IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Exposure Pathways Surface Contamination

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

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

SURFACE Contamination

- Introduction to Surface Contamination
- Control measures
- Monitoring & dosimetry
- Key messages & facilitating questions (2 questions & answers for discussion)

Surface Contamination

- The mining and milling of uranium ores involves the handling and processing of large amounts of ores, process materials and product in both wet and dry form.
- Exposure to surface contamination arising from deposited dust may occur in any area of the mine or process plant. The main risk arising from surface contamination in a uranium processing facility is the possibility of inhaling resuspended loose contamination or ingesting loose contamination.

Surface Contamination

- Surface contamination can become a significant issue in those areas of the plant handling materials with a high concentration of uranium (e.g., high grade ores and in the uranium product section) or other radionuclide (e.g. radium scale).
- The potential magnitude of these hazards depend on
  - The level of surface contamination
  - The specific radiological characteristics of the contamination.
    - uranium ore contains all elements of the ^{238}U and ^{235}U decay chains.
    - the long-lived alpha-emitting nuclides, ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra and ^{210}Po are the most significant radionuclides.

Surface Contamination

- Non-fixed (Removable) contamination can be re-suspended from surfaces during a wide variety of normal work activities in mining, materials handling and process plant as well as from spills and accidents.
- Over a period of time fixed contamination (e.g., ^{226}Ra scale) can build up on surfaces inside the process lines and vessels potentially resulting in significant localised gamma dose rates in the plant.
- Fixed contamination can be liberated into the air during cutting and abrasive activities such as during the decontamination of process equipment.

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Control Measures for Surface Contamination

- **Engineering controls**
- **Administrative controls**

Control Measures for Surface Contamination

- Engineered controls such as
  - the design of facilities for the processing of uranium ores and processed materials to suppress or contain sources of radioactive materials.
  - Radioactive materials that cannot be contained effectively within the process need to be controlled by means of ventilation in order to prevent the release of contaminants and to minimize occupational exposure.
  - physical barriers to limit and direct the spread of materials.
- Special care may be required in planning and performing maintenance operations and in the event of a spill or accident.

Control Measures for Surface Contamination

- Administrative Controls include
  - a formal system of contamination control,
  - administrative procedures such as housekeeping programme, cleaning of equipment, designation of “clean” and “dirty” zones, control of the movement and monitoring of equipment and people between zones and use of appropriate PPE.
  - appropriate cleaning of facilities, particularly high occupancy areas such as control rooms change rooms, and eating areas.
  - monitoring to ensure ongoing effectiveness of controls.

Control Measures for Surface Contamination

- Good housekeeping and working practices are needed to keep spillages to a minimum when loose materials need to be handled (e.g., during ore haulage and maintenance activities).
- Fixed contamination inside the plant process resulting in high localised gamma dose rates can be controlled through replacing or decontaminating components (e.g., tanks, pipes and valves).
- Where there is a build-up of loose material on working surfaces the materials can be washed into the plant sump

Control Measures for Surface Contamination

- The use of PPE such as dust masks, respirators and disposable clothing can help to reduce exposures arising from surface contamination;
- In a clean plant with good housekeeping these personal control mechanisms are normally only necessary during plant maintenance activities or in the event of a spill or accident.

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Monitoring and Dosimetry

- **Monitoring**
- **Exposure Control**

Monitoring and Dosimetry - monitoring

- The extent of the surface contamination monitoring programme needs to be commensurate with the nature and extent of the potential for surface contamination in the workplace and is intended to compliment the airborne and gamma monitoring programmes

Monitoring and Dosimetry - monitoring

- Contamination monitoring is necessary for the following main purposes:
  - To verify the efficiency of designed engineered controls in the plant and process;
  - To confirm good housekeeping practice;
  - To confirm area designations;
  - To identify contaminated areas and the level of contamination;
  - To identify the spread and build-up of contamination;
  - To monitor items and persons exiting designated areas.

Monitoring and Dosimetry

- Surface contamination monitoring programmes are site and facility specific and dependent on factors such as:
  - The ore grade;
  - The type of mining and processing methods;
  - Process plant design;
  - The extent and effectiveness of the engineered controls to contain radioactive materials within the process;
  - Maintenance activities;
  - The age of the plant.

Monitoring and Dosimetry - monitoring

- Surface contamination monitoring activities need to be focused on the following areas and processes:
  - Dry areas of the process;
  - Uranium product section (e.g., product precipitation, filtration, drying, weighing and packaging);
  - Milling and crushing areas;
  - Areas with a potential for dust generation;
  - Product storage areas;
  - Scrapyards;
  - Equipment maintenance workshops;
  - Eating areas;
  - Exit gates from the facility.
  - Other areas of the facility can be monitored at more infrequent intervals (e.g., offices, laboratories and other facilities outside the designated areas).

Monitoring and Dosimetry – Assessing Surface Contamination

- Surface contamination can be assessed by
  - direct measurement (using an instrument to assess total contamination),
  - indirect methods (e.g., using smear papers to assess removable contamination).
- Removable contamination is of particular radiological importance as this material can result in the intake of long-lived alpha and beta emitting radionuclides
    - be ingested via hand to mouth transfer,
    - become re-suspended as particles during routine work activities and inhalation.
- Derived Surface Contamination Limits (DSCLs) are usually set in terms of removable contamination.

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Key messages & facilitating questions

- Key messages
- Facilitating questions
  - 2 questions & answers for discussion

Key Messages

- Contamination controls are used to prevent the spread of contamination to eating, sleeping or recreational areas;
- To monitor items or people moving from a designated area;
- In support of transport of product.
- With standard workplace hygiene practices, there is minimal likelihood of radioactive contamination of workers (mainly hands), clothing, and tools.
- Administrative areas, food preparation areas and eating areas are generally considered clean areas and it is not uncommon for “work” clothing to be banned and wash before eating policy to be enforced to ensure cleanliness.
- Derived Surface Contamination Limits (DSCLs) are usually set in terms of removable contamination.

Guidance Questions

Q1: What are the main risks to workers arising from loose contamination?

Q2: In a plant with good hygiene practices what activities might require the use of PPE (respirators)?

Answers

- A1: The main risk arising from surface contamination in a uranium processing facility is the possibility of inhaling resuspended loose contamination or ingesting loose contamination.

- A2: In a clean plant with good housekeeping the use of respirators are normally only necessary during plant maintenance activities or in the event of a spill or accident. One example might be the release of fixed contamination into the air during cutting and abrasive activities such as during the decontamination of process equipment.

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Thank you!