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 introduction workshop, on-site training and evaluation workshop (Kokshetau, Kazakhstan, 11–13 June 2019) 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 LLC «Altyntau Kokshetau» (Kokshetau, Republic of Kazakhstan)

Contents

Prepared by Dmytro Rudakov and Dmytro Pikarenia
– trainers for the on-site training –
in June 2019, 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 11-13, 2019 in the city of Kokshetau (Kazakhstan). 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 Kazakhstan and beyond in Central Asia, implemented in 2018-2019 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 [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 Kazakhstan, Tajikistan and Kyrgyzstan. The training included a theoretical part – comprised of a seminar on safety issues, outlining the basics of the above UNECE Safety Guidelines, the related TMF Methodology and their practical application – and a practical part, i.e. visiting the facility and conducting a visual check. Mr. Dmytro Rudakov, consultant of the UNECE Industrial Accidents Convention, supported by Mr. Dmytro Pikarenia, led the conduct of the on-site training, facilitated the completion of the checklist documentation by the operator and during the group work, and prepared this report, with the support of the secretariat of the UNECE Industrial Accidents Convention.

The TMF site selection was undertaken by the Kazakh competent authorities, led by the Ministry of Industry and Infrastructural Development 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 possible transboundary effects. At the same time, the site selection for the training was limited by the long distances to other TMFs from the capital, access restrictions to some facilities due to rare metal production which were considered by the Kazakh national competent authorities as strategic raw materials, as well as the readiness of the TMF operators to cooperate and their interest in improving safety of their TMFs. Following the careful evaluation of the various aspects, the company LLC “Altyntau Kokshetau” was selected by the Kazakh national competent authorities for the conduct of the on-site training. The TMF of the gold processing plant LLC “Altyntau Kokshetau” was built and put into operation in 2009 (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) has been used. The TMF Methodology has been developed, tested and considered useful in several projects implemented as a part of the work plan of the UNECE Industrial Accidents Convention under the leadership of the German Environment Agency, including in Armenia, Georgia and Ukraine.[1]

The TMF methodology includes the **Tailings Hazard Index (THI)** – for assessing the hazard of a large number of facilities at the national/regional level – and TMF Checklists – for assessing the safety level of individual TMFs. The THI allows competent authorities to rank the 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. The TMF of the LLC "Altyntau Kokshetau" was ranked 42 out of 121 TMFs in Kazakhstan.

The **Checklists** in the TMF Methodology consist of Questionnaires which allow for the following: a basic 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 subgroups; the first one contains questions for a visual check and the second one questions for a document check. Document check questions are mainly based on UNECE recommendations, while the questions and criteria for visual check are largely based on the professional experience of the experts involved and Checklist developers. Regarding to the great importance of visual check, it would be reasonable to integrate the visual check criteria in the UNECE TMF Safety Guidelines.

The TMF Checklists are accompanied by both 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, allowing for the automatic calculation of the safety level, based on the replies to the questions in the Checklist. The Measure Catalogue, also available in Excel, from which the user can chose relevant measures, provides a number of possible actions to solve the identified safety issues. The developed Excel template for the evaluation matrix and the Measure catalogue were disseminated among all participants prior to the start of the TMF safety evaluation.

The Checklist questions are formulated in a way to cover the minimum set of requirements important to TMF safety and to reliably assess the facility condition. 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 on licensing, risk assessment, dam safety, management, training of personnel, monitoring, emergency planning, closure, etc. A number of Checklist questions are considered as 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 are interpreted as significant problems in tailings safety.

The **Evaluation Matrix** provides a quantitative assessment of the safety level for the TMF being checked in accordance with the current safety requirements formulated in the checklists. The Evaluation Matrix unifies the answers to the questions and generates an overall and categorial

[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 and www.umweltbundesamt.de/en/topics/sustainability-strategies-international/cooperation-eeca-centraleastern-european-states/project-database-advisory-assistance-programme/improving-the-safety-of-tailings-management.

evaluation based on the parameter “Meeting safety requirements”, which allows thorough checking all TMF safety elements and identifying safety problems. In addition, the matrix allows estimating the uncertainty that arises in case of a lack of data about the facility being checked and 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 an acceptable safety level; 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 Checklist B “Detailed Check” including visual check carried out by participants during the training (Checklist B.1 “Detailed visual check”) and the check of the company documentation (Checklist B.2 “Detailed document check”), performed by the personnel of the company responsible for the TMF operation in coordination with the on-site trainers. The other TMF checklists were irrelevant at this case because Checklist A is intended for competent authorities and Checklist C is intended for inactive sites. The TMF safety level has been evaluated using the version from August 2018 of the TMF Methodology.

1.1.Visual check

The TMF is located in Zerendinsky district of Akmola region of the Republic of Kazakhstan (Fig. 1). The views to the TMF from the point 1 (see Fig. 1,b) are shown in Fig. 2. General information on the facility and its production prepared by the company personnel see in Appendix 1 to this report.

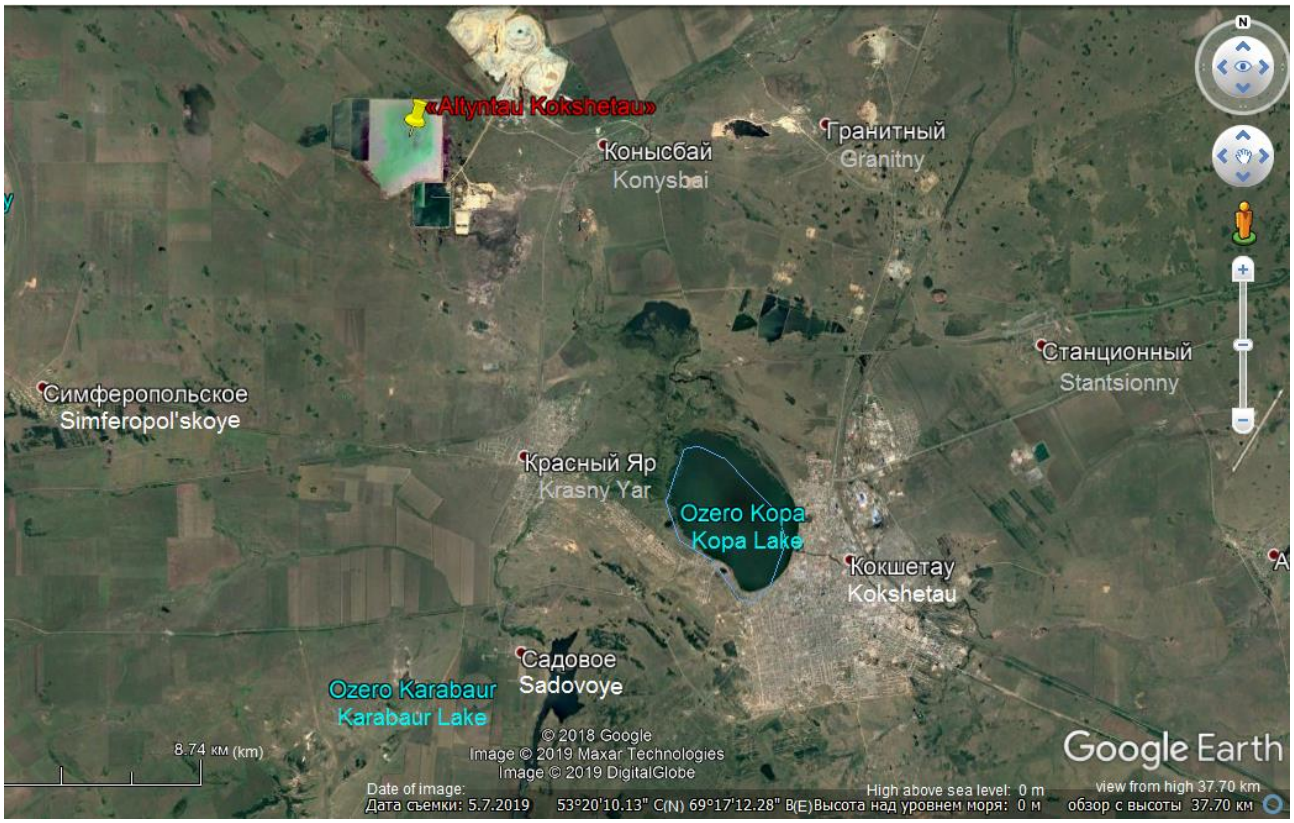
The training participants visited the TMF on June 12, 2019. They were initially at the enterprise from 2:00 pm to 2:45 pm and briefly got acquainted with the company activity; they taught occupational safety instructions and visited the control center of tailings delivery to the facility.

From 3:00 pm to 4:15 pm local time, a group of training participants visited the TMF site using the company bus. Due to the close location of key TMF elements this time was, in the whole, sufficient for a rapid visual inspection. In view of the long dam perimeter it was decided to inspect only critically important and closely located sections of enclosing dams at a maximum distance of 400 m from each other. The following TMF elements were examined:

- the section of the dam crest of the TMF containing sorption waste in the lowest elevation position in the junction of perpendicular dams;
- the settling pond of water from the flotation TMF and equipment for recycling water supply;
- a drainage channel that, in addition, intercepts surface runoff.

Due to the close location of the critically important TMF elements and the possibility to move with only one bus provided by the company, the visual check accompanied by company staff was carried out by a single group with the possibility to deviate from the main route. Afterwards, the participants were divided into two equal groups so that each group had at least one participant from each beneficiary country. Filling in the Checklist and safety level evaluation were performed separately by the two groups of participants, which enabled objectively comparing their results.

Figure 1: TMF location on-site (a) and its elements visited by training participants (b): 1-2 – upstream side of the enclosing dams; 3 – the bottom-line of the dam, observation wells; 4 – enclosing dam of the settling pond; 5 – pumping station for recycling water supply; 6 – drainage channel and enclosing dam of the settling pond. Red lines are the routes of inspecting the TMF by training participants.



a)

b)

Figure 2: Views to the flotation TMF from the point 1 (see Fig. 1,b) to the west (a) and north-east (b)

Particular attention was paid to the stability of dams and slopes, protective covering on the surface of tailings, drainage facilities and water recycling system, the system to control technical conditions of the 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 operated without any evidence of accidents that might occur in the past. Technical conditions of the dams are monitored regularly and, in general, sufficiently; in addition the company is introducing new control systems for individual, previously unrecorded parameters. At the same time, the lack of a protective coating on a certain part of the tailing pond leads to deflation (swelling of tailings materials by wind) and dusting that participants felt on themselves. It has been noticed that the conditions of technical systems to respond in case of emergency meet the safety requirements.

Forty minutes after examining the critically important TMF elements the trainers together with all participants and consulted by the accompanying company managers preliminarily filled in the answers to all 37 questions of Subgroup B.1 “Visual inspection” of the TMF Checklist. Some questions caused a discussion between the participants; they were proposed to be discussed in more detail the next day when filling in the Checklist in the MS Excel file during the work of the groups after the on-site training.

1.2. Check of TMF documentation

Answers to the Checklist B.2 questions “Detailed document check” were filled in by representatives of the enterprise using technical documentation [3-15] and discussed with the trainers. The training participants had the opportunity to verify the correctness of the answers using the basic information provided by the TMF operator in advance (see Annex 1) and to pose questions to the company personnel who attended the training.

In the whole, the basic information provided by the operator on the TMF (see Annex 1) contains the data necessary for familiarization with the facility and its location. At the same time, it does not describe some issues, in particular, the TMF impact on groundwater, hydrogeological regime near the TMF, chemical composition of flotation tailings; the measures to prevent dusting and the dust content in the atmosphere; the features of functioning the TMF in winter; monitoring of groundwater and parameters of dam physical stability; the presence of a protective screen at the base of the tailings and groundwater protection.

Most of the questions for checking documentation in Checklist B.2 were answered positively, which the trainers have realized when communicating with the company personnel and during the site visit. At the same time, in order to justify all 267 answers in that Checklist, as required by the

TMF Methodology, the trainers requested clarifications from the operator for 44 questions of Checklist B.2 for which such had been lacking or not been clear. After receiving clarifying information, 24 questions could not be answered positively and the trainers introduced the appropriate changes in the Excel file. These questions concerned some aspects of the design and construction of the TMF, monitoring of atmospheric air condition, prevention of dusting, control over dam technical conditions and actions in case of emergencies.

The results from checking the documentation, including a short justification for each answer, were included in the Checklist in MS Excel format, which was used in the safety evaluation in combination with the visual check. The general findings of the two groups are presented in the next section; the detailed evaluation results are contained in two MS Excel files, not available for public use.

2. Evaluation results

The overall evaluation results (Table 1, Fig. 3) showed, on the whole, 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 check, both groups rated the TMF safety level as follows: the parameter "Meeting safety requirements" at 79.4-86.1% and "Credibility" at 64.7-80.6%. The same parameters for the Subgroup B.2 were evaluated at 91.5% and 91.9%, respectively.

Despite the relatively 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. According to the Methodology, a TMF can only have an acceptable safety level if 100% of the minimum safety requirements are met ("Meeting safety requirements" (MSR) is 100%). In all other cases (MSR < 100%), the safety level is considered unacceptable. Such an approach has been taken in order to rouse the operator to take measures to improve the TMF safety level until 100% of the minimum set of the safety requirements [1] are met.

Some inconsistencies with the safety requirements have been revealed during the visual check, which reduced the evaluation of the TMF safety level. For example, until now the problem to reduce dusting has not yet been solved; the strategy for the TMF closure and rehabilitation has not yet been provided, the access to the TMF area of livestock and wild animals is not prevented. This poses a number of dangers like air and soil contamination. The access of nearby livestock to grazing in this area may negatively impact them due soil and air contamination and the consumption of contaminated animal products by the humans. In the worst case the access of livestock and wild animals may lead to their death followed by the decomposition of their bodies and the emerging risk of epidemics.

Appendix 2 contains the answers to Checklist B.1 questions of visual check. Regarding some questions, there was a subjectivity of assessments; as a result, different opinions concerning the answers to the questions were voiced. Analysis of the table shows that some discrepancies in the responses in the participant groups did not affect significantly the overall result. In general, the answers of groups to various questions are well agreed with each other at the statistically significant correlation rate of 0.65.

At the same time, the answers of Group 2 are more critical. This is probably due to the fact that the company managers took part in discussions of the participant Group 1 when filling the Checklist in contrast to Group 2, thus providing more complete information and their arguments to substantiate the answers. Besides, it might be the manifestation of subjectivity in assessment; its effect on the discrepancy of the parameter "Meeting safety requirements" can be estimated below 7%. In a

number of cases, due to the short visual survey time the participants did not see direct evidence to confirm positive answers and were only provided with the comments of the TMF personnel.

Table 1: Overall evaluation results of the TMF

Evaluators	Checklist questions	Not applicable, %	Yes, %	Mostly yes, %	Mostly no, %	No, %	MSR, %	Credibility, %
Group 1 (D. Rudakov as the trainer)	Subgroup B.1 «Visual check»	2.7	73.0	13.5	5.4	5.4	86.1	80.6
Group 2 (D. Pikarenia as the trainer)		8.1	54.1	24.3	8.1	5.4	79.4	64.7
TMF personnel*	Subgroup B.2 «Document check»	7,5	83,5	3,0	2,6	3,4	93,4	93,9

* with corrections of the trainers.

Figure 3: Overall TMF safety evaluation obtained by Group 1 (a) and Group 2 (b) of training participants. **Red circle** shows the visual check result; **blue square** the result of document check. MSR = Meeting safety requirements.

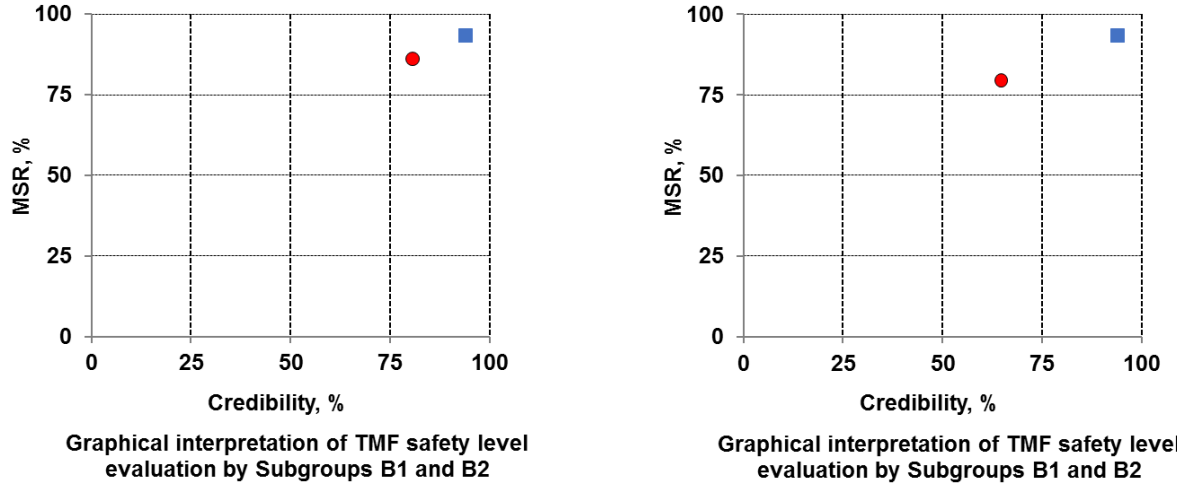


Table 2 shows the answers to the critical questions of the "Visual check" Checklist B.1, on which the TMF safety significantly depends. Analyzing this table shows some discrepancies in the answers given by the participant groups but their results look quite similar.

The general conclusion about the unacceptable TMF safety level was drawn following the criteria outlined above.

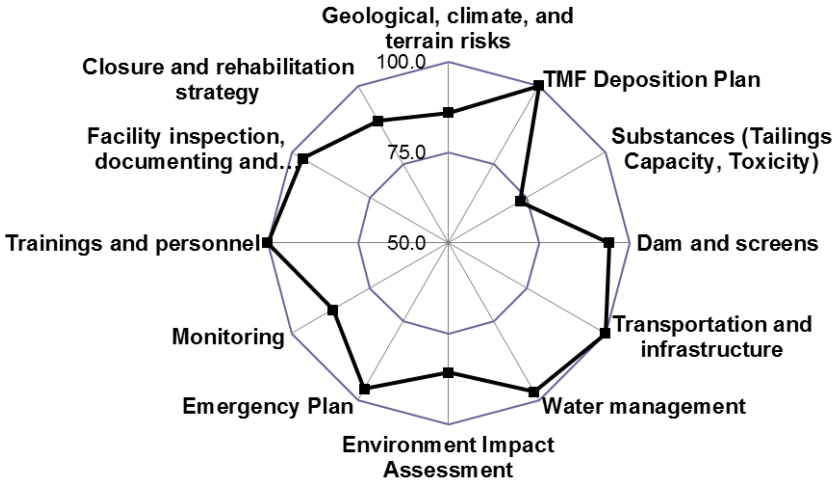
The categorical evaluation (Fig. 4) revealed those aspects of the TMF operation with the lowest safety performance, which should be addressed first by the appropriate safety improving measures; they include neutralization of toxic effects of substances contained in tailings; water management; Environmental Impact Assessment; monitoring; closure and rehabilitation strategy.

The results of visual check and document check differ insignificantly, which indicates that the actual state of the TMF is generally consistent with what is reflected in the available documents.

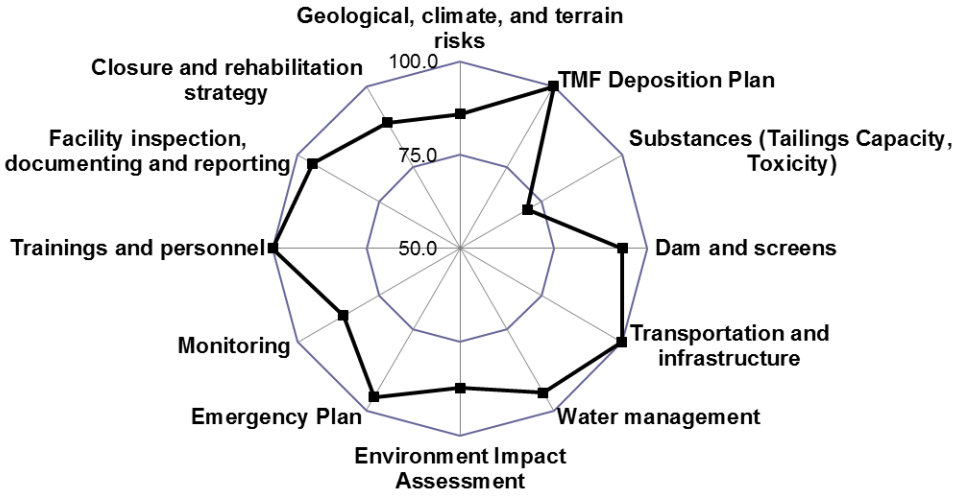
However, this conclusion can be revised upon more complete familiarization of the trainers with the TMF documentation.

The use of the TMF Checklist in the training showed its successful application as an effective tool for the visual inspection of a TMF condition. The checklist approach can help reveal the main incompliances with industrial and environmental safety requirements.

Figure 4: Categorial evaluation of TMF safety obtained by Group 1 (a) and Group 2 (b)



a)



b)

3. Recommended measures to take by the operator and competent authorities

Based on the Measure Catalogue of the TMF Checklist, both groups of training participants recommended applying the measures from Table 2 (see below). The presentations of the two groups of participants with the evaluation results and recommended measures are attached to this report in electronic form. Based on the document check, the trainers recommended applying the measures included in Table 3 (see below).

Table 2: Recommended measures to improve revealed safety deficiencies at the TMF, based on the results of the visual check

No.	Recommended measure	Priority
1.	Identify hazardous substances and mixtures stored in the TMF	Short-term
2.	Analyze the feasibility of neutralizing acid/base tailings materials	Short-term
3.	Define the measures intended to isolate and neutralize hazardous materials and substances	Short-term
4.	Study the feasibility of using tailings materials as secondary raw	Short-term
5.	Assess pollution risk to surface waters	Short-term
6.	Assess pollution risk to soils near the TMF site	Short-term
7.	Assess pollution risk to air quality and take measures to prevent dusting.	Short-term
8.	Check the conformity of checkpoints to the design documentation	Short-term
9.	Equip the TMF with facilities preventing unauthorized access	Short-term
10.	Construct, if justified, the bottom protective screen	Mid-term
11.	Carry out technical upgrading of checkpoints	Mid-term
12.	Install additional drainage facilities	Mid-term
13.	Equip the TMF site with additional wells and checkpoints for monitoring basic parameters	Mid-term
14.	Regularly check monitoring parameters (see Recommendations to TMF monitoring in the TMF Methodology)	Mid-term
15.	Employ the technologies that minimize the volume and toxicity of tailings materials with maximum extraction of useful components	Long-term

Table 3: Recommended measures to improve revealed safety deficiencies at the TMF, based on the results of the document check

No.	Recommended measure	Priority
1.	Inform local communities and NGOs on the essence of the TMF design and get their opinion	Short-term
2.	Assess the TMF impact on the environment and health of population	Short-term
3.	Assess pollution risk to ground waters	Short-term
4.	Assess the impact of nearby TMFs, other hazardous sites near the TMF site, and/or possible transboundary effects	Short-term
5.	Study the feasibility of neutralizing (isolating) hazardous substances before their disposal to the TMF	Short-term
6.	Assess stability of TMF technical components considering site soil properties and appropriate safety criteria	Short-term
7.	Define the measures intended to isolate and neutralize hazardous materials and substances	Short-term
8.	Collect and analyse the available data on the intensity of precipitation and floods if possible for the last 100 years, or sufficient to support calculations of a 1:100 year return event	Short-term
9.	Create accumulating ponds for catching water in case of severe floods (if the need confirmed)	Mid-term
10.	Regularly check monitoring parameters (see Recommendations to TMF monitoring in the TMF Methodology)	Mid-term
11.	Submit regularly monitoring data to local authorities and emergency departments	Mid-term
12.	Study the feasibility of using tailings materials as secondary raw	Short-term
13.	Appoint personnel responsible for control over the closed / rehabilitated TMF (for the further stages of closure and rehabilitation)	Short-term
14.	Employ the technologies that minimize the volume and toxicity of tailings materials with maximum extraction of useful components	Long-term

The proposed measures will allow addressing the following safety deficiencies.

1. Avoid groundwater pollution (measures nr. 1, 2, 3, 10, 12, 15 of Table 2 and nr. 3, 5, 7, 14 of Table 3).
2. Avoid surface water pollution (measure nr. 5 of Table 2 and nr. 8, 9 of Table 3).
3. Minimize soil pollution (measures nr. 6, 7 of Table 2 and nr. 6 Table 3).
4. Ensure the safety of local population (measure nr. 9 of Table 2 and nr. 2, 4, 11 of Table 3).
5. Reduce the amount of tailings materials stored in the TMF (measures nr. 4, 15 of Table 2 and nr. 12, 14 of Table 3).
6. Increase the effectiveness of monitoring the TMF operation (measures nr. 8, 11, 13, 14 of of table 2 and nr. 2, 4, 11 of Table 3).
7. Raise public awareness about the safe operation of the TMF (measures nr. 1, 11, 13 of Table 3).

Conclusions

1. The TMF was largely selected due to the far distances to other facilities from the city of Nur-Sultan, as well as the willingness of the management of LLC "Altyntau Kokshetau" to cooperate and its interest in improving the safety of this TMF. The company management provided an opportunity for a brief visual inspection during the on-site training; the TMF personnel gave preliminary answers to the Checklist questions on checking the documentation prior to the training.
2. The use of the TMF Checklist in the training showed its successful application as an effective tool for the visual inspection of a TMF condition, whereby the checklist approach can reveal the main incompliances with industrial and environmental safety requirements.
3. In general, the assessments made by the two groups of participants regarding the visual check correlate; the key indicator "Meeting safety requirements" was evaluated at 79-86%. Taking into account the high value of this indicator for the check of the documentation of 93.4%, the TMF condition can be assessed as relatively good. However, currently it does not meet all requirements from the minimum set defined by the relevant UNECE Safety Guidelines. Taking into account that even 1% of incompliance with the basic safety requirements may cause a disaster, the TMF safety level was identified as unacceptable.
4. The answers to 11 out of 37 questions of Checklist B.1 "Visual check" caused a discussion among the training participants (see questions with an Asterix in Annex 2). This was caused due to the lack of time for more a thorough testing, the participation of company representatives in the discussion of one group, and, partially, due to subjectivity. However, these discrepancies of less than 7% did not influence critically the safety level evaluation. Most trainees actively participated in the discussion; company representatives gave explanations to all the questions raised.
5. During the visual check of the TMF some safety deficiencies have been 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 are: upgrading the neutralization system of hazardous substances, drainage, monitoring, as well as refining the risk assessment of environment pollution.
6. Kazakhstan has a well-developed and interconnected system of checklists and a risk assessment methodology for hazardous facilities [16] in place, developed by authorities in cooperation with operators. A comparison of the national Kazakh approach and possible similar approaches in Central Asia with the TMF methodology could be useful in view of their interoperability and the ongoing Global Tailings Review.[2] In any case, the TMF Methodology can be recommended for use by the competent authorities, which requires its

[2] More information about the Global Tailings Review, 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/.

consideration at the level of an inter-agency committee with the representatives of all competent authorities in the fields of mining, industrial, and environmental safety.

7. The practical application of the Checklist in Armenia, Kazakhstan and Ukraine, has shown a lower TMF safety evaluation based on the visual check in comparison to the document check. This can be explained, notably, by faster real changes of the TMF conditions on the site compared with the update of the documentation. Due to the critical importance of the visual check in evaluating the safety of a TMF, there is a need to update the UNECE Safety Guidelines and Good Practices for TMFs to include more detailed recommendations for the visual check (in particular, clause 100 of Section B.3).
8. It would be useful to involve the experts not dependent 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 safety guidelines and methodology.

Annex 1. Basic information on the TMF of LLC «Altyntau Kokshetau» (Zerendinskiy district, Akmolinskiy region, Republic of Kazakhstan)

Nr.	Category	Information provided by the TMF operator
1	**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.	According to the design, the processing plant capacity is 8 million tons per year. The factory processes gold-bearing ore with the gold content of 2 g/t. The TMF was put in operation in 2009; it stores the tailings materials deposited by the hydraulic fill method. The TMF design capacity is currently 54 mcm[3] of which about 44 mcm have been already filled. Tailings materials are filled hydraulically by the zenith method. The starter dam is filled with a stone riprap; the TMF dam height of clayey sand is 23 m. Currently, the company uses the following system of water disposal and recycling for the flotation TMF. The clarified water from the settling pond of the flotation TMF is discharged to the collector of the circulation water pumping station and then by gravity to the secondary settling pond. Then, water is delivered by the coastal pumping station to the circulation water tanks at the site of the gold extracting plant (site no. 5). The water discharge facilities of the flotation TMF consist of two water intake wells “BK-1” (inactive and plugged) and “BK-2”, and a launder DN1000. The maximum water throughput capacity of the water discharge facilities is 6000 m^3/h. The water intake well “BK-2” is a flashboard of 20 m height and the level of the foundation of about 232 m; the top level of the well is 252.30 m. The head above the highest point is determined by the height of the installed flashboards. The overflow layer thickness of water above the flashboard required to pass the maximum volume of drainage from the TMF ranges from 0.1 m to 0.4 m. The water spillway is equipped with a pontoon and a hand hoist. For maintenance of the well a road access and a protective dam are provided that are raised during operation as a result of constructing the bund wall. The pontoon is connected to the dam crest with the service bridge. A discharge collector for circulating water transportation from the well “BK-2” to the pumping station is installed on the impoundment bottom; it is made of steel pipes DN1000 and DN800 of 1288 m long. The section of the DN1000 collector from the well “BK-2” of 1260.43 m long is reinforced with concrete casing.
2	**Geographical site information:** climatic conditions, including weather extremes, wind speed, precipitation, and floods.	The industrial site of LLP “Altyntau Kokshetau” is located in the Zerendinsky district of the Akmola region of the Republic of Kazakhstan, 18 km north of the city of Kokshetau. Some settlements are situated in close proximity to the TMF that are the villages Vasilkovka, Abay, Krasny Yar. The nearest settlement Konysbay is located 4 km south-west of the deposit, the village Krasny Yar is 12 km far to the south. The nearest railway station Chaglinka is located 14 km south-west of the deposit. The industrial site of LLP “Altyntau Kokshetau” is located within the northern margin of the Central Kazakhstan folded region. The

[3] mcm = million cubic meter

Nr.	Category	Information provided by the TMF operator
		industrial site area is mostly flat terrain bordered by an elevated denudation plain from the north and west. In the east, the denudation plain is the watershed of the lake Shunkyrkol and the river Chaglinka. The TMF is located at a distance of ~2.1 km south-west of the gold extracting plant. The landscape of the TMF site is relatively flat with absolute elevations of 220-250 m. The continuous gradient of the land surface ranges from 0.2% to 1.7% eastward toward the Chaglinka River. The area has a typical steppe landscape and belongs to the zone of insufficient watering. The landscape has been changed by man-made impact caused by TMF construction and operation. Climatic data for the gold extracting plant area are based on the data provided by the Kokshetau meteorological station in accordance with surveys of 2018. According to Sanitary Norms and Regulations of RK 2.04-01-2001 "Building climatology" the TMF area refers to a climatic region "1в". The climate of the region is sharply continental with cold, long winters and short warm summers, relatively little rainfall, active evaporation and an air humidity deficit. The average annual climatic characteristics of the region of LLC "Altyntau Kokshetau" are given below. The average annual temperature is +3.5 ºC. The average temperature of the warmest month (July) is +19.3 °C; the absolute maximum temperature is +41.7 °C. The average temperature of the coldest month (January) is –15.9 °C; the absolute minimum temperature –48.3 °C. Estimated temperature of the coldest five-day period is –33 °C, the warmest one is +21 °C. The average duration of the summer period is limited by the spring and autumn transition of average daily temperatures through the point of 0 °C and lasts 198 days. The winter period lasts on the average of 5 months. The transition of average daily air temperature through the point of 5 °C in spring usually occurs in the third decade of April, and in the fall in the first decade of October. The warm season of the year with temperatures above +10 °C lasts an average of 137 days from May 6 to September 21. The average duration of the frost-free period is 123 days. The duration of steady frosts is 133 days. The period with a steady snow cover lasts up to 153 days. The snow cover thickness on the permanent flat surface in the open space varies from the minimum of 9 cm to the maximum of 48 cm; with the average value being 11.2 cm. Due to strong winds the snow cover is intensively redistributed. The first snow sometimes falls at the end of October, but often absent till December and falls on the frozen soil, which leads to deep freezing the soil. The average date of stable snow cover formation is November 10; snow cover disappears on the average by April 8. The average annual wind speed is ~4.2 m/s. The prevailing wind direction is from southwest (43%) observed mainly in winter. The average wind velocity over a period with an average daily air temperature below 10 °C is equal to 4.8 m/s. The maximum wind velocity reaches 27 m/s with the maximum gusts up to 39 m/s. The standard velocity impact air pressure of the wind is

Nr.	Category	Information provided by the TMF operator
		60 kg/m^2. The average humidity of atmospheric air is 69%. The average long-term annual precipitation is 336 mm, the amount of precipitation for the period October-March is 100 mm, and for the period April-September is 236 mm.
3	**TMF Deposition Plan:** maps, schemes, cadastral borders, adjacent infrastructures.	 Site location. The industrial site of LLP "Altyntau Kokshetau" is located in the Zerendinsky district of the Akmola region of the Republic of Kazakhstan, 18 km north of the city of Kokshetau. Some settlements are situated in close proximity to the TMF that are the villages Vasilkovka, Abay, Krasny Yar. The nearest settlement Konysbay is located 4 km south-west of the deposit, the village Krasny Yar is 12 km far to the south.
4	**Geological and hydrogeological conditions:** seismic activity, landslides, faults, karst areas, soil properties, groundwater regime, etc.	In accordance with the Sanitary Norms of RK 2.03-30-2006 for seismic zone mapping (OSR-A, B and C), the seismicity of the region Kokshetau is 5 points. Additional complex seismic studies showed that the seismicity for the zone B can be of 6.60-6.78 points (up to 7 points) with the return period of 1000 years.
5	**Ecological environment:** flora, fauna, water and land ecosystems.	The territory around the TMF belongs to the Northern Kazakh hillocky steppe province, Ubagan-Chaglinsky district, Chaglinsky district that is characterized by a flat-terrain landscape with separate areas of hummocky topography. Almost all fertile soils are plowed. The preserved natural vegetation is represented by automorphic fescue, fescue-wormwood, feather grass, feather-wormwood, and other various grass communities. The fauna of Zerendinsky district is typically steppe with certain originality. The presence of floodplain forests and steppe lakes significantly enriches the territory with dendrophilic, waterfowl and near-water animal species. 30 species of fish, 3 of amphibians, 8 of reptiles, 180 of birds, and 55 of mammals have been found in for the region of TMF location. The invertebrate fauna is rich and diverse.
6	**Social**	The TMF is located in the administrative district of the village of

Nr.	Category	Information provided by the TMF operator
	environment: location, condition and size of communities and settlements; land use, access to the TMF territory.	Konysbay, Konysbay rural district, Zerendinsky district of Akmola region, 18 km north of the regional center of Kokshetau at the coordinates 53 ° N. and 69 °E The village Konysbay covers the area of 72 ha; its population is about 800 inhabitants engaged mainly in animal husbandry, gardening and agriculture. The access to the TMF area is free.
7	**Risks to:** surface water bodies, groundwater, air, soils, and biota.	The TMF has a complete water circulation system, which allows re-using water in the production process and eliminating the discharge of industrial wastewater into surface water bodies and water courses. Water losses from the TMF are only due to evaporation from its surface. The drainage network includes a concrete channel to discharge surface water run-off. All possible emergencies (including potential dam failure) are included in the TMF safety declaration.
8	**Stored material**: hazardous substances and materials stored in the TMF.	After processing the copper ore the residual flotation tailings are delivered through a pipeline of the diameter of 630 mm and deposited in the flotation tailings pond. At the time being, about 20,000 tons of tailings materials are deposited daily at the TMF. Tailing consist mainly of small particles formed by grinding the original ore.
9	**TMF history:** construction and operation periods, contractor(s), accidents occurred.	The TMF of the gold processing plant LLC “Altyntau Kokshetau” has been built and put into operation in 2009.
10	**TMF management:** bodies/persons responsible for TMF operation/ maintenance.	Kogai Igor Sergeevich is the Director General of LLC “Altyntau Kokshetau”

Brief description of the technology process

The technical plan of the processing plant provides for three-stage crushing in jaw and cone crushers, fine crushing and softening in high-pressure crushers (roller-press), ball grinding, flotation and gravity ore dressing, hydrometallurgical processing of collective flotation concentrate, and transporting of flotation and hydrometallurgical tailings via the pulp pumping station to the TMF.

The initial data for designing the technological plan are:

• annual processing of 8.0 million tons of raw ore;

• gold content in ore of 2 g/t;

• the number of working days per year of 365;

• the maximum size of the pieces coming from the quarry to the body of medium and fine crushing that is 350 mm.

Ore processing technology

The designed technological plan of ore processing involves the following processes:

• three-stage crushing in jaw and cone crushers to the size of 30 mm;

• fine crushing in high-pressure crushers (roller-press) to a particle size of 5.2 mm for 75-80% (15% of the ore to 0.074 mm);

• two-stage ball grinding to a particle size of 0.074 mm (90%) in a closed cycle with hydraulic cyclones (two-stage classification);

• flotation concentration of ore in the grinding cycle (inter-cycle flotation) of a grain size of 0.074 mm for 60-65%;

• gravitational enrichment of sands by the calibration classification on centrifugal concentrators with periodic concentrate unloading (KC-XD);

• flotation concentration of ore crushed to a particle size of 0.074 mm (90%); the main, control, and two cleaning operations);

• gravity concentration of inter-cycle flotation tailings on centrifugal separators with periodic concentrate unloading (QS-70);

• grinding of the combined flotation-gravity concentrate to a particle size of 0.045 mm (95%);

• thickening of gold concentrate;

• ultrafine grinding of condensed collective concentrate flotation and gravity to a particle size of 0.010 mm (90%);

• oxidation of finely ground concentrate with oxygen in Match reactors;

• preliminary and sorption cyanidation of the oxidized concentrate;

• desorption of gold from saturated coal and electrolysis of eluates, followed by melting of the sludge and obtaining Dore alloy;

• disposal of hydrometallurgical tailings.

Annex 2. Answers of training participants to the questions of Checklist B.1 "Visual inspection" of the TMF Checklist

Nr.	Question	Answers of training participants	
		Group 1	Group 1
1	Is the TMF site located beyond the zones/areas subject to negative atmospheric conditions (floods, strong winds, and extreme temperature)?	Mostly yes	Mostly yes
2	Does the design documentation correspond to actual locations of TMF elements?	Yes	Yes
3	Have all TMF infrastructure components (roads, ponds, sanitary facilities, pipelines etc.) been displayed in the design documentation?	Yes	Yes
4*	Is there evidence of a well-functioning record keeping process?	Yes	Mostly yes
5	Do the drainage facilities match the TMF operation manual?	Mostly yes	Mostly yes
6	Is there a functioning dam water management system that appears to be in good condition?	Yes	Yes
7	Does the dam have drainage facilities and emergency spillways that allow water to pass at the maximum level in TMF?	Yes	Yes
8*	Are there functional and sound water diversion (tunnel) structures?	Yes	Mostly yes
9*	Are there functional and sound water diversion or emergency water release structures?	Yes	Mostly yes
10*	Are all natural surface water inflows captured and diverted beyond the TMF borders?	Yes	Not applicable
11	Are there additional storages near the TMF for accumulating water from emergency spillways?	Yes	Yes
12*	Is the surrounding area free from evidence of TMF impacts on the environment?	Mostly no	Yes
13*	Is the zone of TMF impact free from evidences of soil erosion?	Yes	Mostly yes
14	Is humus layer removed for the future rehabilitation and stored (if applicable)?	Yes	Yes
15	Do the dam surface and the dam walls appear to be in sound condition?	Yes	Yes
16	Is the TMF structure free from evidence of movement, failure or instability?	Yes	Yes
17	Is there evidence of a starter dam or dams (e.g. rock fill)?	Yes	Yes
18	Is there evidence of carefully managed material selection for the dam wall?	Yes	Yes
19	Is the dam free from evidence of leakage, seepage, or piping?	Yes	Yes
20*	Is the TMF equipped with impervious screens (lining)?	Yes	Mostly yes
21	Is there cover layer on the TMF surface to reduce/prevent from dusting (if applicable)?	Mostly no	Mostly no
22*	Is the TMF free from evidence of acidic or base tailings material?	Mostly yes	Mostly no
23	Are the facilities functioning for collecting, control and neutralization of acid or base water (if applicable)?	Not applicable	Not applicable
24	Are substances hazardous to aquatic eco-systems removed / neutralized before their disposal to TMF (if applicable)?	No	No
25*	Is drainage water cleaned before discharge?	Yes	Not applicable
26	Is there evidence of a functioning monitoring system?	Yes	Yes

Nr.	Question	Answers of training participants	
		Group 1	Group 1
27	Does the monitoring network ensure the regular acquisition of contamination indices for water, soil, and air?	Mostly yes	Mostly yes
28	Are the wells for checking ground water level and composition in the TMF site in operational condition?	Yes	Yes
29	Are the wells for checking pore pressure in the dam in operational condition?	No	No
30	Is slope slippage/movement and/or soil subsidence monitored?	Yes	Yes
31*	Are the lagoon parameters in agreement with the design parameters?	Yes	Mostly yes
32	Is there evidence of a well-functioning system downstream of the tailings dam?	Yes	Yes
33	Is the surrounding area free from evidence of external hazards that pose risks to the TMF?	Yes	Yes
34	Is there evidence of emergency preparedness?	Yes	Yes
35	Is there equipment in operable condition that terminates tailings material delivery in case of pipeline rupture?	Yes	Yes
36*	Are tailings facilities isolated or guarded so as to prevent unauthorized access to the TMF?	Mostly yes	Mostly no
37	Is TMF equipped with necessary fire extinguishing facilities (if applicable)?	Yes	Yes
Total answers "no"		**2**	**2**
Conclusion about the TMF safety level		**Unacceptable**	**Unacceptable**

* questions with different answers of two groups of training participants.

References

1. Safety guidelines and good practices for tailings management facilities. (2008, updated version 2014) UNECE. Geneva, 34 p.
2. TMF Methodology https://www.umweltbundesamt.de/en/publikationen/raising-knowledge-among-students-teachers-on
3. The design of TMF operation for the period 2019-2021. The main technical solutions for dust suppression on the beach areas of the filtration TMF. Hydrotechnical solutions. - Mekhanobr-Engineering, Saint-Petersburg. 3724-8-ГР.10.
4. The design of TMF operation for the period 2019-2021. Technical and economic calculation for the rehabilitation of TMF elements. Hydrotechnical solutions. - Mekhanobr-Engineering, Saint-Petersburg. 3724-8,9-ГР.11.
5. Report on engineering-geological and engineering-geophysical studies to evaluate the possible soil liquefaction and dam stability under conditions of seismic load of magnitude 7 at the flotation TMF of LLC "Altyntau Kokshetau" in the Republic of Kazakhstan. Engineering and geological surveys. Book 2. Neftegazproektstroy LLC, Stavropol. 2017.
6. Report on industrial environmental monitoring of compliance with its parameters for the facilities of LLC "Altyntau Kokshetau" during 1st quarter of 2019. "Ecology Business Consulting" LLP. Astana, 2019.
7. The design of TMF operation for the period 2019-2021. Stage 1. Embankment dam of the flotation tailings. LLC "Altyntau Kokshetau".
8. Technological regulations for the operation of the condensation department, industrial water supply and tailings facilities. LLC "Altyntau Kokshetau".
9. Order on the Implementation of the Deadly Hazards Protocol No. 15 "TMF Management" ("PSO No. 15"). LLC "Altyntau Kokshetau".
10. Accident response plan for the gold recovery plant of LLC "Altyntau Kokshetau" for 2019. LLC "Altyntau Kokshetau".
11. Memorandum of mutual cooperation within the framework of public-private partnership dated 31.05.2019 between the Akimat of the Akmola region, the Department of Emergencies of the Akmola Region and LLC "Altyntau Kokshetau".
12. Log book of seepage water discharge. TMF. Started on January 1, 2016. LLC "Altyntau Kokshetau".
13. Log book of water level observations in piezometers. TMF. Started on January 1, 2016. LLC "Altyntau Kokshetau".
14. Book of accounting, verification, availability and condition of fire extinguishers and fire hydrants of Department of condensation, industrial water supply, and tailings facilities. Started on November 14, 2018. LLC "Altyntau Kokshetau"
15. The design of TMF operation for the period 2015-2018 Stage 6. Drainage facilities of the flotation tailings and secondary sedimentation pond. (Drainage facilities of the 1st level). Estimation for power electrical equipment. Mekhanobr-Engineering, Saint-Petersburg.
16. Joint order of the Minister for Investment and Development of the Republic of Kazakhstan and the Minister of National Economy of the Republic of Kazakhstan of December 15, 2015 No. 1206, December 28, 2015 No. 814 "On approval of risk assessment criteria and checklists in the field of industrial safety" http://base.spinform.ru/show_doc.fwx?rgn=88769