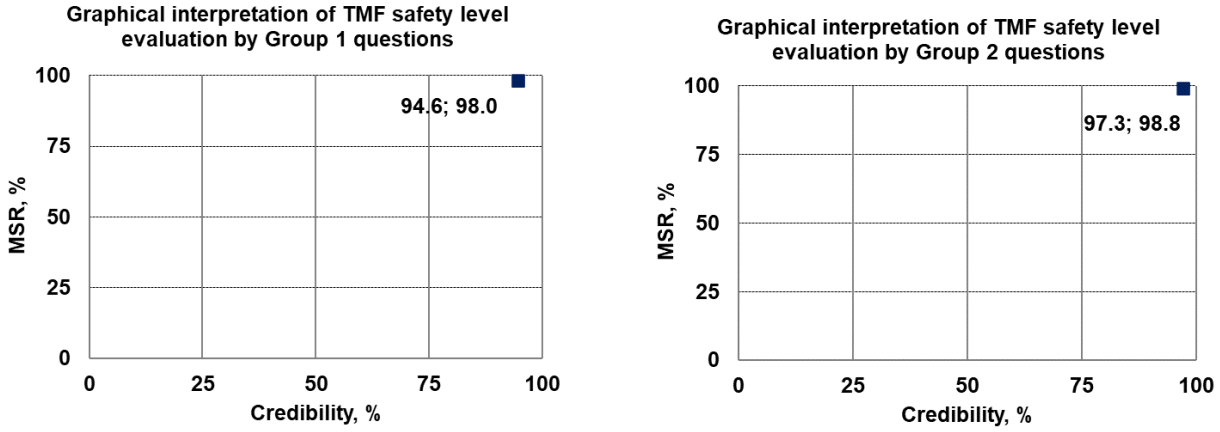
During the inspection, some inconsistencies regarding the safety requirements were identified. The participants found some inconsistencies with the design project of the pipeline positioning and noticed the incompleteness of the meteorological data collected for the site. Based on the provided photos and videos, the trainers also noticed the need to neutralize drainage water and maintain a protective layer (i.e. water) covering the entire surface of the tailings dump (f. i., with water).

Annex 2 contains the answers to Checklist B Group 1 questions for the visual inspection. The trainers evaluated the TMF conditions online and did not have access to work with the confidential documentation on-site. They agreed with the explanations and arguments of the training participants and enterprise representatives regarding the answers to the visual inspection questions.

Table 1: Overall evaluation results of the TMF

Evaluators	Checklist questions	Not applicable, %	Yes, %	Mostly yes, %	Mostly no, %	No, %	MSR, %	Credibility, %
Group of trainees	Checklist B Group 1 «Visual inspection»	2,6	92,1	2,6	2,6	0,0	98,0	94,6
Trainers (D. Rudakov and D. Pikarenia)	Checklist B Group 2 «Document check»	0,9	95,5	2,7	0,0	0,9	98,8	97,3

Figure 3: Overall TMF safety evaluation: a) the visual inspection results, b) the results of document check. MSR = Meeting safety requirements.



a) b)

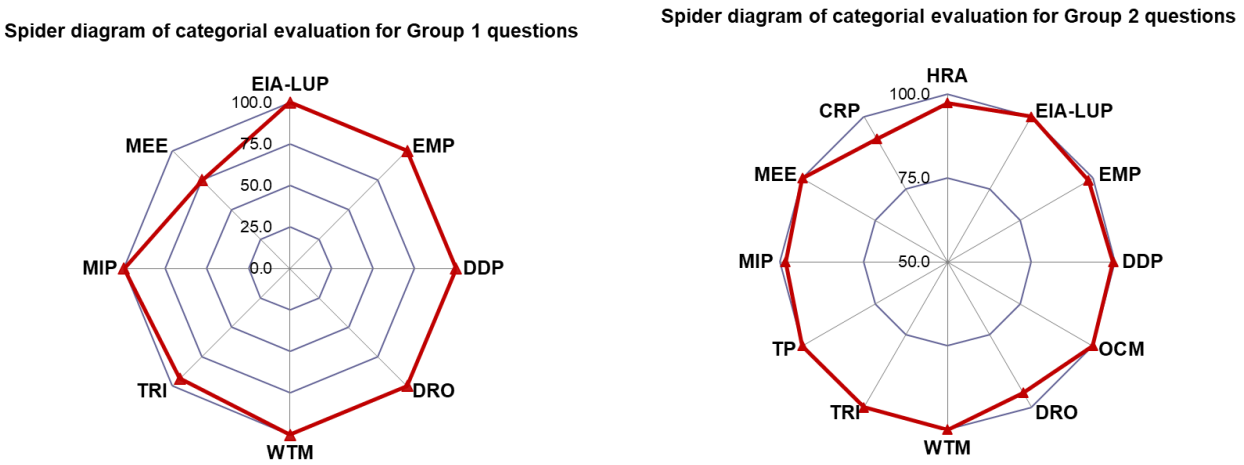
The general conclusion about the unacceptable TMF safety level was made based on the above-mentioned criteria.

The categorical evaluation (Fig. 4) revealed aspects of the TMF functioning with lower safety indicators, which should be addressed first by the appropriate safety improvement measures: monitoring, including the dam and infrastructure condition, closure and rehabilitation plan.

The results of the visual inspection and documentation verification look similar, which indicates that the actual state of the TMF is generally consistent with what is reflected in the available documents. However, this conclusion can be corrected upon the trainers' familiarization with the confidential documentation on the TMF on-site.

The application of the TMF Checklist in training in Tajikistan showed its successful application as an effective tool for the visual inspection of the TMF condition. Moreover, the checklist method can help reveal the primary deviations from industrial and environmental safety requirements.

Figure 4: Categorial evaluation of TMF safety for visual inspection (a) and document verification (b)



a) b)

Abbreviations in Figure 4 see in Table 2

Table 2: Abbreviation of categories of TMF performance

Abbreviation	Categories
HRA	Hazard Identification and Risk Assessment
EIA-LUP	Environmental Impact Assessment and Land-use Planning
EMP	Emergency Planning
DDP	Design Documentation and Permitting
OCM	Organizational and Corporate Management
DRO	Dam Raising Operations and Tailings Control
WTM	Water Management
TRI	Transportation and Infrastructure
TP	Trainings and Personnel
MIP	Monitoring Infrastructure Elements and Processes
MEE	Monitoring of Environmental Elements
CRP	Closure and Rehabilitation Plan

3. Recommended measures to be taken by the operator and competent authorities

Based on the Measure Catalogue of the TMF Checklist, the training participants recommended applying measures 1 through 5 from Table 3 (see below), with which the trainers agreed. The presentation, made by the participants during the training with the evaluation results and recommended measures, is attached to this report in electronic form. Based on the documentation verification , the trainers recommended applying the measures included in Table 4 (see below).

Table 3: Recommended measures 1-5 to overcome observed safety deficiencies at the TMF based on the results of the visual inspection, suggested by training participants

No.	Recommended measure	Priority
1.	Update or prepare documentation on the pipeline locations and routing	Short-term
2.	Check that pressure pipelines are not laid on the surfaces of the embankment	Short-term
3.	Check that all vulnerable pipelines are equipped with devices to detect unwanted leakage and discharges	Short-term
4.	Check the compliance of checkpoints with the project documentation	Short-term
5.	Check the technical conditions of the monitoring network	Short-term

Table 4: Recommended measures to overcome observed safety deficiencies at the TMF, based on the results of the visual inspection, suggested by training participants

No.	Recommended measure	Priority
1.	Assess flooding risk for the TMF	Short-term
2.	Perform the study per possible accident scenarios and their after-effects	Short-term
3.	Assess the stability of TMF technical components considering site solid matter properties and appropriate safety criteria	Short-term
4.	Assess the feasibility of measures to stabilize/strengthen the dam	Short-term
5.	Check the conformity of checkpoints to the design documentation	Short-term
6.	Equip the TMF site with additional wells and checkpoints for monitoring basic parameters (see Recommendations for TMF monitoring)	Mid-term
7.	Carry out technical upgrading of checkpoints	Mid-term
8.	Regularly conduct trainings and field exercises to enhance the TMF staff preparedness for emergencies	Mid-term
9.	Develop an action and monitoring plan for TMF closure	Short-term
10.	Elaborate technical measures for rehabilitation of the TMF using suitable (artificial) topsoil	Long-term
11.	Check the consistency of the TMF operation manual	Short-term

The proposed measures will allow addressing the following issues identified during the visual inspection:

1. Improve the design documentation, including the development/update of the TMF closure/rehabilitation plan (measures nr. 1 of Table 3 and nr. 1, 9, 10, 11 of Table 4).
2. Assess all environmental impacts caused by the TMF (measures nr. 1, 2 of Table 4).
3. Ensure compliance of the pipeline and dam characteristics with safety requirements (measures nr. 2, 3 of Table 3 and measures 3, 4 of Table 4).
4. Improve the monitoring schedule and/or network (measures nr. 4, 5 of Table 3 and nr. 5, 6, 7 of Table 4).
5. Improve emergency preparedness and response at the TMF (measures nr. 8 of Table 4)

Conclusions

1. The TMF was primarily selected due to its transboundary importance, as well as the willingness of the management of the JV "Zarafshon" to cooperate and its interest in improving the safety of this TMF. The enterprise management provided an opportunity for a brief visual inspection during the on-site training and the use of photos and video by the trainers for independent TMF safety evaluation.
2. The use of the TMF Checklist in training showed its successful application as an effective tool for the visual inspection of a TMF condition even with the online support of the trainers or experts, thanks to which the checklist approach can reveal some non-compliances with industrial and environmental safety requirements.
3. The assessments made by the participants (on-site) and trainers (online) based on the visual inspection coincide, with the key indicator "Compliance with safety requirements" being evaluated at 98%. Taking into account the high value of this indicator for the documentation verification 98,8%, the TMF condition can be assessed as relatively good. However, currently, it does not meet all the requirements from the minimum set defined by the relevant UNECE Safety Guidelines and Good Practices for TMFs. Therefore, considering that even 1% of non-compliance with the basic safety requirements may cause a disaster, the TMF safety level was identified as unacceptable.
4. Trainees actively participated in the discussion; company representatives answered all the questions; the trainers were also involved in the discussions. The TMF safety level, evaluated based on the documentation check by the trainers based on the provided photos/videos, is quite high, with the indicator "Meeting safety requirements" assessed at 99,8%.

5. During the visual check of the TMF, some safety deficiencies were identified; the participants recommended that the operator should take a number of measures to improve the safety level of the TMF; among them, the most important is improving the monitoring system.
6. The on-site training conducted in Penjikent and the application of the TMF Methodology was an important step towards strengthening the safe management of mine tailing facilities in Tajikistan. This case study adds to the pile of those few examples that demonstrated the detailed application of the TMF Methodology, thereby improving cooperation among competent authorities and operators and strengthening their capacity. The approach taken by Tajikistan would also help other countries with tailings management facilities to strengthen their safe management at the national and local levels. The TMF Methodology can be recommended for use by other national competent authorities and should be considered at inter-institutional meetings with representatives of all competent authorities in the fields of mining, industrial, and environmental safety. As such, the application of the UNECE Safety Guidelines and TMF Methodology will complement efforts to strengthen tailings safety by applying the Global Industry Standard on Tailings Managment.[2]
7. According to the opinion of the trainers, the critical importance of the visual check (even if performed online with remote control devices) in evaluating the safety of a TMF requires updating the UNECE Safety Guidelines and Good Practices for TMFs in terms of the inclusion of more detailed recommendations for the visual check (in particular, clause 100 of Section B.3).
8. It would be useful to involve the experts who would not be dependent both on the TMF operator and competent authorities (for example, environmental auditors) in the follow-up to on-site trainings, which would facilitate the dissemination of the TMF methodology among its potential users and support the continued and sustainable use of the UNECE Safety Guidelines and related TMF Methodology.
9. There are three remarks on improving the TMF Methodology updated after the project in Romania [2]. 1. Since the TMF Checklist is intended to be used both inside and outside the EU, three questions of the Checklist B Group 2 (nr. 31, 32, and 201) should be amended by mentioning national regulation without reference to the EU regulation. 2. The weight "1" of the answer "No" in Table 8 should be replaced with "0" to avoid overestimation of the TMF safety level; if all questions are answered "No" and the weight "1" the "Compliance with Safety Requirements" becomes equal 25%, but it should be equal 0% because no safety requirement is met. Besides, the numbers N_1 and N_2 of questions in Eq. 14 for TMF safety level evaluation should account for the number of relevant questions. This is not significant for the inspected site in Tajikistan with a quite low share of non-negative questions but may be applicable for other sites. 3. Regarding the conclusion on "the unacceptable safety level" drawn based on just one answer "mostly no" and the overall evaluation of over 90% the criteria of the TMF Methodology are recommended to be refined.

[2] More information about the Global Industry Standard on Tailings Management, conducted by the International Council on Mining and Metals (ICMM), the United Nations Environment Programme (UNEP) and the Principles for Responsible Investment (PRI), is available from https://globaltailingsreview.org/.

Annex 1. Basic information on the TMF of JV "Zarafshon" (Penjikent district, Sughd region, Tajikistan)

<table>
<tr><th>Nr.</th><th>Category</th><th>Information provided by the TMF operator</th></tr>
<tr><td>1</td><td>Technical information and design documentation: flowcharts, description of the production process used at the enterprise, specification of input raw materials, chemical and physical composition of tails, etc.</td><td>The design and estimate documentation of the TMF of JV "Zarafshon" was prepared in accordance with the requirements of norms and rules on safety and environmental protection, approved by the Ministry of Industry and New Technologies of the Republic of Tajikistan (RT) and the Service of the State Supervision over the Safe Conduct of Work in Industry and Mining Supervision under the Government of the Republic of Tajikistan, has a positive conclusion of the environmental expertise and construction expertise.
The accident elimination plan has been agreed upon with the Committee for Emergencies and Civil Defense under the Government of the RT, the Headquarters of the Paramilitary Rescue Units (HMRS) and the local executive authorities of Penjikent city.
The ores are processed by the method of carbon-in-leach (CIL) and the method of dump leaching. The chemical composition of processed ore waste includes Au, Ag, Cu, As and other components in small quantities.</td></tr>
<tr><td>2</td><td>Geographical site information: climatic conditions, including weather extremes, wind speed, precipitation, and floods.</td><td>Climatic characteristics of the area are taken from long-term meteorological observations at the station Penjikent, located 30 km away from the site location, and the archives of the State Enterprise "Hydrometeorology".
The region's climate is typical for the semi-desert mountain regions of Central Asia; it is characterized by sharp changes in air temperature in the annual and daily cycle. The area belongs to the zone of dry subtropics; this climate is characterized by a high recurrence of dry weather with high summer temperatures. The area's climate is continental and influenced by the mountains, which leads to dry, hot summers and cold winters. The average annual air temperature is 12,3 °C, the average annual minimum temperature is 5,2 °C. The average monthly temperature of the hottest period is 25 °C, and temperatures of the coldest period in December-February are –1,2 °C, –2 °C, and –1,6°C. The maximum temperature is 39 °C.
The annual precipitation varies from 264,5 to 765,6 mm, with an average of 332 mm. In winter, precipitation has the form of rain and wet snow ranging from 43 to 48 mm per month. The long-term average annual total height of snow cover for winter does not exceed 87 cm, and the weight of snow cover is 25,2 kg/m^2.
The average annual potential evaporation for the region ranges from 1600 mm to 1700 mm, which is 3-5 times higher than the annual precipitation. The maximum absolute humidity of 10.5-10.7 mb is observed in July-August.
The maximum wind velocity possible once a year, 5 years, 10 years, 15 years, 20 years reaches 15, 19, 21, 24 m/s, respectively. The number of days with dust storms averages 9 days a year, and the days with fog do not exceed 4 days a year.
The average annual wind rose according to long-term observations is in the table below (in %):
<table>
<tr><td>N</td><td>NE</td><td>E</td><td>SE</td><td>S</td><td>SW</td><td>W</td><td>NW</td><td>calm</td></tr>
<tr><td>1</td><td>4</td><td>31</td><td>3</td><td>2</td><td>14</td><td>41</td><td>4</td><td>34</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Nr.</th><th>Category</th><th>Information provided by the TMF operator</th></tr>
<tr><td></td><td></td><td>No soil subsidence and landslides were recorded for this area.</td></tr>
<tr><td>3</td><td>TMF Deposition Plan: maps, schemes, cadastral borders, adjacent infrastructures.</td><td> 

The TMF of JV “Zarafshon” is located within the land allotment allocated to the company as the land for industrial use in accordance with the certificate issued by the Government of the RT.
The TMF borders the following settlements: the village of Sogdiana at a distance of up to 1,5 km, the village of Novichomok at a distance of 1,5 km, and the village of Humgaron at a distance of 1,5 km. In addition, there is an auxiliary infrastructure for maintenance on the territory of the TMF site, and a store of highly toxic substances is located 0,5 km from the TMF.</td></tr>
<tr><td>4</td><td>Geological and hydrogeological conditions: seismic activity, landslides, faults, karst areas, soil properties, groundwater regime, etc.</td><td>The TMF is located 450 km away from the borders of the seismic zone of high activity in the south (Afghanistan); it is located directly in the city of Penjikent, Sughd region of the RT. According to the previous geological studies conducted by “Naid Pisold MGRE” during the design and construction of the facility, the area consists geologically of low-thickness layers of fine-grained sand and siltstone clays. Landslides, soil subsidence and faults were not recorded for this area. A small amount of groundwater was found in depth; during the construction period, they were diverted outside the TMF section and the dam with the drainage trenches and a network of drainage pipes.
The table of seismic acceleration of the ground evaluated during the construction by the company "Naid Pisold" can be seen below.
<table>
<tr><th>Return period, years</th><th>Soil acceleration, parts of g</th></tr>
<tr><td>20</td><td>0,034</td></tr>
<tr><td>50</td><td>0,047</td></tr>
<tr><td>100</td><td>0,060</td></tr>
<tr><td>500</td><td>0,140</td></tr>
<tr><td>1000</td><td>0,207</td></tr>
<tr><td>5000</td><td>0,517</td></tr>
</table></td></tr>
<tr><td>5</td><td>Ecological environment: flora,</td><td>The river Magiandarya flows close to the site at a distance of 2 km; an irrigation canal is at a distance of 1,3 km from the site; the river Zarafshon is at a distance of more than 12 km from the site, and a</td></tr>
</table>

Nr.	Category	Information provided by the TMF operator
	fauna, water and land ecosystems.	small pond with fish and birds (murgobi) is located 0,3 km downstream. Water quality is constantly monitored in these reservoirs and rivers by the department of the ecology of the company. The site is surrounded by plots of land at a distance of 0,8 km and more belonging to local farmers, where various crops are grown (millet, barley, corn, peas, legumes, potatoes, carrots, etc.), there are orchards (apple, almond, peach etc.). On the periphery of the site, the laboratory of the Committee of Ecology of the RT annually monitors water quality in open reservoirs and groundwater, as well as soil, air, noise and radioactivity. The sanitary norms and limits, and maximum permitted discharges were not exceeded.
6	**Social environment:** location, condition and size of communities and settlements; land use, access to the TMF territory.	The facility is located near the city of Penjikent in theSughd region of the RT. The town of Sogdiana with a population of more than 4500 people is located at a distance of 1,5 km, the villages of Novichomok and Humgaron are at a distance of 1,5 km with a population of 2900 and 2500 people, respectively, and downstream the village of Chorbog at a distance of more than 3.0 km with a population of more than 9000 people is located. All the land outside the land allotment of the company belongs to local farmers. Access to the TMF area is strictly prohibited; the site is guarded around the clock by the police protection department of Penjikent under a contract with the company.
7	**Risks to:** surface water bodies, groundwater, air, soils, and biota.	There are no risks to water bodies and groundwater, as all groundwater is diverted, 100% of the bottom surface and sides of the TMF are completely lined with a special film, which eliminates the ingress of technical water into reservoirs and other water sources. The operation of this facility eliminates the ingress of waste from the TMF area, the sanitary protection zone of the enterprise. This prevents from pollution of water basins and groundwater, soil, air, which is proved by the annual analysis and results of environmental monitoring carried out at the enterprise.
8	**Stored material**: hazardous substances and materials stored in the TMF.	Only waste from processed ores is stored in the TMF area in two separate sections. Section no. 1 contains Au, Ag, WO_3 in tailings, the section no. 2 contains Au, Ag, Cu, As and other chemical elements at insignificant quantities. Before being delivered to the tailings pond, the materials are neutralized, the content of sodium cyanide in tailings is below the maximum allowed concentration.
9	**TMF history:** construction and operation periods, contractor(s), accidents occurred.	Construction of the TMF nr. 1 began in 1994 according to the UK company design; construction works were carried out under the control of “Naid Pisold” and the USA company “Bateman”. Construction of the TMF nr. 2 began in 2008 according to the Chinese company design; construction works were carried out by the Chinese company “BASIN Engineering”. The State Committee for Architecture of the RT monitored the progress of construction.
10	**TMF management:** bodies/persons res-ponsible for TMF operation/maintenance.	The management and operation of the TMF is handled by JV “Zarafshon”. Rajabov Narzullo, the head of the TMF, is responsible for its operation.

Annex 2. Answers to the questions of TMF Checklist B Group 1 "Detailed visual inspection"

Nr.	Question	Answers of training participants
1	Is the TMF site located beyond the zones/areas subject to negative influence of extreme atmospheric conditions (floods, extreme precipitation, strong winds, extreme temperature)?	Yes
2	Is the zone of TMF impact (downstream or beyond the TMF protective zone) free from evidences of soil erosion which might happen as a result of uncontrolled drainage? (If applicable)	Yes
3	Is the surrounding area of the TMF free from evidence of impacts to the environment caused by the TMF, that can lead to dam stability problems?	Yes
4	Does the actual location of the elements of the TMF correspond to the permitted design documentation and TOP?	Yes
5	Do the TMF infrastructure components (roads, ponds, pipelines, protective zone facilities etc.) match the licensed TMF design documentation or TOP?	Yes
6	Are there facilities functioning in line with the project documentation for control the concentration of dangerous substances in process water and an alarm system for the case of increased concentration? (if applicable)	Yes
7	Is the position of the pipeline system and disposal points compliant with licensed working procedures?	Mostly yes
8	Are flowmeters of the inlet pipe in full working order, ensuring that inlet pipes are clear of obstructions?	Yes
9	Are return pumps and flow switches in full working order and operate in secured pump chambers?	Yes
10	Are the joints of the pipeline system free of failures, leakage or deterioration?	Yes
11	Is there a controlling system in the operable condition that terminates tailings material delivery in case of emergency at the TMF?	Yes
12	Is the functionality of the tailings drainage system checked regularly (daily / weekly…) in line with the monitoring procedures fixed in the TMF operation manual?	Yes
13	Is there a functionally integrated dam water management system that works in line with the licensed project documentation?	Yes
14	Does the dam have drainage facilities and/ or emergency spillways that allow water to pass if the normal retaining (working) level in the TMF is exceeded?	Yes
15	Are there functional and well-maintained water diversion (tunnel) structures that diverts all-natural surface runoff around the TMF borders during heavy rainfall or snowmelt periods?	Yes
16	Are there functional and well-maintained emergency water release structures for the case of overtopping, which are functioning in line with the licensed documentation?	Yes
17	Are there facilities functioning for collecting, control and neutralization of drainage water before discharge to surface watercourses? (if applicable)	Not applicable
18	Are substances hazardous/dangerous to aquatic eco-systems removed/neutralized before their disposal to TMF down to the permitted emission limits (if applicable)?	Yes
19	Are there functional and well-maintained storm water retaining structures that fulfil their functions shown in the licensed documentation?	Yes

Nr.	Question	Answers of training participants
20	Do the dam crest surface and walls appear to be in sound condition and maintained against dam erosion?	Yes
21	Is the TMF dam body free from evidence of movement, failure or instability?	Yes
22	Are the TMF dam junctions free from evidence of movement, failure or instability?	Yes
23	Does the embankment slope have an angle that fulfils the minimum long-term factor of safety requirements fixed in the design documentation?	Yes
24	Does the embankment crest slope have an angle that fulfils the minimum short-term or dynamic factor of safety requirements fixed in the design documentation?	Yes
25	Is there evidence of carefully managed material separation for the dam wall which fulfils the quality requirements fixed in the TOP?	Yes
26	Is the total tonnage and volume of tailings and water discharged into the TMF recorded on a regular daily basis?	Yes
27	Is the dam free from evidence of leakage, seepage, or piping?	Yes
28	Is there a cover layer on the TMF embankment surface to reduce/prevent dusting?	Yes
29	Are the wells for checking groundwater level and composition around the TMF site in operational condition and monitored in line with the licensed TOP?	Yes
30	Are the wells for checking the phreatic surface level and pore pressure in the dam in operational condition and monitored in line with the licensed TOP?	Yes
31	Is slope slippage/movement and/or soil subsidence monitored in line with the licensed TOP?	Yes
32	Are operational parameters (rate of rise of the lagoon surface, minimum permitted width of beach, beach/ lagoon ratio, freeboard between lagoon surface and dam crest) of the lagoon in agreement with the licensed TOP?	Yes
33	Is there evidence of a well-functioning drainage system downstream of the tailings dam, and its monitoring is in line with the licensed TOP?	Yes
34	Is the site meteorological data recorded on a daily regular basis?	Mostly no
35	Is there evidence of monitoring procedures in line with the licensed operation manual for regular acquisition of contamination indices for water, soil, and air?	Yes
36	Is there evidence of internal emergency preparedness (existence and condition of an alarm system, communication equipments, availability of emergency protocols at the site)?	Yes
37	Are the TMF and adjacent facilities secured at a satisfactory level (warning sign / fence / security staff) against the third party and animal ingress?	Yes
38	Is TMF equipped with necessary fire extinguishing facilities (if applicable)?	Yes
Total answers “no”		**0**
Conclusion about the TMF safety level		**Unacceptable**

Annex 3. Answers to the questions of TMF Checklist B Group 2 "Detailed document check"

The trainers answered "Yes" to all questions except those in the table below. See justifications for all answers except "Yes" in the table.

Nr.	Question	Answer	Justification
5	Based on a risk assessment, are human settlements located outside the area of the TMF impact?	No	In case of dam failure, the settlements located downstream in the valley are in the zone of impact.
37	Was potential underlying mineralization (former or planned underground workings) taken into account in the EIA?	Not applicable	Underground workings are missing in the area of TMF impact.
66	Was a detailed waste management plan for the TMF worked out during the development phase?	Mostly yes	The plan was likely to be developed, but no confirmation has been provided.
92	Do inspection protocols prove that the dam erosion conditions are monitored and are within a safety range defined in the design documentation?	Mostly yes	The control over horizontal displacements is confirmed.
149	Is a Major Accident Prevention Policy and Safety Management System (or equivalent documentation) developed and regularly updated for the TMF?	Mostly yes	The information on the existence of such a document was not provided, but it should exist.
158	Are inundation maps developed for slow, rapid and practically instantaneous dam failure scenarios?	Mostly yes	Such maps should exist, but no relevant information was provided.
176	Is seismic activity monitored at the TMF, considering that the TMF is located in a medium-high risk seismicity area? (If applicable)	Not applicable	There is information on the seismic activity of a large area, but it is not monitored at the TMF.
177	Has erosion phenomena of the TMF dam checked regularly according to operation documents?	Mostly yes	The control over horizontal displacements is confirmed.
206	Were measures considered and applied to ensure long-term stability of physical, geotechnical and biological parameters of the site after TMF closure?	Mostly yes	Such measures were likely to be considered, but no information in the closure and rehabilitation plan was provided.
210	Is it planned to cover the rehabilitated TMF site with artificial topsoil?	No	Covering with the artificial topsoil in the mountain region in rehabilitation is impossible due to scarce topsoil.

References

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3. Environmental impact assessment on the production and economic activities of the Tajik-Chinese LLC JV Zarafshon. Volume 1 (explanatory note). Ministry of Industry and New Technologies of the Republic of Tajikistan, Tajik-Chinese LLC JV Zarafshon. Dushanbe, 2021.