Decommissioning and Potential Remediation of Mining/Processing Projects Affected by Naturally Occurring Radioactive Material

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Throughout the life-cycle we provide advice to operators, investors and regulators in ... 

**Strategy**
- Feasibility assessment
- Document/data review
- Permitting support
- Stakeholder communication
- Policy advice
- Compliance verification

**Technology**
- Radiation safety
- Radioecology
- Decontamination
- Residues management
- Facility decommissioning
- Site remediation

... from conceptualization on and optionally until engineering/realisation.
Overview

Motivation and objective
Project-'cycle' and Purpose
Implications of Decommissioning & Remediation
1a Equipment & Facilities – Radiological Characterisation
1b Equipment & Facilities – Decommissioning
2a Sites – Radiological Characterisation
2b Sites – Remediation of Soil & Groundwater
3  Management of Residues/Waste
4  Post-closure Monitoring
Costs
Conclusions
Motivation and objective:
Supporting NORM affected mining/processing projects:
• to get permitted
• to enable safe and compliant closure
• to prevent from legacy risks
Project-'cycle' and Purpose of D&R

1. Pre-Operation
   - Prospection/Exploration
   - Design/Engineering
   - Env. Monitoring
   - Permitting

2. Operation
   - Mining
   - Processing
   - Env. Monitoring

3. Closure (D&R)
   - Facility dismantling
   - Site reclamation/clean-up
   - Closure/Post-Closure Monitoring
   - Site re-use/release
   - Prevention of legacies/liabilities

Preliminary Closure Plan
Implications of D&R NORM affected projects

Uranium - decay to strongly radioactive Radium / Radon

Rare-Earths - contained Thorium decays to Radium / Radon

→ Numerous aspects of D&R:

→ Clean-up Criteria?

→ Effort depends on former activity

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1a Equipment & Facilities – Radiological Characterisation

Objects:
- Equipment and installations – disassembled/fragmented
- Mining & Processing facilities – dismantled
- Left-over operational residues – treated/disposed off

1) Assessment of operational history → any accidents documented?
2) Systematic determination of
   - Activity/specific dose → NORM residues inventory
   - Kind of radionuclides etc.

→ Safety (occupational radiation protection/no contaminant spreading)
1b Equipment & Facilities – Decommissioning

I. Fragmentation /disassembly

II. Decontamination
- Manual brushing
- Water-jetting
- Chemical bath
- Abrasive blasting

III. Dismantling

Activity?

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2a Sites – Radiological Characterisation

Objects:
- Potentially contaminated soil
- Groundwater/soil water
- Tailings impoundments, waste rock, ore stockpiles → re-injected, water cover, cover, drainage, dewatering, purification of effluents etc.

[]- Pipelines etc. (above-ground/buried) → decontaminated/fragmented]

1) Assessment of radioecological monitoring, footprint, operational history

2) Radiological screening / qualitative characterization
   → Aeroradiometric/on foot survey, selected drilling/sampling

   Essentially contaminated?

3) Quantitative radiological characterization
   → Systematic drilling/sampling: spatial determination of radionuclide concentration
2b Remediation of Soil & Groundwater

- Soilwater treatment
  - Pump & Treat (active)
  - Phytoremediation (passive)

- Soil washing / soil separation
  - Soil washing/excavation
  - Conveyor belt monitoring

- Confinement of contamination
  - Seal wall
  - Cap/cover
  - Immobilisation

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- Water/effluents purification
  - Precipitation/reagents
  - Adsorption/filtration/osmosis
  - Passive treatment

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Management of NORM residues/waste

Measurement of decontaminated components, generated waste and used agents (water, sand):

→ Radiological release criteria separate in *NORM waste* – *conventional waste*

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I. Measurement

II. Optional: NORM waste *treatment*

III. Disposal
5 Post-closure Monitoring

~ Radiological screening + environmental monitoring

Objects:
- Soil
- Surface-/Groundwater
- Air
- Plants/wildlife/food (indicators)

Purpose:
- prior to closure: determines contamination-free condition or indicates need for remediation
- during closure: ensures safety during decommissioning & remediation
- following closure: verifies remediation success and long-term safety

→ Once final release of the site is possible:
   Hand-over to institutional control
Costs

1. Direct costs (OPEX/CAPEX)

Forecast decommissioning Cameco’s Key Lake mill: CAD$ 222.5 million
Estimation rehabilitation ERA’s Ranger Mine: AUD$ 1600-2200 million

- Radiological screening ~ € 250,000-1 million/km²
- Detailed characterisation ~ € 10 million/km²
- Remediation costs ~ € 5-40 million/km²
- Disposal costs up to € 5000-10,000/m³

Preliminary Cost Estimation:
→ submitted with permitting application
→ determines financial securities/provisions

2. Follow-up costs could arise from potential liability risks
Conclusions

- General precondition to prevent potential legacies as well as to avoid liability risks is to perform complete and appropriate – but reasonable – closure.

- Already for realization of NORM affected projects it is essential to demonstrate capability for future decommissioning as regulators increasingly require a *Preliminary Closure Plan (and Preliminary Cost Estimation) as precondition for permitting* a mining/processing operation.

- Even before start of operation its future decommissioning produces significant costs as *provision of securities* can be required.

- Effort and costs of decommissioning strongly depend – apart from size and kind of the former activity – on a safe and compliant operational history *without any accident*.

- Beyond regulatory and safety requirements the extent of decommissioning measures and possible benefits – e.g. decontaminating NORM residues vs. treating generated NORM waste – should be reasonably balanced.
If your project needs relevant support, fill out the contact form on our website or simply get in touch by:

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