Monte Carlo Forecast for ^{241}Am/Be DSRS Management Optimization in Cameroon

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ABSTRACT

- Optimal option for Disused Sealed Radioactive Sources (DSRS) management based on Monte Carlo simulation.
- Design of the appropriate means for radioactive waste conditioning to avoid material and economic losses .
- Particle and Heavy Ion Transport code System (PHITS) used to design & validate waste containers with appropriate DSRS.
- ^{241}Am/Be neutron DSRS from well-logging and petroleum exploration.
- Disk and cylinder: most appropriate geometries.

INTRODUCTION

- Growth of the use of sealed radioactive sources (SRSs) with weak or no appropriate regulatory infrastructure/measures in place. when the SRSs become disused, their management becomes a challenging task.
- Regional Technical Cooperation Project "*Strengthening Cradle-to-Grave Control of Radioactive Sources*": deal with the issue of DSRSs (most vulnerable at their end of use as being spent or otherwise).
- **Objective**: This work aims to develop a Monte Carlo-based method that will set the appropriate geometry for ^{241}Am/Be neutron source package into the appropriate capsule and concrete-filled drum.
- To dismantle collected DSRSs and assemble them for long-term storage or disposal there is a need to set up a technical cooperation with the IAEA, US-DOE assistance, or an Expert mission as the work to be done is delicate.

MATERIALS AND METHODS

MONTE CARLO SIMULATION

- Subset of computational algorithms that utilize the process of repeated random sampling to numerically estimate unknown parameters. Neutron flux escaping the geometry and the effective dose rate from the enclosed geometry were computed
- The Particle and Heavy Ion Transport code System (PHITS), a Monte Carlo tool was used to investigate the most optimizing source geometry for the DSRS package.

GEOMETRY OF THE DSRS PACKAGE

- Investigated geometries: point-like source (a single identifiable localized source of ^{241}Am/Be), Disk source (which is plated on the surface of a disk and the active area is the surface of the disk), Spherical source (uniformly distributed in a sphere), Cylindrical source, and Rectangular or parallelepiped solid.
- Assessment of the capacity of the above mentioned geometry form available to be used for radioactive source disposal as depicted in Figure 1.

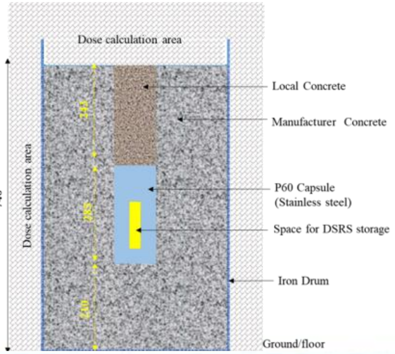

Figure 1. Geometry of the simulation designed for DSRSs waste management optimization

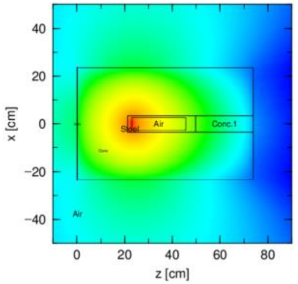

Figure 2. Neutron flux from Disk source

RESULTS

- The simulation using the source activity limit demonstrates an agreement with the targeted result of less than 1 mSv in the adjacent public area
- The obtained results (Table 1) are stored for the upcoming IAEA expert mission to dismantle and store the DSRS in Cameroon

Geometry	Effective dose at different position (µSv/h)	
	At contact (x-axis)	1 m away
Point-like	3.04E+01	1.72E+00
Disk source	3.03E+01	1.70E+00
Sphere 1	3.24E+01	1.81E+00
Sphere 2	3.41E+01	1.87E+00
Sphere 3	3.44E+01	1.88E+00
Cylindrical 1	3.37E+01	1.84E+00
Cylindrical 2	3.42E+01	1.85E+00
Rectangle 1	3.42E+01	1.86E+00
Rectangle 2	3.48E+01	1.89E+00

Table 1: result of the effective dose rate in different geometries based

CONCLUSION

- Disk and cylinder were found to be the most optimizing geometries for DSRS long-term storage while the parallelepiped geometry was found to be the worst case as can be seen in Table 1.

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- Guembou et al. AIP Advances 11, 10 (2021); doi: 10.1063/5.0063005

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