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Case Study Surface Mining

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

Process Description

- Most common mining method for ore body that is close to surface or has surface expressions
  - Generally most economic method for shallow low grade deposits
  - Bench mined

Design your own open cut uranium mine

- Depth of deposit?
- Uranium grade?
- Localised geology/hydrogeology?
- Climate & topography?
- Ore crushing?
- Ore carriage?

Model Mine Default Design

- Deposit extends to 200m
- Ore grade ~0.3%
- Ore hosted in schist rock with some localised faulting
- Major aquifer at 70m, dewatering possible
- Tropical environment (wet/dry seasons)
- No major water features nearby
- Flat topography
- Trucked to surface jaw crusher to feed mill

Design & Operation – Mine Design

- All support facilities (offices, rest areas, maintenance workshops, etc.) should be situated away from mine, associated stockpiles & crushing
- Dust suppression should be a primary concern to control occupational, environmental & public exposure
- Gamma exposures can be easily determined from ore grade
- Water control (pit dewatering)

Determine the Exposure Pathways

- For each stage/exposure group 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

Determine the Exposure Pathways

Stage/Pathway	Gamma	Radon	LLRD	Special
Production				
Drill & Blast				
Pit Maintenance				
Surface Maintenance				
Surface Support				
Crushing				

Model Answers

Stage/Pathway	Gamma	Radon	LLRD	Special
Production	M	L	L	M radon in deep pits
Drill & Blast	M	L	M	H for LLRD without controls
Pit Maintenance	M	L	L	M for radon in deep pits
Surface Maintenance	L	VL	L	M for LLRD without equipment cleaning
Surface Support	VL	VL	VL	
Crushing	L	L	M	H for LLRD without controls

What are the potential critical areas for radiation protection

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Critical Areas – Model Answers

- External gamma exposure from stockpiles & in mine
- Inhalation of dust in pit & around crusher
- Inhalation of radon in confined spaces for ore handling
- Contamination of vehicles & other equipment (pit dewatering pumps)

What Monitoring is Required

- **Gamma** – which groups need personal monitoring, can monitoring be optimised?
- **LLRD** – Sizing, solubility, personal monitoring program for SEGs?
- **Radon** – monitoring methods, program to make dose assessment, localised or default DCF, where to locate monitors?
- **Contamination** – what are the critical areas/equipment?
- **Control Monitoring** – what program needs to be developed to monitor controls?

Develop a Monitoring Program

Stage/Pathway	Gamma	Radon	LLRD	Special
Production				
Drill & Blast				
Pit Maintenance				
Surface Maintenance				
Surface Support				
Crushing				

Develop a Monitoring Program – Model Answers

Stage/Pathway	Gamma	Radon	LLRD	Special
Production	P	Area	SEG	
Drill & Blast	P	Area	SEG	
Pit Maintenance	P	Area	SEG	
Surface Maintenance	SEG	Area	SEG/Area	
Surface Support	N/A	Area	Area	
Crushing	P	Area	SEG	

Model Answers – Monitoring

- Gamma – Personal monitoring for all work groups working in pit or stockpiles, selective monitoring for others
- LLRD – Determine AMAD & solubility, develop SEGs & implement appropriate personal monitoring program, area based monitoring can be used for workshops/offices
- Radon – Area based monitoring, averages to be applied based on occupancy, measurements to determine localised or default DCF requirements
- Contamination – Program to monitor vehicles & equipment leaving mine, inspection of offices, workshops & rest areas
- Control Monitoring – Regular inspections of dust suppression

What Controls do you need for your mine?

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Model Answers for Controls

- Gamma – Ensure office & workshops remain away from stockpiles, use of clean fill for base in production areas
- Radon – Enclosed cabins & offices with flow through AC
- LLRD – Dust suppression (water trucks, water sprays at crusher)
- Contamination – clearance processes, housekeeping schedules

Dose Assessment

- How do assess gamma for those not given personal monitors?
- What is the dose conversion factors for the various areas and what does it consider – radionuclides, particle size, solubility
- How will radon areas be selected?
- What is the process for selecting SEGs?

Dose Assessment Model Answers

- Workgroup averages for workers without personal monitors
- LLRD, use equilibrium & assume default AMAD, use maximum DCF for each radionuclide solubility.
- Radon areas can be broad (i.e. office/workshop if located nearby)
- Discuss with operators their tasks to determine SEGs & take statistically valid sampling

Key Messages

- All non-critical work & infrastructure away from operations (pit, stockpiles & crushing)
- Use enclosed cabins with flow through AC for production & drilling
- Determine critical information (DCF, particle sizes, solubility) but can use conservative assumptions
- Develop effective monitoring program & review regularly
- Inspect all controls regularly & work with operations to ensure they are maintained

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Thank you!