Dose Rate Distribution from a Standard Waste Drum Arrangement

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1 Introduction

- Dose rates as a function of the distance between source and detector are only known for a limited number of geometries (e.g. point source, line source, plane circular source)
- For most source-detector geometries numerical calculations or Monte Carlo Simulations are necessary to determine the dose rate in dependence of the distance

2 Objectives

- The dose rate distribution from a set of six 200-liter waste drums arranged on a standard wooden pallet should be calculated by Monte Carlo Simulation
- Data should be fitted with analytical functions for future estimation of the dose for personnel at the Austrian Interim Radiological Waste Storage facility at Seibersdorf

3 Materials and Methods

- Monte Carlo Simulations were performed using the MCNP computer code

__Assumptions and conditions:__

- Waste drums are filled with concrete with a density of 2.3 g/cm^3
- Drum contains ^{60}Co in a homogeneous distribution (gamma energies of 1.17 MeV and 1.33 MeV)
- Model of waste drum according to figure 1, Modeled source-detector geometries see figure 2
- Particle histories were chosen for statistical uncertainties on the result below 1%

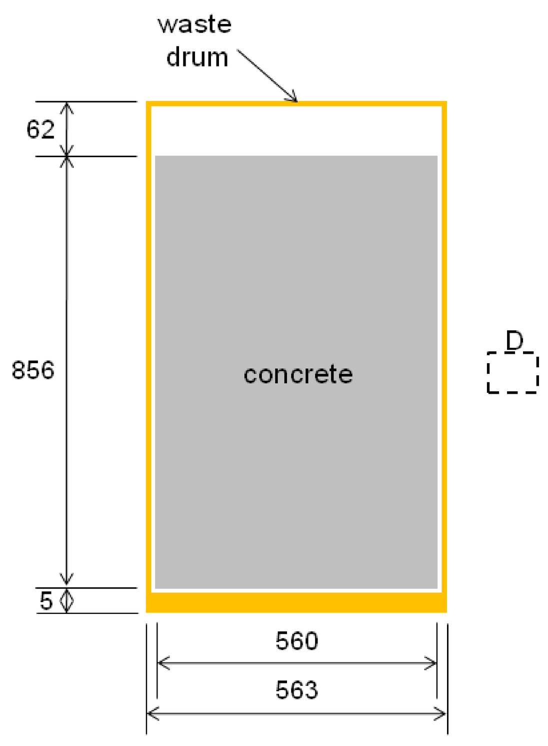

Figure 1: Model of the waste drum. Measures in cm. The detector (D) was set to the mid-height of the concrete cylinder inside the drum.

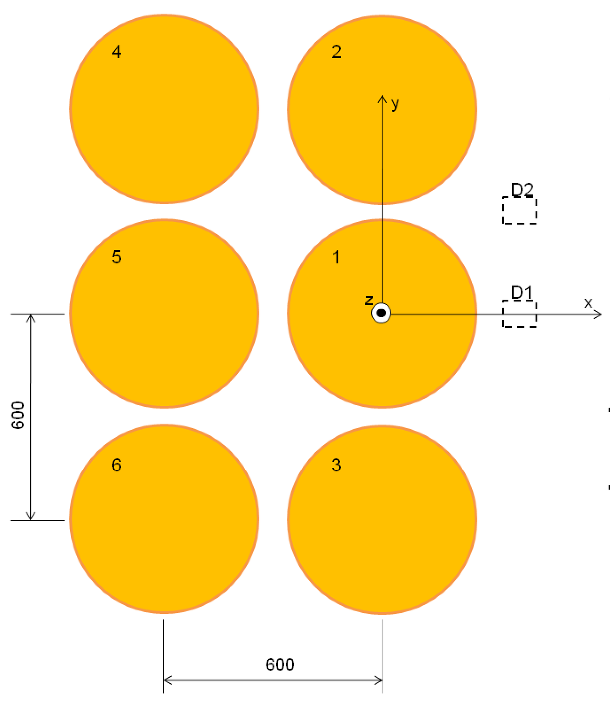

Figure 2: Modeled geometries. Measures in cm. Two detector locations were considered:
__D1:__ in front of the center drum
__D2:__ between two drums in the front row.
Detector distances along the x-axis were 5cm to 20 m

4 Results and Discussion

The results for the two detector positions are compared in figure 3

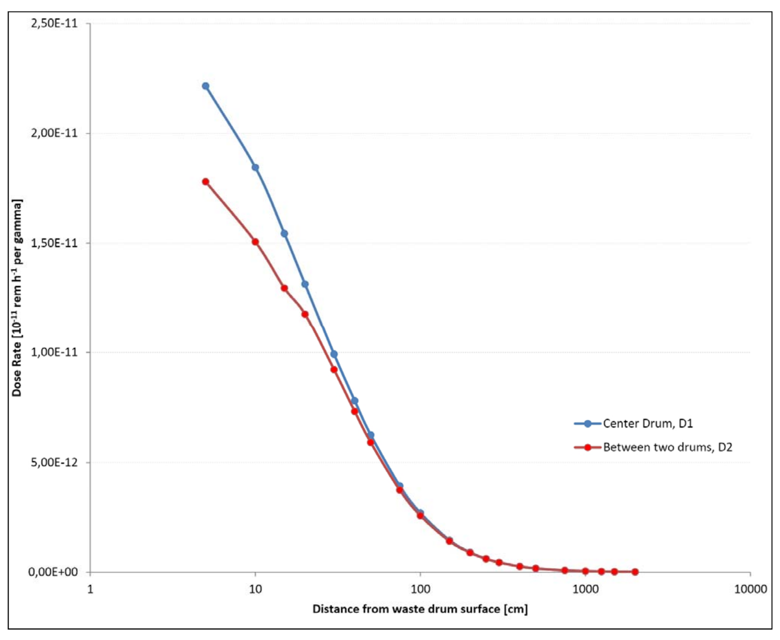

Figure 3: Comparison of the two detector geometries. In the far-zone (distances > 1m) both distributions are equal. In the near-zone (below 1m) dose rates vary up to a factor of two, which is most likely due to the slightly increased surface-to-detector distance due to the cylindrical waste drum curvature.

The data for detector position D1 were fitted to smooth analytical functions (see figure 4).

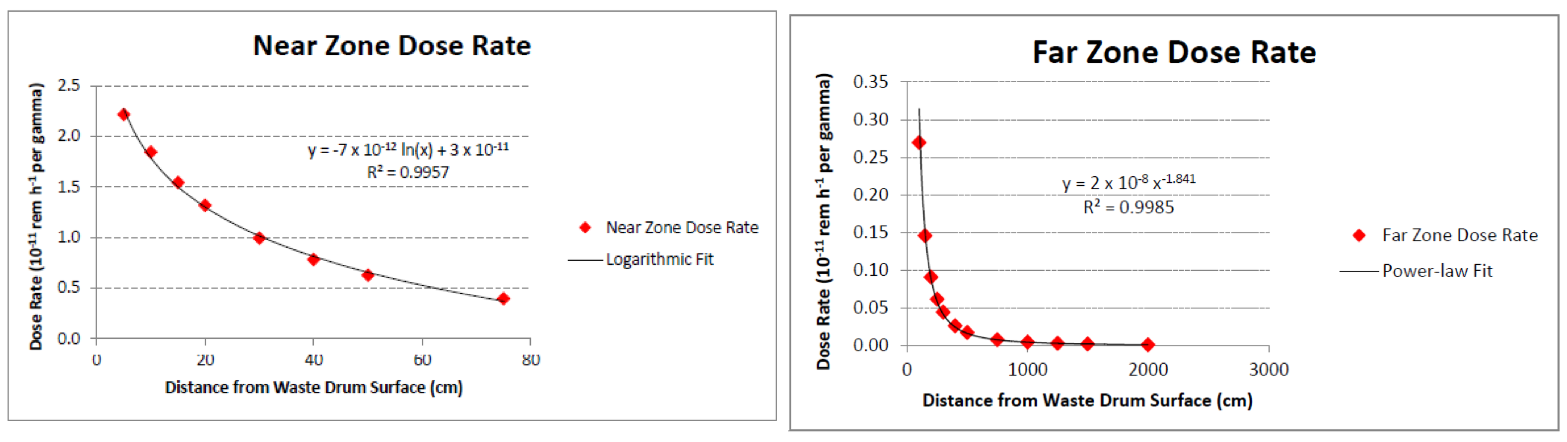

Figure 4: Least-square fits of the far- and near-zone.
Near-zone: Dose rate follows a logarithmic function

$$DR = -7*10^{-12} \ln(x) + 3*10^{-11}$$

Far-zone: power-law function

$$DR = 2*10^{-8}\ x^{-1,841}$$

Dose rate (DR) in units rem h^{-1} per gamma ray

5 Conclusions

- Most conservative dose rate was obtained in the mid-height and the center of the drums
- No single analytical function was found by fitting
- The power law function for x>1m closely approximates the 1/r^2 relationship for point sources

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