Case Study Tailings (and Other Bulk Wastes)

Training Package on Occupational Radiation Protection in Uranium Mining and Processing Industry
Tailings (and other Bulk Wastes) Description

• Every uranium operation generates wastes which will require management and eventual disposal
• For most mines the major waste will be tailings (the residual solid material after milling and leaching), with exception ISL
• Other wastes can include mineralised waste rock or below grade ore, heap leach residues, scales arising from piping and vessels, etc.
Some Aspects of Disposal Facilities

- Site selection and construction;
- Treatment;
- Thickening;
- Deposition;
- Backfill;
- Long term storage and isolation.
Build your own Disposal Facility

- Chose your type of disposal facility: tailings retention system, waste rock pile, heap leaching material, miscellaneous contaminated waste disposal
- Choose your disposal method: surface disposal (ring dyke, valley, mined out pit, surface stockpile), shallow disposal, underground disposal
- Size and activity of the disposal facility
- Disposal methodology: subaerial, subaqueous, slurry, solid, liquid
- Waste characteristics and treatment: thickened, paste, acid, alkali, neutralised, additional material (flyash, cement)
- Site factors: geological, climatic, community, topographical, ground water, surface water,
- Bottom waterproofing of tailing facility
Model Answer Disposal Facility

- Tailings Retention System
- Ring Dyke
- 100ha. in size with a height of 15m and containing material with an activity of 10 Bq/g per radionuclide in the uranium series (1 Bq/g U)
- Material thickened to approximately 45% solids and then deposited as a slurry subaerially
- Decant water collected and returned to the process plant
- Tailings are deposited un-neutralised (acid pH1.6)
- Site is in an arid area on clay terrain with deep saline groundwater and no nearby communities or surface water features
- Bottom waterproofing of tailings facility
Determine the Exposure Pathways for your Disposal Facility

• For each stage assign a relative level for the importance of the exposure pathway
  – VH-very high, H-high, M-medium, L-low, VL-very low
• Special is for unusual cases such as maintenance
## Exposure Pathways for your Disposal Facility

<table>
<thead>
<tr>
<th>Stage/Pathway</th>
<th>Gamma</th>
<th>Radon Progeny</th>
<th>LLRD*</th>
<th>Special</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site selection and construction</td>
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<tr>
<td>Treatment</td>
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<tr>
<td>Thickening</td>
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<td>Deposition</td>
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<td>Backfill</td>
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<tr>
<td>Long term storage</td>
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* LLRD – Long Lived Radioactive Dust
# Model Answer: Exposure Pathways for your Disposal Facility

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<tr>
<td>Site selection and construction</td>
<td>VL</td>
<td>VL</td>
<td>VL</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>L(H*)</td>
<td>L</td>
<td>L</td>
<td>H* Return of decant liquor may generate $^{226}$Ra scale</td>
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<tr>
<td>Thickening</td>
<td>M(H*)</td>
<td>L(H*)</td>
<td>VL</td>
<td>H* Density gauges with gamma potential and radon during vessel entry</td>
</tr>
<tr>
<td>Deposition</td>
<td>M</td>
<td>L</td>
<td>VL(M*)</td>
<td>M* If tailing dry out dust may arise</td>
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<td>Backfill</td>
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</tr>
<tr>
<td>Long term storage</td>
<td>L</td>
<td>L</td>
<td>VL(M*)</td>
<td>M* Worker access infrequent but tailings will be dry</td>
</tr>
</tbody>
</table>

* LLRD – Long Lived Radioactive Dust
What are the potential critical areas for radiation protection?
Model Answer Critical Areas

• Majority of the normal exposure will be from gamma due to working in close proximity to the material
• If the tailings dry out and there is high winds there may be high dust concentrations
• The use of density gauges during thickening require precautions for gamma
• Maintenance (vessel entries) to thickeners or decant structure which may have radon
• The decant liquor return system may generate scales with a very high quantity of $^{226}\text{Ra}$ and become a significant gamma source
What Monitoring is Required

• Gamma – which groups need personal monitoring, can monitoring be optimised
• Long Lived Radioactive Dust (LLRD) – breakdown what radionuclides in what areas, how to determine, activity measurement
• Radon Progeny – where and when to monitor
• Contamination – what is the critical areas and do you need biological monitoring (uranium in urine)
Model Answer Monitoring

- Gamma – Given the area that tailings workers cover, the cheapest method is to use personal dosimetry for all workers.
- Radon progeny – No personal monitoring and some radon alpha track detectors (ATD) for area levels on tailings area. Radon progeny monitor during confined space access and duration of entry logged.
- LLRD – Occasional personal area sampling as a low priority.
- Contamination monitoring not performed as not expected to be a significant pathway. Urine analysis only considered if there is an accident with the potential for direct ingestion or injection.
What are Some of the Critical Controls
Model Answer: Critical Controls

- Entry to confined spaces restricted and monitored with entry permits and radon progeny measurements prior to entry. Forced ventilation is used if the radon levels are above a trigger value.
- Density gauges clearly identified and only qualified workers may move, operate or modify the density gauges.
- Worker access may be restricted during high wind speed events causing dusting.
- Periodic gamma monitoring will be undertaken around the decant liquor return pipes, tanks and pumps to determine if the gamma rate is changing and hence indicating the build-up of radium scale.
Dose Assessment

• How to determine total dose?
Model Answer Dose Assessment

• For gamma use personal dosimetry results. If a dosimeter is lost then use the workgroup average.

• For LLRD use the work group average airborne dust concentration (mg/m$^3$) and multiply it by the measured activity (Bq/mg) to get the average airborne activity concentration. If the activity is unavailable use the concentration of the higher grades in the ore body (conservative approach).

• Calculate LLRD dose using the time the workers are on site, the workgroup average airborne activity and a dose conversion factor based on equilibrium from $^{230}$Th down and an AMAD of 5µm.

• Assume radon progeny is not significant unless radon alpha track detectors show enhanced levels.
Key Messages

• Doses from normal tailings operation will be primarily the result of gamma exposure
• Other disposal facilities may have different dose characteristics and care is required when dealing with material containing scales
• High levels of dusting may occur if the wastes are dry and there is a high wind speed event
Thank you!