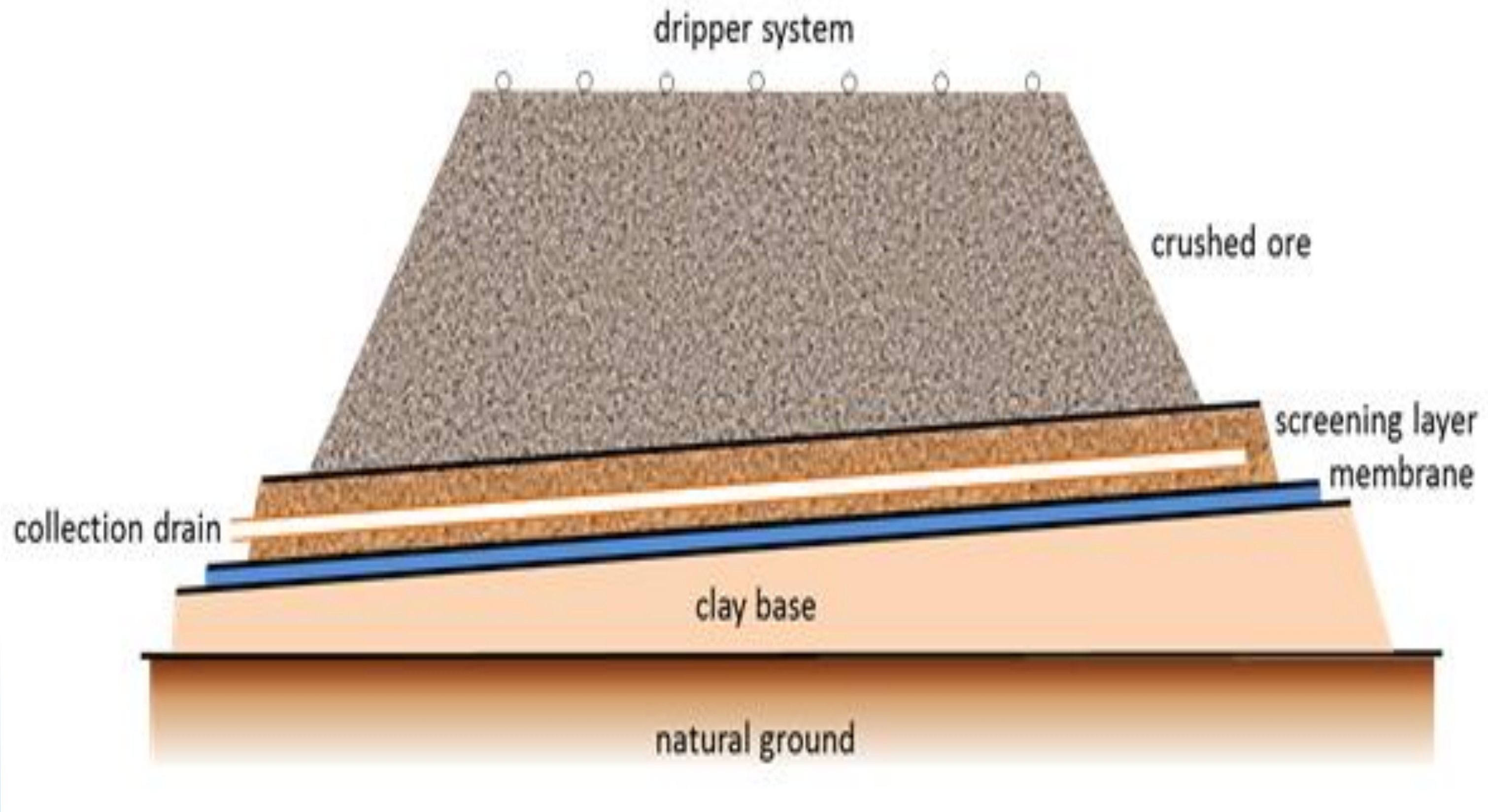
Heap Leaching

Training Package on Occupational Radiation Protection in Uranium Mining and Processing Industry

Heap recovery

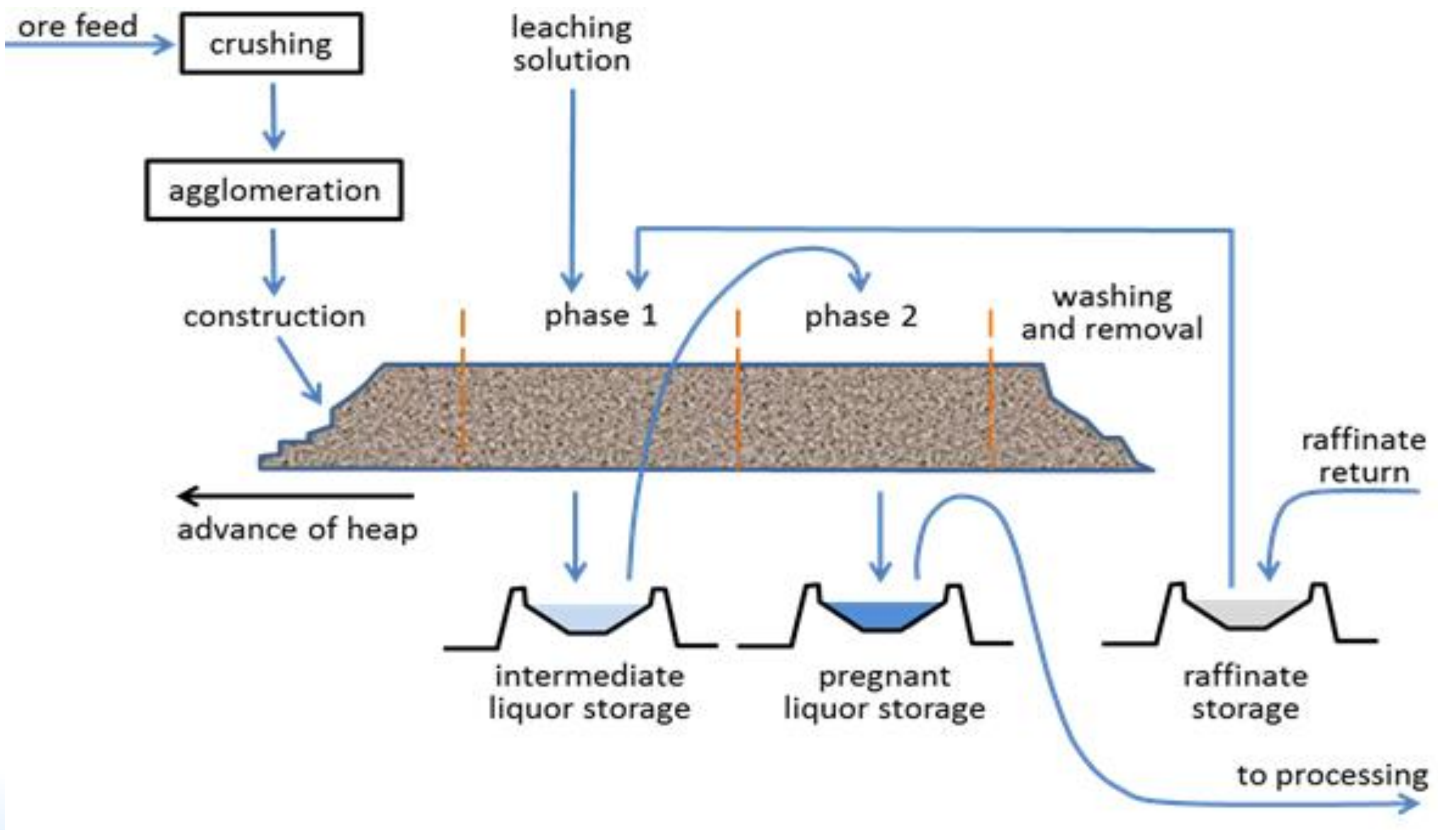
- Heal leaching, < 1% of uranium production
- Heap leaching is an alternative method of extracting uranium rich liquor from extracted ore. Mining of the ore is conventional (either underground or surface) and the ore is placed on surface pads where extractive liquors (acid or alkaline) are pumped over and through the material. This process may be repeated until liquor of sufficient uranium content is transferred for further processing to extract the uranium.



Design and operation

The supply of fresh leaching solution involves a storage and delivery network. The intermediate solutions (partially uranium loaded leachate for reapplication) and “pregnant liquor” (fully uranium laden leachate) need impermeable retention ponds. Provision also needs to be made to handle natural rainfall, including containment within the site of unusual rainfall events.

In the simplest designs, the “pregnant liquor” will be pumped to a separate processing plant for treatment and the production of a final uranium product. In some cases, some preliminary processes, such as solvent extraction of the uranium, may be carried out within the heap leach area.



Principal exposure pathways

- Gamma exposure will be the dominant exposure pathway;
- Long Lived Radioactive Dust (LLRD) and radon progeny exposures are usually much lower.
- A heap of uranium ore in the open presents a large source of relatively low concentration radioactive material for which little can be done in the way of shielding from external radiation or of mechanical or wet containment of any emissions.
- Control of occupational exposure will depend primarily on restricting the time spent on or in proximity to the heap and on ensuring that the heap remains saturated to restrict the emission of radon and LLRD.

Principal exposure pathways

- External exposure (gamma) – medium;
- Inhalation of radon progeny – low (except for special areas where radon can degas & concentrate);
- Inhalation of LLRD – low;
- Internal exposure via surface contamination – low;

Monitoring and dose assessment

- A risk assessment and exposure pathway analysis are needed to establish the types and frequency of monitoring needed for demonstrating compliance with health and safety standards and with the principle of optimization of protection.
- Provided good occupational hygiene practices are observed, intakes of radioactive material other than by inhalation are expected to be negligible.
- If chemical processing of the leachate takes place near the heap, additional monitoring may be necessary.

Monitoring and dose assessment

- Measurement of gamma dose rates at specified monitoring points;
- Measurement of radon progeny or the equilibrium equivalent concentration of radon and LLRD;
- Measurements for surface contamination;
- Dose assessment and review to investigate ways to reduce doses;
- Results of an initial monitoring and dose assessment program will allow the subsequent routine program to be designed and implemented.
  - Decisions can be taken on what fraction of the workforce would need to be subject to personal monitoring
  - Extent and frequency of any area monitoring can be determined.

Determine the Exposure Pathways

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

Stage/Pathway	Gamma	Radon Progeny	LLRD*
Heap			
Extraction			
Gangue			
Liquor recirculation			

* LLRD – Long Lived Radioactive Dust

Model Answer Exposure Pathways

Stage/Pathway	Gamma	Radon Progeny	LLRD*
Heap	M	L	L
Extraction	M	L (wet based)	L (wet based)
Gangue	H (collect)	VL	L (wet based)
Liquor recirculation	L(H* scales)	L(H* radon degassing)	VL

* LLRD – Long Lived Radioactive Dust

Control

- Flow through filtered air conditioned cabins for drivers so they avoid opening windows and doors as far as practicable.
- Minimising occupancy time of workers in working areas (i.e. on the heap).
- Using dust suppression during the construction and operation of the heap.
- Gamma surveys to ensure that radium scale does not build-up in recycled liquor infrastructure.
- Ventilate where potential for radon progeny from liquor degassing & prior to vessel entry.

Key Messages

- A successful radiation protection program is based on a detailed understanding of the technological infrastructure.
- Gamma exposure will be the dominant exposure pathway.
- Radiation protection by reducing time on the heap to protect workers.
- Proper gangue management reduces radiation risks.
- It is important to use water dust suppression during the construction and operation of the heap.
- Vehicles needs to be fitted with filtered air conditioned cabins and drivers have to avoid opening windows and doors as far as practicable.
- Gamma surveys to ensure that radium scale does not build-up in recycled liquor infrastructure.
- Potential for radon progeny exposure from liquor degassing & vessel entry

Guidance Questions

Q1: Where is the high impact of gamma exposure?

Q2: What do need do for decrease impact of radioactive dust?

Q3: Where is radon progeny a potential problem?

Guidance Answers

A1:

- On the heap;
- ^{226}Ra scales in the liquor circulation

A2:

- Flow through filtered-air cabins for drivers and they have to avoid opening windows and doors as far as practicable.
- Accounting of the time of stay of workers in working area (on the heap);
- Using water dust suppression during the construction and operation of the heap.

A3:

- Where degassing of liquor occurs and during vessel entry

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Thank you!