

Federal Environmental Agency

Checklists

Draft

Changes in Version 6:

red characters:

Prof. D. Stematiu (Bucharest Technical University),

in blue characters:

Addition to Chapter 4: according to Inspection Recommendations of the ICPR

**for the
analysis and assessment of
the state of facilities
treating substances and preparations
hazardous to water**

No. XX

Safety of Industrial Tailings Management Facilities (TMF)

Introduction

Scope:

The recommendations shall apply to minerals tailings and waste-rock management facilities (tailings management facilities) if they are governed by the provisions of the following directives and international agreements:

- SEVESO II Directive,
- UNECE-Convention on the Transboundary Effects of Industrial Accidents, and
- UNECE -Convention on the protection and use of transboundary watercourses and international lakes.

Definition:

Minerals tailings and waste-rock management facilities (TMF) within the meaning of the present recommendations are facilities for the management of the residues generated at mining operations in tailings ponds.

Tailings Management Facilities include facilities for tailings and waste rock management including

- heaps of topsoil and overburden as far as these are used in tailings management and
- the parts of processing plants relevant for tailings management.

Recommendations:

Tailings management facilities shall be inspected for the application of the **Best Available Techniques (BAT)** (according to the BREF-document MTWR of EIPPCB of July 2004) and this BAT shall be applied.

1. Management and risk assessment

- a) Tailings management facilities shall be operated on the grounds of a tailings and waste rock management plan.
- b) The management plan shall be based on the life-cycle management approach and include all life-cycle phases (design, construction, operation, closure, after-care).
- c) Construction phase of a tailings embankment shall take into account the design-construct process. (During construction time many conditions may change, so it is essential to maintain a flexible approach and amend the design as required.)
- d) Tailings management facilities may only be permitted if closure and after-care are compulsorily regulated.
- e) Owners and operators have specific responsibilities for their dams and the need to formulate safety management procedures. Technical and managerial approaches should be utilised to improve safety and reduce risk.
- f) The potential hazard risk of the facility shall be classified (high-hazard dam).
- g) As a result of different geological and hydro geological conditions each industrial tailings management facility shall be planned, constructed, operated and closed "Case by case" or "Site by site".

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

2. Prevention and control of hazardous substances (additional safety requirements)

- a) Tailings management facilities shall have additional impoundments to receive the inflow from emergency outlets during the operational phase.
- b) Hazardous substances and process water shall be reused, as far as technically possible, i.e. recycling - closed-cycle use.
- c) Should it not be possible to avoid the use of hazardous substances (recycling), such substances shall be neutralised, if possible, before they are discharged into the tailings management facilities.
- d) Tailings management facilities whose tailings/ waste rock have acid rock drainage potential must have a management plan to prevent, reduce and treat acid waters generation.

3. Dam safety

Dams shall be designed, constructed, raised, operated and decommissioned in such a way that sufficient safety is guaranteed in each life-cycle phase. In this context the following aspects are of particular importance:

- a) **In the design, management and construction of tailings dams shall be engaged competent persons only.**
- b) When planning tailings management facilities, the backfilling of tailings directly into or as closely as possible to the underground mine should have as much priority as the construction of the tailings management facility in an open pit.
- c) **For tailing ponds shall be selected a place, where the consequences of failure can be reduced considerably. (Tailings can usually be transported over considerable distances relatively cheaply, so that it is a great freedom to select a site which is relatively free of constrains.)**
- d) There must be sufficient emergency outlets whose sizing shall be carried out in accordance with the risk class of the dam.
- e) For the measurements in the operational phase and the closure and after-care phases a safety factor of 1.3 shall be taken account of (in particular for the stability of dams and heaps).
- f) The ground on which the dam is built and the material to be used for the pioneer dam shall be processed or selected in such a way that sufficient stability is guaranteed in each life-cycle phase. **The site has to be thoroughly investigated to see if the foundation conditions are satisfactory. Information about the geotechnical properties of the foundation are an essential prerequisite for the design of the dam.**
- g) The risk of a too high pore pressure inside the dam shall be regularly and compulsorily monitored and evaluated by an independent expert (structural engineer specialised in dam and heap stability) before each raise . Seepage waters shall be avoided, reduced and/or monitored.
- h) The dam raising method shall be chosen with regard to the local conditions (seismicity, tailings composition). **Dams built by the upstream method are particularly susceptible to damage by earthquake shaking. (There is a general suggestion that this method of construction should not be used in areas where there is risk of earthquake.)**
- i) **Properly designed internal drains of suitably graded material within the downstream shoulder has to be introduced during construction, or as a toe berm in order to avoid erosion or failure of the downstream slope as impounding levels increase.**

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

- j) Special attention should be paid to tailing pond located in severe climate. Freezing of the downstream slope can prevent evaporation from the slope and so increase pore pressures within the body of the dam. Prolonged freezing can also cause ice lenses to form, drawing pore water towards the surface of the slope. During thaw the released water can initiate slope instability.
- k) Dam stability shall be regularly monitored with regard to maximum capacity/freeboard, pore pressure, groundwater level, functioning of the drainage system, surface water diversion, dam movements and slope stability.
- l) In the event of emergency, sufficient diversion options and additional impoundments (substitute basins) shall be available for the tailings and additional impoundments (tailings ponds) for emergency outlets.

4. Inspected by authorities and independent experts in regular intervals

- a) Monitoring by authorities shall above all embrace:
 - checking on the monitoring performed by the operator on his own responsibility,
 - verifying the extent to which monitoring by independent experts is arranged by the operator and whether orders must be issued on the basis of the monitoring findings, and
 - spot checks by the authority or checks by authorised third parties in installations.
- b) Monitoring by authorities may also be ensured by independent certified experts who, for example, check that especially important parts of the installation are in proper condition before commissioning and thereafter at regular intervals.
- c) Monitoring activities by authorities and experts should be co-ordinated in time and with regard to the monitoring tasks.

5. Contingency planning and hazard control measures

- d) A contingency planning must be available for each tailings management facility.
- e) The staff must be regularly instructed in safety aspects.
- f) Elaboration of incident scenarios for the design, construction, operation and closure of each tailings management facility.
- g) Accidents shall be reported to the competent authorities, the causes shall be identified and taken account of in the management plans and contingency planning

General data on industrial tailings management facilities / framework conditions:

Type of tailings/ waste-rock:

Occurrence of highly toxic substances (which ones?):

Risk classification of the dam:

ARD potential of tailings?
 no low medium high

Proportion of particles (<0.075 – 4 mm in per cent):per cent

Type of dam:

conventional type dam design (borrow material)	<input type="checkbox"/>
upstream method	<input type="checkbox"/>
downstream method	<input type="checkbox"/>
centreline method	<input type="checkbox"/>

Seismic risk: none very low low high

Other water inflow to the industrial tailings management facility?:

0. Are Best Available Techniques (BAT according to the BREF-document MTWR of EIPPCB, July 2004) applied and is their application monitored?

- yes no not applicable
- measure no measure

1. Management and risk assessment

1.1 Does the facility’s general management plan include a management plan for tailings and waste-rock (MTWR)?

- yes no not applicable
- measure no measure

Comments:´

1.2 Is the management plan for tailings and waste-rock based on the life-cycle management approach?

- yes no not applicable

1.2.1 Have the following life-cycle phases of sedimentation and retention basins been taken account of?

a. Planning phase (environmental status prior to plant construction, characterisation of residues and overburden produced by mining activities, plans and studies (such as site selection studies, EIA, risk analyses, emergency preparedness plans, waste management plan, water balance and water management plan, closure plan), construction plans for sedimentation and retention basins and associated facilities, supervision and monitoring)

- yes no not applicable
- measure no measure

Comments:

a. Construction phase (documents and documentation of the construction phase)

- yes no not applicable
- measure no measure

Comments:

b. Operational phase (maintenance plans (OSM Operation System Service), technical inspection plans, plans for the reduction of the use of substances hazardous to water)

- yes no not applicable
- measure no measure

Comments:

c. Closure phase and after-care (long-term closures, special closure plans for heaps, sedimentation basins, dry basins, water management facilities)

- yes no not applicable
- measure no measure

Comments:

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

medium-term:

Elaboration of interim plans in analogy to the BREF-document

long-term:

Elaboration of new studies and expertises by certified organisations

2. Emission prevention and control (additional safety measures)

2.1. Impoundments to receive inflow from emergency outlets

2.1.1 Does the industrial tailings management facility have additional impoundments to receive inflow from emergency outlets?

- yes no not applicable
 measure no measure

Comments:

2.1.2 -Are these sufficiently dimensioned (see item 3.1)?

- yes no not applicable
 measure no measure

Comments:

Examples of measures:

2.2 Avoidance of the occurrence /reduction of hazardous substances by recycling

2.2.1 Are all possibilities used to avoid hazardous substances or to reduce them through recycling?

- yes no not applicable
 measure no measure

Comments:

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

2.2.2 Is process water recycled?

- yes no not applicable
- measure no measure

Comments:

Examples of measures:

2.3 Reduction/ neutralisation of hazardous substances/ substances hazardous to water before they are discharged into the industrial tailings management facility?

2.3.1 Are measures taken in order to reduce or neutralise hazardous substances before they are discharged into the industrial tailings management facility?

- yes no not applicable
- measure no measure

Comments:

2.3.2 Are cyanides used?

- yes no not applicable

If yes:

2.3.2.1 Are cyanides eliminated/ transformed before they are discharged into the industrial tailings management facility?

- yes no not applicable
- measure no measure

Comments:

2.3.2.2 Does the sizing of the neutralisation facility correspond to at least twice the capacity on the grounds of the latest requirements?

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

- yes no not applicable
 measure no measure

Comments:

2.3.2.3 Has a preparedness system been installed for adding limestone or other neutralisation agents/ reagents?

- yes no not applicable
 measure no measure

Comments:

2.3.2.4 Do sufficiently functional stand-by generators exist?

- yes no not applicable
 measure no measure

Comments:

Examples of measures (for substances hazardous to water - in particular CN) :

short-term:

- o *repair of the dykes and diversion systems for surface waters (springs, precipitations, snow melt)*
- o *maintenance of stand-by generators*
- o *sealing of reservoirs*
- o *storage of sufficient neutralisation agents (surplus of limestone)*

medium-term:

- o *use of impermeable material for sealing existing ponds and basins*
- o *changes in technology to increase the proportion of recycling*
- o *special clear-water reservoir to collect seepage water and as a requirement for complete recycling*
- o *development of a special cyanide-minimising strategy; special safety concept*
- o *collection of drainage water, seepage water etc. and re-circulation into the pond*
- o *purchase of stand-by generators*

long-term:

- o *increasing the share of backfilling*
- o *new design of the processing facilities with regard to the latest technology with the aim to recycle the waters to a large extent*
- o *strengthening/new construction of the cyanide elimination facility foreseeing double capacity/ automatic cyanide control*
- o *emergency facility (replacement facility) for limestone addition*

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

2.4 ARD management (= acid rock drainage management (of acidic reaction products))

2.4.1 Are measures taken to avoid/reduce acidic reaction products?

- yes no not applicable
- measure no measure

Comments:

2.4.2 Does ARD management exist? Are leaking seepage waters neutralised or measures taken in order to treat the generation of acidic reaction products?

- yes no not applicable

Which measures are taken?

active measures:

- neutralisation by hydrated lime
neutralisation by soda
others

passive measures:

- artificial wetlands
open limestone ditches/ drains
diversion wells
others

- measure no measure

Examples of measures:

short-term:

- sufficient storage capacities of neutralisation agents*
- monitoring routines*

medium-term:

- minimisation of acidifiers in tailings (separate disposal; backfilling, road construction)*

long-term:

- wastes to be covered (final operation plan)*
- subaqueous management*

3. Safety of dams (emergency planning)

If dams are required, they shall be designed, constructed, raised, operated and decommissioned in such a way that a sufficient safety of the dam is guaranteed in each life-cycle phase.

3.0 Are be engaged in design, construction and management of tailings dams competent persons only? How do competent persons verify expertise (certificate, accreditation)?

- yes
- no
- not applicable
- measure
- no measure

Kind and date of accreditation:

3.1 Design and dimensioning of dams

3.1.1 Have all options been examined whether it is possible to backfill the tailings directly into or as closely as possible to the underground mines (backfilling), to construct the TMF in open pits or on another place, possessing reduced consequences of case of failure?

- yes
- no
- not applicable
- measure
- no measure

Comments:

3.1.2a Sizing of the emergency discharge capacity for low-hazard dams:

Has the once in 100-year flood event been used as the design flood for the sizing of the emergency discharge capacity?

- yes
- no
- not applicable
- measure
- no measure

Comments:

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

3.1.2b Sizing of the emergency discharge capacity for high-hazard dams:

Has the once in 5,000-10,000-year flood event been used as the design flood for the sizing of the emergency discharge capacity?

- yes no not applicable
- measure no measure

Comments:

3.1.3 Has a safety factor of at least 1.3 been taken account of for the designing and sizing of the dam stability?

- yes no not applicable
- measure no measure

Comments:

3.2 Construction of dams

3.2.1 Are the foundation conditions investigated satisfactory?

- yes no not applicable
- measure no measure

Comments:

3.2.2 Was the natural ground below the dam completely stripped of all vegetation and huminous soils?

- yes no not applicable
- measure no measure

Comments:

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

framework condition	conventional type dam	upstream method	downstream method	centreline method
seismic risk				
none				
very low				
low				
high				
sludge contains a proportion of sand (>0.075 – 4 mm) of under 40%				
impoundment must also be suitable for the storage of water				
permanent monitoring of beaches				
tailings are not suitable for raising the dam				
facility is remote				
facility is inaccessible				
long retention period is needed to degrade toxic substances				
high surface-water inflow to the impoundment or high variations				

Comments: **Red cells** → conflicting BREF, management plan urgently to be controlled, facility is to be closed down, if necessary.

3.3.3 Are within the downstream shoulder during construction or as a toe berm introduced properly designed internal drains of suitably graded material?

- yes no not applicable

Documentation on hand?

- measure no measure

Comments:

3.4 Management/monitoring of dams

3.4.1 Does a monitoring plan exist?

- yes no not applicable

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

measure no measure

Comments:

Are the following inspections/reviews foreseen in the monitoring plan and are the inspection intervals complied with:

maximum capacity/ water level	<input type="checkbox"/>	daily
beach width	<input type="checkbox"/>	daily
quantity of seepage water (dam, foundation)		
visual inspection	<input type="checkbox"/>	daily
monitoring of seepage lines (sediment/dam)	<input type="checkbox"/>	weekly
monitoring of pore pressure	<input type="checkbox"/>	yearly
seepage composition	<input type="checkbox"/>	monthly
groundwater level around the pipelines and in the vicinity	<input type="checkbox"/>	monthly
ground movements (deep inclinometers)	<input type="checkbox"/>	every six month
movement of dam crest and tailings	<input type="checkbox"/>	every six month
seismicity	<input type="checkbox"/>	continuously
soil mechanics, parameters (shear strength, water content, proportion of particles)	<input type="checkbox"/>	yearly
monitoring of tailings placement procedures	<input type="checkbox"/>	yearly
dynamic pore pressure	<input type="checkbox"/>	yearly

Drainage/ dewatering

diversion of surface waters	<input type="checkbox"/>	monthly
drains	<input type="checkbox"/>	monthly
interception wells	<input type="checkbox"/>	monthly

3.4.2 Is it guaranteed that the alarm is set off as soon as the following parameters are below the indicated values?

- **freeboards below 1.5 m * (1.8 m for high-hazard dams) or**
- **beach width less than 100 m (200 m for high-hazard dams)**

yes no not applicable

measure no measure

Comments:

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

3.4.3 Have measures been taken to cut off/divert all natural inflows and collect them elsewhere in the event of an emergency?

- yes no not applicable
 measure no measure

Comments:

3.4.4 Are there sufficient alternative possibilities for sludge collection (retention basins/ impoundments)?

- yes no not applicable
 measure no measure

Comments:

4.4.5 Are there sufficient alternative discharge facilities (emergency outlets and/or pump pontoons/ barges if the maximum capacity is reached (reaching freeboard)? And are these fully functional?

- yes no not applicable
 measure no measure

Comments:

The emergency outlets should include additional impoundments (tailings ponds) (see 2.1).

3.4.6 Do design and construction documents exist? And is it compulsory to include all changes to the construction in such documents?

- yes no not applicable
 measure no measure

3.4.7 Does the dam have a sufficiently dimensioned and regularly maintained drainage system?

- yes no not applicable
 measure no measure

Comments:

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

3.4.8 Are all natural inflows (surface waters) collected separately and diverted outside the industrial tailings management facilities?

- yes no not applicable
- measure no measure

Comments:

3.5 Closure

**3.5.1 Is there site restoration? Is there a restoration/re-vegetation plan (final operation plan)?
Is this plan being implemented?**

- yes no not applicable
- measure no measure

Comments:

3.5.2 Is a safety factor of at least 1.3 applied to the measurements of the dam stability in the phases of closure and after-care?

- yes no not applicable
- measure no measure

Comments:

Examples of measures:

short-term:

- o checking of documents/ calculations*
- o repair of emergency discharge capacities and other sensitive facilities*
- o repair of the dykes and diversion systems for surface waters (springs, precipitations, snow melt)*
- o increased monitoring by staff (freeboard, beaches)*

medium-term:

- o adjustment of the emergency discharge capacities*
- o adjustment of the operational system to the safety requirements*
- o elaboration of a mandatory internal testing plan and its internal implementation*
- o installing automatic devices constantly taking measurements*

5. Contingency planning and hazard control measures

5.1 Does a contingency planning exist?

- yes no not applicable
 measure no measure

Comments

5.2 Is staff training carried out on a regular basis?

- yes no not applicable
 measure no measure

Comments

5.3 Does an annual safety report exist as part of the management plan?

- yes no not applicable
 measure no measure

Comments

5.4 Does the safety report include possible scenarios (incidents) for each operational phase of the industrial tailings management facility?

- yes no not applicable
 measure no measure

Comments

Checklist No. XX: Safety of Industrial Tailings Management Facilities (TMF)

5.5 Are all accidents reported to the competent authorities, all causes identified and the results of the analysis taken account of and included in the management plan (safety manual) and the contingency planning?

- yes no not applicable
- measure no measure

Comments

Examples of measures

short-term:

- *staff training*
- *larger number of staff*
- *internal interim testing plan*
- *evaluation of the causes for accidents*

medium-term:

- *elaboration of a mandatory safety manual and internal implementation*
- *elaboration of possible scenarios (incidents)*
- *elaboration of a safety report and contingency planning*

long-term:

- *elaboration and implementation of a safety concept by external experts*