SAFETY EVALUATION OF AURUL TAILINGS POND

The case study dedicated to Aurul tailings pond illustrates the use of risk analysis for developing a proper risk management program after a severe technical accident.

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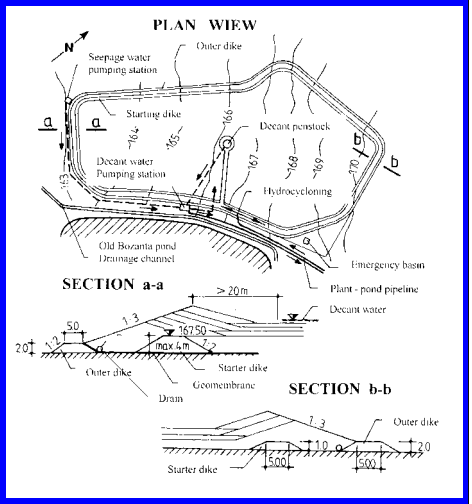
INITIAL LAYOUT

Flat land pond
Area: 89ha.
Volume: 15 mil. m ^{3}
Maximum height of the contour dike : 17-18m



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Aerial view of the pond before the technical accident

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The technical accident

On January 30, 2000, at 10pm

* a breach of approx. 20m, with a depth expansion until the top of the starter dike on the southern side of the pond

* 100.000 m^3 of cyanide-contaminated water were released, beyond control

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Dike breach after the technical accident

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- Brerach closure to stop spillage

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TECHNICAL ACCIDENT CAUSES

- *The faulty design*

integral recirculation of water

- *The excessive input of rainwater*.

massive thawing + rain of 35.7 l/m^2

- *Lack of adequate monitoring*

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A preliminary risk evaluation based on numerical indices

@allows for a rational rating of constructive measures

A complete quantitative risk assessment

@renders evident the efficiency and the benefits of the structural and non-structural measures in terms of risk management.

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FAILURE MODES, EFFECTS AND CRITICALITY ANALYSIS

Criticality index :

$$IG = CM \,.\, PC \,.\, DC$$

where:

CM - expresses the component share in the failure mechanism;

PC - expresses the component failure probability;

DC - expresses the extent to which the component failure may be detected in advance.

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Criticality index IG for Aurul pond

Parameter /component	*CM*	*PC*	*DC*	***IG***= *CM·PC·DC*
Freeboard	5	4	1	**20**
Beach width	4	4	1	**16**
Downstream slope	5	4	1	**20**
Grain size of dikes	3	4	3	**36***
Water collecting system	5	3	4	**60 *****
Drainage system	5	2	4	**40****
Pond-plant pipes	3	4	2	**24**

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Prioritization of safety measures established on the basis of criticality index IG :

- performance of a second decant tower was given priority
- effective drainage of the perimeter dike
- close monitoring through an adequate system

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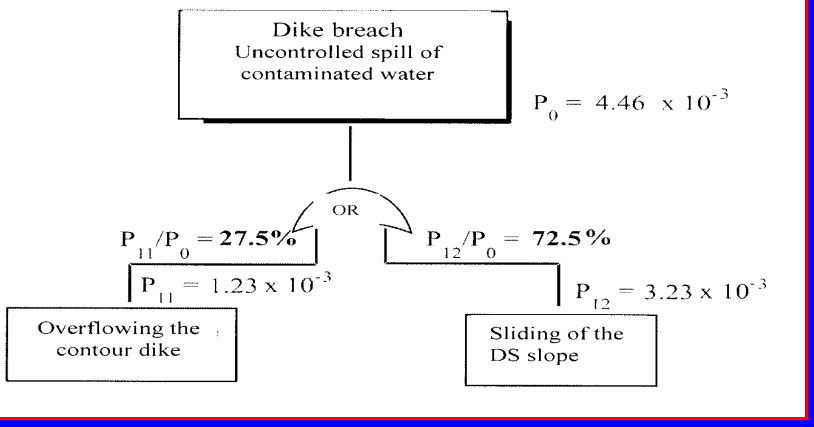
Failure mechanisms and associated probabilities



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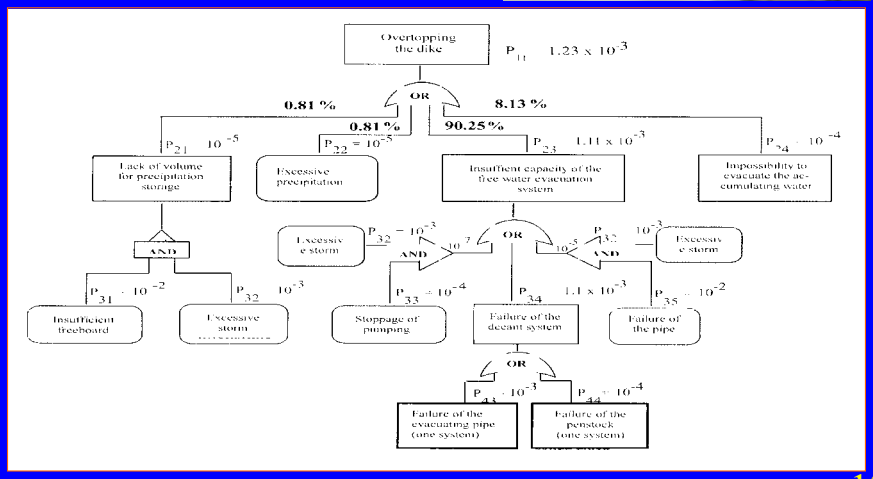

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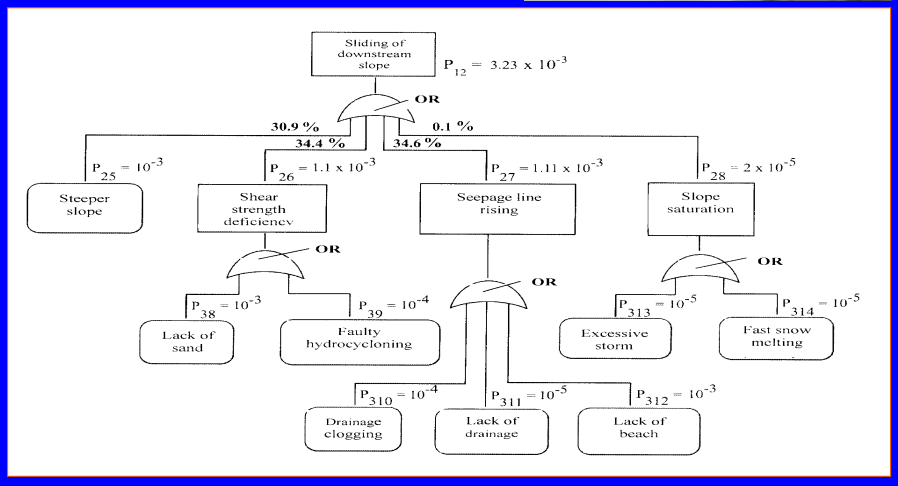

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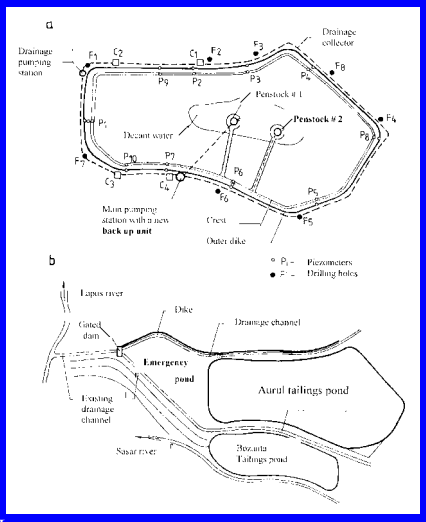
Increasing safety measures:

@ second penstock ;

@ supplementary pump unit with a Diesel engine;

@ treatment plant for the decant water, 150 m^3/h capacity;

@ direct discharge of 100 m^3/h with pipe treatment.



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Failure probabilities

Probability of primary events :

cyclical actions - annual probability based on statistic study of annual maximum values

engineering judgment - annual probabilities on the basis of some numerical equivalence

Dam breaching failure probability:

initial $P_b = 4.46 \times 10^{-3}$

with safety measures $P_b = 1.412 \times 10^{-3}$

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Consequences global quantification

$$C = \beta \Sigma_i CG_i \; P_{ei} \; \alpha_i$$

where:

CG_i - *the gravity index of consequence i;*

P_i - *the probability of effective emergence of category of consequence i;*

α_i - *efficiency of the mitigation measures*

β - *owner's capacity to intervene rapidly for the breach closure.*

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CG Index – gravity consequences

i=1 casualties (C) $CG_1 = 10^6$

i=2 effects on the environment (EE) $CG_2 = 10^6$

i=3 economic loss for the third parties (DTP) $CG_3 = 10^3$

i=4 damage to the owner (DD) $CG_4 = 5x10^2$

i=5 effects on the company image (EI) $CG_5 = 10^2$

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Risk management considerations

- Risk control is ensured by the imposed safety measures, by monitoring the tailings pond behavior and by complying strictly with the operation regulations.

- The failure probability of 1.4×10^{-4} is in the range of the tolerable limits for earth dams.

- Reduction of more than 3 times of the probable consequences by successive defensive lines is a rare case in the tailings pond field.