

## ASSESSMENT QUESTIONNAIRES FOR TAILING PONDS SAFETY – APPLICATION TO A CASE STUDY

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**Abstract:** In this article it is presented the proposal to adapt the procedure for evaluating ponds based on field inspections and surveys, depending on the stages of the life cycle. It also stresses the importance of specific legislation on mining ponds; presents the current state of mining legislation in the world. Article includes a case study on the adaptation and application of the proposed procedure.

**Keywords:** specific legislation, tailing pond, procedure, questionnaire, case study.

### 1. INTRODUCTION

This article presents another case study that illustrates procedure for the safety assessment of tailing ponds based on field inspections and surveys. The purpose of the proposed procedure is the general characterization of tailing pond state and quantification of intervention priorities and remediation activities.

The case study that illustrates the procedure for a pond settling in conservation - Săliștei Valley. First it is presented a description of the work, structural and technological aspects, UCC system. Based on questionnaire it is determined the technical functional and safety condition, of the facility and prepare a report on the assessment of the safety level.

### 2. MINING LAW IN THE WORLD

ICOLD (1989) - International Commission on Large Dams, provides various recommendations on how the mine legislation on ponds can be achieved. [1]

In the context of the risk of accidents contributing to transboundary pollution affecting watercourses and international lakes, CEE (Central and Eastern Europe) countries have decided to draw up safety guidelines and best practices for ponds. They have the form of a set of recommendations. The requirements are established by the technical documents and agreements. [2], [3], [4], [5], [6]

In different countries there are detailed regulations concerning the safety of the mine, but the

closure is not covered in detail, as well as the opening. Mining license is usually based on a closure plan approval.

Greening and post-closure are covered by the authorization procedure for mine closure. In the case of rehabilitation requirements there are specific provisions in most countries. However, in many cases there are no procedures for assessing the safety of tailing ponds.

All new Member States of the European Union and candidate countries have undergone political and economic changes in the late eighties and early nineties. In all cases, new legislation in the field, was introduced by the Mining Law. The first legislative innovative ideas were usually followed by corrective actions and subsequent changes to the mining laws.

### 3. PROPOSAL FOR ADAPTATION OF PROCEDURE FOR EVALUATION OF TAILING PONDS SAFETY BASED ON SITE INSPECTION AND QUESTIONNAIRES

The proposed procedure was presented in "Hydrotehnica -Volume 59 No. 12", and published in the article entitled "Assessment questionnaire for evaluation of tailing ponds safety". It was presented a proposal for a safety assessment procedure for tailing ponds based on site inspections and completion of questionnaires [7]. First there are selected the questions that relate to general aspects that can be clarified with a minimum of detailed information and then there are analyzed the sets of questions on specific safety issues. The rating is gradual, and are proposed two steps:

*Evaluation Phase I* - Preliminary assessment based on a synthesis questionnaire;

*Evaluation Phase II* - Detailed assessment based on questionnaires differentiated by categories of problems.

The procedure is applied differently depending on the life cycle of the tailing pond. Breakdown on problems of questions can be followed in Table 1,

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referred as Questionnaire and includes groups of questions.

Questionnaire including groups of questions.

Table 1. Group of questions

#	Question group	Question	Purpose	Data source	Users	Assesment of tailing pond safety
1	Basic (Group A)	31 basic questions	preliminary and prompt assessment of the level of pond safety	documentation submitted by the operator	control authorities, independent auditors and pond operator	Stage I Evaluation
2	Detailed (Group B)	266 specific questions of basic group	comprehensive and detailed assessment of the safety level of the pond in order to define the need to take action.	documentary studies submitted by the operator as well as additional studies and tests that clarify all tailing pond parameters performed by external experts	control authorities, independent auditors and pond operator	Stage II Evaluation
3	Internal Monitoring (Group C)	16 questions selected from the detailed group and changed	internal routine check of monitoring parameters to control the safety of the dam	The operator's records on monitoring parameters in normal pond operation	Tailing ponds operator	Group C is not used in the assessment process

#### 4. APPLICATION OF PROCEDURE - CASE STUDY

To test the applicability of the proposed procedure, Săliștei Valley tailing pond was selected. The pond is situated at the stage of conservation and questionnaires were completed based on a site survey assisted by the owner managers and by specialists from Romanian Waters National Administration. [9]

Săliștei Valley pond is a valley pond belonging to the FIL. ROSIAMIN SA ROSIA MONTANA CNCAF MINEVEST SA DEVA 2014 SC. In 1982 construction was started at the pond and its operation began in 1986. The objective Gura Rosia processing plant is located on the left bank of the river Abrud, upstream of its confluence with the Rosia stream, occupying an area of 4 ha. Ore preparation plant at Gura Rosia dates from 1852 and has been continuously improved over the years.

In terms of particle size, the deposited material in the slope area, is a fine and average rate sand of about 80-82% and a sand and silty lenses at a rate of 18-

20%. The pond was constructed over a length of about 800 m by closing with a rockfill dam located on the Seliște river, about 500 m upstream of the confluence with Abrud river, having a height of about 58 m. There is not any diversion gallery of the upstream tributary waters of the pond. The system booster, after exceeding the starter dam height, it is realized by upstream withdrawal from hydraulic deposition of tailing resulted from gold ore processing plant Gura Roșiei. No guard channels for water flow on slopes. [9]

Tailings deposit is in restoration since 2006, is stable but shows local seepage phenomena on the downstream of the retention and on the sealing contact between the dam and the right side, where he was made a collection drain. The slopes adjacent to the pond has no active phenomena of instability, but areas with springs that have been collected and channeled downstream through drainage systems. Plants used in the process during operation of tailing pond were partially dismantled. Downstream of tailing pond no chemical treatment plant wastewater, but on the watercourse downstream, a monitoring section. The pond has in case of large waters, a large coastal spillway and an concreted exhaust manifold where are routed downstream, both upstream tributary waters and large waters collected in the pond. [9]

Currently pond monitoring is no longer done only by visual observations made monthly by former staff, currently working at Conversmin.

Lake clarification is very low and is pulled towards the tail pond near inverse probe still in operation. During operation Săliștei Valley pond, some dangerous phenomena for the safety of tailings deposit occurred. There were suffusion, strong seepage of increasingly heights, dangerous lifting of water level in piezometers. In 2004 began construction of a prism for the setting of downstream slope disposed at its base in order to improve the stability of the pond. Ballasting work has not been completed to this day, but it is contained in the technical design of the closure of the facility to be launched in the future. [9]



Figure 1. Săliștei Valley location



Figure 2. General view of Săliștei Valley pond

#### 4.1 EVALUATION RESULTS OF THE PRELIMINARY STAGE

For this case study, the evaluation procedure was adapted according to the life cycle stages of the pond. Săliștei Valley pond is in the stage of conservation, and the questionnaire was adapted according and have a reduced number of questions.

Based on the results obtained after processing the questionnaire, a rapid preliminary assessment of the safety level of the ponds can be achieved.

For example, Table 2 shows the Phase I Questionnaire, with additions related to Săliștei Valley. Table 3 shows the results of this evaluation.

Table 2. Questionnaire – Phase I – Preliminary

#	Questions	yes	no	Insuff. data
<b>DESIGN</b>				
1	International and national regulations are complied with requirements to design documents pond?	1		
2	The public and local authority agreed with the tailings dam location?	1		
3	The operator has developed plan (manual) for operation and management of the pond?	1		
4	Evaluation of the pond excluded negative impact on the environment and neighboring populations?	1		
5	Risk assessments for all of pond components confirmed their safety?	1		
6	There is a description of the composition and quantity of tailings to be stored in the pond?	1		
7	Were taken into account local geological risks, hydraulic and geochemical during design and construction of the pond?	1		
8	Dam Evaluation confirmed its safety in the design phase?	1		
9	Safety requirements were followed during pipeline design?	1		

Table 3. Results of Preliminary Evaluation

Evaluation indices	Tailing pond state	General safety level
IS = 81.7%	Good	Safe
ICE = 87.1%	Good	

At the 31 questions, the maximum score was 93, and the number of questions to which the answer was "insufficient data" was 4. Safety Index "IS" of 81.7 and Credibility Index "ICE" of 87.1% are good. Diagnosis of safety level was characterized as "safe".

The overall result of the evaluation can be represented graphically as a point on a two dimensional diagram, with IC and respectively ICE axis, in the range from 0 to 100% on both axes, shown in Figure 3, referred as the two-dimensional safety indices diagram. The diagram includes representation in colors from red to green (in the article are greyscale) and percentage (0 to 100).

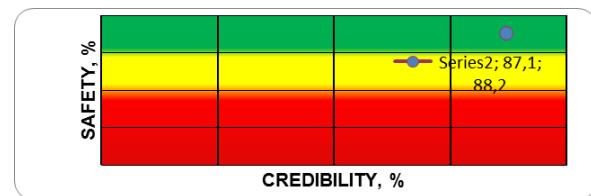


Figure 3. Two-Dimensional diagram of safety indices

The overall level of safety represented as a blue dot is positioned in the green and in the high credibility area.

In conclusion, inspected pond is classified as "safe" and do not require the use of the recommended actions from the catalog of measures.

#### 4.2 ASSESMENT RESULT IN DETAILED EVALUATION PHASE

In this phase are independently evaluated, each of the specific aspects that contribute to the safety of tailings, called *categories*.

Detailed assessment phase was based on a questionnaire with 225 questions. The result of the safety indices on categories of problems is shown in Table 4.

Table 4. Results of final evaluation

#	Category	Abreviation	IS (%)
I	Geology, climate, terrain hazards	GCR	90.0
II	Location, technologies	TDP	74.2
III	Ore substances, toxicity	STC	75.0
IV	Dam and screens	DSC	68.8
V	Transport and infrastructure	TRI	86.7
VI	Water management	WTM	70.4
VII	Environmental Impact	EIA	72.2

	Assessment		
VIII	Emergency Plan	EMP	74.6
IX	Monitoring	MON	77.2
X	Preventive measures	PRM	72.5
XI	Inspection and Reporting	INR	81.8
XII	Closure and ecological rehabilitation strategy	CRS	87.9

Overall safety index = 77,6%

At the 225 questions score was 675, and the number of questions to which the answer was "insufficient data" was 61. Global index of credibility was very good, 72.9%.

Safety index values for each category are used to create a polar diagram (spider diagram), shown in Figure 4. Figure includes representation in colors from red to green (in the article are shades of gray) and percentage (from 0 to 100) for values of the 12 safety indices centered on values (0.0).

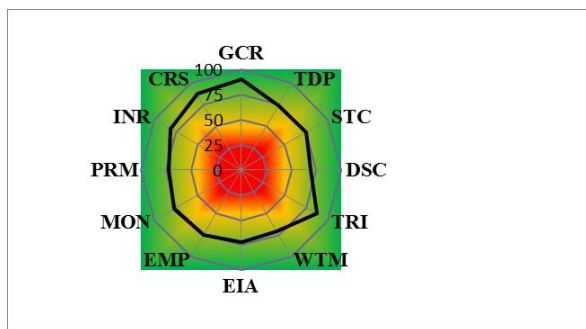


Figure 4. Polar ("spider") diagram of safety indices

In conclusion inspected tailing pond is classified as "safe" and do not require the use of the recommended actions from the catalog of measures.

## 5. CONCLUSIONS

The proposed procedure in order to assess the safety of tailing ponds is based on site inspection and evaluation stages based on questionnaires.

The procedure allows for verifying the actual state of tailing ponds and discovery of failures in order to comply with regulatory requirements in force.

Adaptation and evaluation procedure for a case study shows the viability and usefulness. For the Săliștei Valley pond was established the safety level.

As an overall conclusion can be emphasized that the safety of tailing ponds in conservation, closure and rehabilitation phase, depends essentially on the designers, constructors, operators and inspectors of the State, individuals that must be properly qualified and continuously trained.

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