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Case Study Transport

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

Process Description

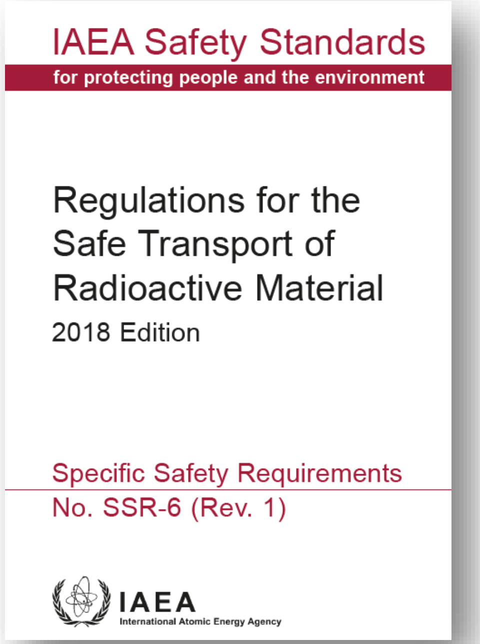
- Wide variety of radioactive materials including **ore, ore concentrates, intermediate products, final product, wastes and contaminated items** may need to be transported by road, rail and sea on private and public roads.
- Transport examples:
  - Final product to the customer
  - Ore and ore concentrates from the mine to the process plant
  - Intermediate process materials to a central processing facility (e.g., central ISL plant)
  - Contaminated material;
    - Scrap items to recyclers or smelters (all types of metal scrap)
    - Plant items for refurbishment (e.g. valves, fans etc.)
    - Plant items for use in a uranium or other processing plant (e.g. larger plant items such as stainless-steel tanks, valves and pipes)
    - Items for decontamination

Process Description

- The final product may be in many **chemical forms** (U_3O_8, UO_4, UO_2 or ADU) or combination depending on the process.
- It is crucial and may change the packing density (and hence the gamma dose rate) and the solubility of the product.
- There are a range of options for the transport of ores or liquids between mining and processing operations.
- The transport may be fully contained within the site boundary of the operation or may occur on dedicated transport routes or on public roads.
- Material can be transported by rail, road, and conveyors or by pipelines depending on the distance and the physical form.

Process Description

- Uranium product is usually packed into metal drums and then stacked into a shipping container for transport.
- The most commonly used package is Package Type IP-1 steel drums (~200 l) which are secured into the shipping containers.
- From the occupational exposure standpoint, the type of package does not significantly change the radiation protection requirements.
- The transport requirements for all types of radioactive materials are set down in SSR-6 (Rev. 1), 2018.


IAEA Safety Standards
for protecting people and the environment

Regulations for the Safe Transport of Radioactive Material
2018 Edition

Specific Safety Requirements
No. SSR-6 (Rev. 1)

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Design and operation

- Initial stage: Ensuring that packages meet the specified requirements for transport (e.g. packing type, cleanliness, labelling, sealing, etc.).
- The containers may be stored for a period prior to a bulk shipment of containers.
- For mine to mill transport there are a wide range of options in use.
  - conveyor belts
  - roll conveyors
  - uncovered lorry loads of low grade material within the site boundary to fully enclosed
  - specially designed transport containers for high grade ore material on public roads
- Liquids/slurries can be transported in specially designed tankers or directly by pipe networks.

Principal exposure pathways

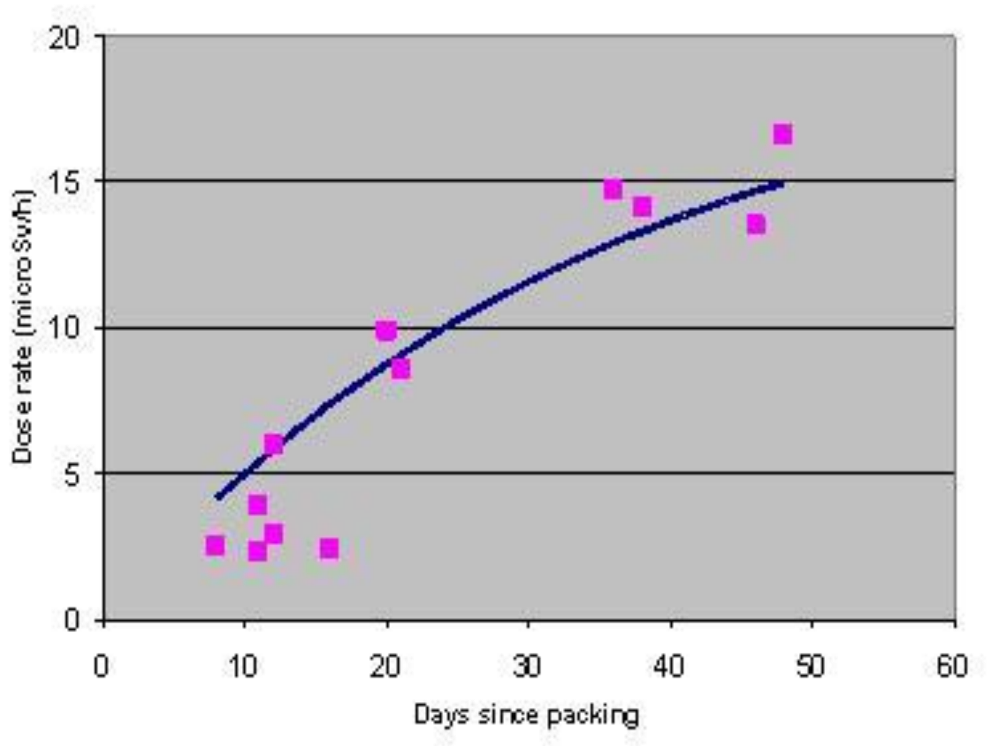
- The only exposure pathway of significance is **direct gamma exposure**.
- Prior to transport the exterior of the container and the interior of the cab should be monitored in a systematic manner.
- Dose rates are taken on contact and at 1 metre.
- **Most significant areas for potential under estimation is the ingrowth of progeny from the parent uranium isotopes.**
- When uranium product is produced it generally has a high degree of purity and only the uranium isotopes (^{238}U, ^{234}U and ^{235}U) are present.
- Shorter lived decay products immediately begin to grow in and this can significantly change the gamma dose rate of the package over time.

Principal exposure pathways

- The uranium isotopes have a relatively weak low energy gamma signature so "fresh" uranium product will generally be a low gamma emitter, over the next few months the gamma dose rate will increase significantly as the gamma emitting progeny grow in.

- The increase in the gamma dose rate is due to the decay of the ^{238}U to ^{234}Th which is a gamma emitter.

- The ^{234}Th comes into equilibrium with the ^{238}U after about two to three months, so the gamma dose rate ceases to significantly increase after this time.



Principal exposure pathways

- In general:
  - For final product, the dominant pathway is gamma
  - In the transport from the mine to the processing plant, the gamma pathway and the inhalation of radionuclides in airborne dust needs to be considered.
  - For higher grade ore the gamma dose rate can become a very significant exposure pathway.
  - During the transport of liquids in pipes the critical pathways are likely to be gamma radiation from the build-up of radium scale on pipework and the inhalation of radon progeny due to degassing of radon from the liquor upon discharge.

- In case of an accident:
  - additional pathways including the inhalation of Long Lived Radioactive Dust (LLRD), ingestion, wounds and skin adsorption may be considered

Control mechanisms

- For the routine transport of uranium product, the normal control practices of time, distance and shielding apply.
- Limiting the time of exposure to radiation is the most effective control practice.
- Simple practices such as automated drum cleaning and pre-printing the labels onto the drum surface during manufacture can significantly reduce occupational doses.
- The packing and securing of the iso-containers needs to be planned and optimised to reduce the time spent in contact with the drums.
- The container placards need to be put in place prior to drum loading.

Emergency planning

- An emergency plan is needed for the transport of radioactive materials in case of an accident during transport.
- The transport crew will need to be trained in accordance with the arrangements for emergency response. In the event of an accident there may be a risk of the inhalation of LLRD and environmental contamination.
- The use of personal protective equipment (PPE) (i.e. respirators, disposable overalls, gloves) in emergency situations is standard procedure for most hazardous materials (including uranium).
- The transport of ores from the mine will also benefit from the control system outlined above for the product transport. If the ore is being carried uncovered, wetting or wind deflectors can significantly reduce dusting.
- In addition, any spilt ore at the loading area needs to be removed promptly.

Monitoring and dose assessment

- The gamma exposures associated with the transport of uranium product are usually low.
- A variety of methods can be used to estimate the exposure of driving crews.
- The primary workplace (e.g. the truck cabin) can be surveyed to measure the gamma dose rate and the dose estimated by multiplying the dose rate by the number of hours spent in the drivers' position.
- Another method is to issue the driver with an electronic personal dosimeter (EPD) and to record the total dose per trip (routine practice in modern uranium operations)
- Workers loading the packages and preparing the containers can be assessed by many methods including similar exposure group (SEG) averaging and the use of EPDs, TLDs, or OSLDs.
- EPDs are useful to estimate the dose of individuals performing specified tasks.
- The storage and loading area needs to be surveyed on a regular basis for dose estimation, to assist in control and to detect any surface contamination.

Monitoring and dose assessment

- In emergency situations involving transport, monitoring may be needed for gamma dose rate, LLRD and surface contamination.
- The potential LLRD exposures of the workers and members of the public can be assessed via air sampling but if not possible bioassay such as urine and faecal analysis or lung and whole body counting.
- For areas where the degassing of process liquors occurs there may be a need for periodic monitoring of radon progeny

Key Messages

- IAEA Transport Regulations are mandatory
- Regulations can appear to be detailed and complex
- Need to have good understanding of material being transported
- Emergency plans need to be developed

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Thank you!