

Review Article

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Automated Class 7 Transport Preparation of Radioactive Preconcentrates

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ABSTRACT

Annually, up to 200,000 t of a preconcentrate from physical processing shall be transported from the mine to the remote refinery. With enriching the rare earths also, the contained radioactivity increases and Class 7 transport will be required. The high throughput of packages (bags) to be prepared for transport suggests some level of automation, as only then a maximum of 275 1m³ bags per day can be safely managed.

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Introduction

Typical rare earths minerals can contain uranium or thorium as part of their lattice. If those rare earths minerals will be enriched, for example by magnetic/gravimetric sorting and flotation, the contained radionuclides become concentrated as well. By consequence, the produced preconcentrate might be classified as Naturally Occurring Radioactive Material (NORM).

Moreover, Class 7 transport is required, if the activities of natural uranium or thorium are higher than 10 Bq/g, what corresponds to approximately 400 ppm uranium or 2500 ppm thorium (provided the material was not chemically or thermally treated, otherwise that limit concentration could be lower) [1]. By consequence, the project will need to have overarching provisions like transport-specific Radiation Protection Plan, Emergency Response Plan, Staff Training Program, and Quality Assurance Plan etc.

In addition, each filled bag needs to be checked for contamination as well as the activity and dose rate measured [2]. These determine the transport category (UN 2910, if the surface dose rate is ≤ 5 μ Sv/h; UN 2912, if > 5 μ Sv/h), which require different marking and labelling of the bags and fixing of warning signs (placards) at the outer freight containers. All relevant data need to be recorded by accompanying transport documents (Figure. 1).

Automated Transport Preparation

To be able to cope with a high throughput of preconcentrate bags to be transported (in the exemplary project every 5½ minutes a further 1m³ bag could be filled) at least the following transport preparation steps should be automated:

- Radiological characterization of the bags;
- Marking/labelling (determined transport category etc.);
- Generation of the accompanying transport documents.

Components of a Suitable Automated System

Electronic Control and Tracking System (ECTS): Throughout the complete transport preparation (steps 1-12) the ECTS controls the radiological measurements and further actions and tracks all bags; on base of the measured data, it determines the transport category and the labels of the bags (and placards of the freight containers); the achieved data are recorded.

In addition to the bag filling station (0) - being the interface between the beneficiation unit and the subsequent transport preparation unit - 2 further stations will be needed:

- Station 1 for radiological characterization of each bag;
- Station 2 for printing the individually marked labels directly on the bags.

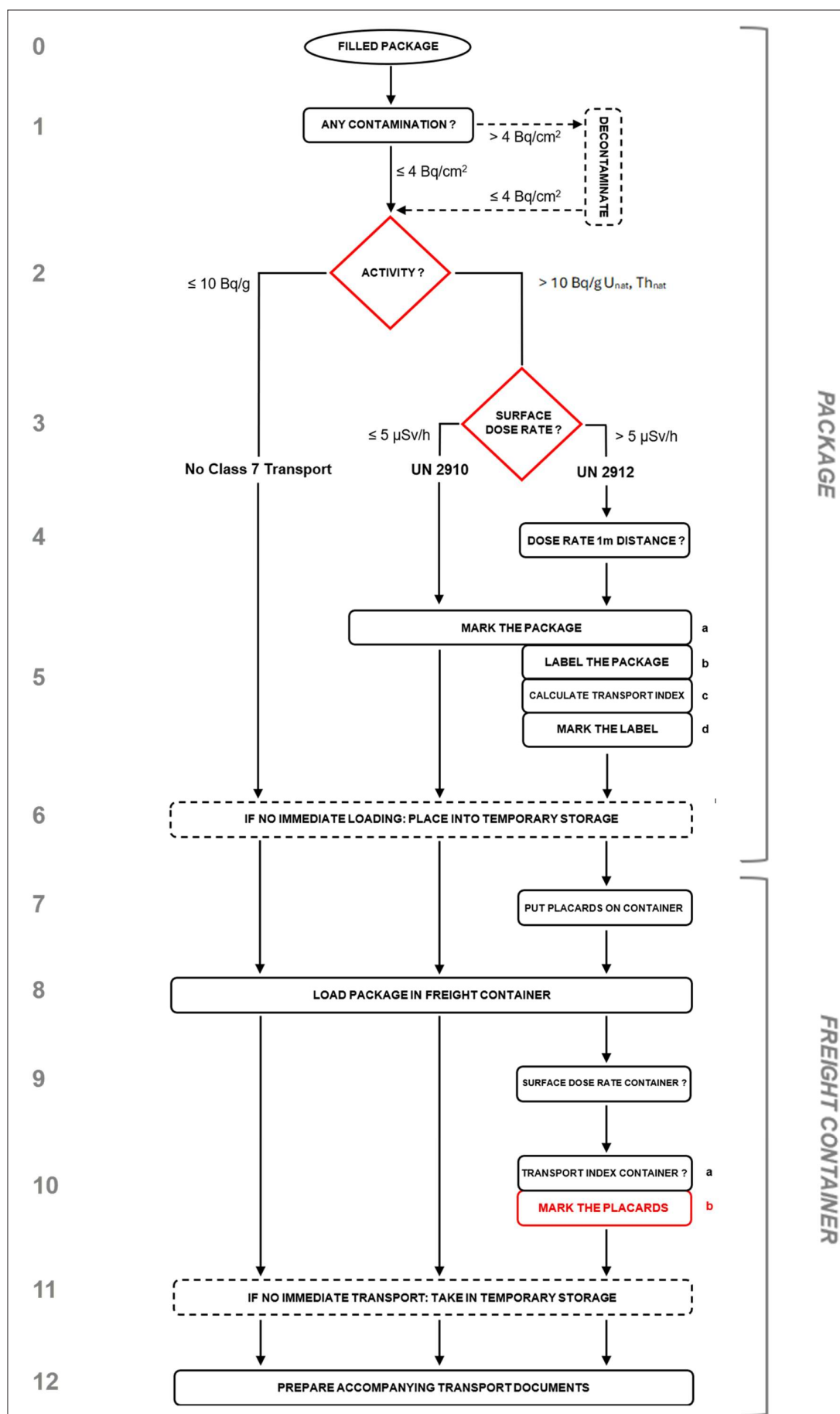


Figure 1: Class 7 Transport Preparation, here of Bags and Freight Containers

The different stations are connected through a belt conveyor, which automatically transports the bags after filling at station 0 to station 1 and, after the measurements are taken, from there to station 2. After station 2 the bags can be removed manually or ejected automatically to a waiting area (for manual loading into the freight containers).

Radiological Characterization of the Bags Contamination Monitoring

The conventional approach for contamination monitoring is taking manually a wipe test to be analysed in the laboratory. As that analysis might take at least 15 minutes the bag would need to move to a waiting position until results are available and only return to be further processed, if any contamination is below 4 Bq/cm² averaged over 300 cm². However, as every bag is required to be monitored, the transport preparation could be significantly delayed and it could be impossible to keep the available time.

Alternatively, an automated wipe test device, to be integrated in the radiological measurement system at station 1, can be used to determine any contamination. The results here would be slightly less precise than laboratory results, but sufficient for the given task.

In case it would happen that a bag is found to be contaminated above the limit, it would have to be decontaminated before returning to the process. For that via a switch between station 1 and station 2 that bag would be discharged to a decontamination position.

Activity Determination

The activity of each bag will be determined at station 1 with help of a gamma detector and recorded by the ECTS. If the preconcentrate is radiologically in natural equilibrium, the allowed activities are unlimited, but need to be documented anyway.

As the preconcentrate composition could change suddenly (due to the variability of the ore deposit) calculating the activity on base of selected samples which were analysed in advance in the laboratory would not be possible.

Surface Dose Rate Determination

Central is the determination of the surface dose rate as it decides about the transport category to be used. The same detector as employed for the activity determination could be used for determination of the surface dose rate, but a separate dose rate meter could be advantageous.

Dose Rate in 1m Distance (only UN 2912)

To calculate the transport index also the dose rate measured in 1m distance is needed. For this the same dose rate detector will be able to move in that position.

Marking/Labelling of the Determined Transport Category Marking/Labelling of the Bags

At station 2, based on the radiological results each bag will be marked and labelled. The automatized system prints the label (with the calculated transport index, if necessary) directly on each bag.

Automation could include also the freight containers, however, a similar system as for the bags might be overdone with view to the less complex and less frequent preparation of the freight containers. In the exemplary project only every 1 - 1½ hour a further freight container will be loaded, radiologically characterized and placard. Determination of the surface dose rate of the freight containers

(only UN 2912) can be done manually as regularly this will be the only measurement.

Generation of the Accompanying Transport Documents

On base of the determined data of all loaded bags and freight containers the Accompanying Transport Documents (which have to accompany each transport) will be generated by the ECTS and printed. The documents need to be signed by responsible staff.

Conclusions

Reasonable Automation of the Transport Preparation is Most Capable to Cope with the Maximum High Number of Filled Bags:

- Only automated transport preparation might be able to cope with the maximum throughput of filling (and thus preparing) every 5½ minutes a further 1 m³ bag;
- Only automated transport preparation could provide the required reliability to determine the correct transport category and to mark/label/placard always correctly.

Moreover, lower radiation exposure for staff could be achieved as well as improved cost efficiency (e.g. due to reduced staff size). Automation allows easy tracking and data exchange to inform the receiving refinery of the nature of the prepared bags instantaneously or to respond to any other information need.

Acknowledgements

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References

1. International Atomic Energy Agency (2018) Regulations for the Safe Transport of Radioactive Material. Specific Safety Requirements No. SSR-6, Vienna https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1798_web.pdf.
2. World Nuclear Transport Institute (2024) Package Types used for Transporting Radioactive Materials. Fact Sheet, London <https://www.yumpu.com/en/document/view/48353891/package-types-used-for-transporting-radioactive-materials>.

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