MCNP Training – PTNR/NDAWM/Nuc Eng January 2019

Waste Drum Exercise

Aim: To model a simple drum of radioactive waste using MCNP

Geometry: A smeared (reduced density) volume of Magnox waste is shielded by 50mm of concrete inside a stainless steel drum. Wall, lid & base thicknesses are all 3mm. Surround the drum with air to a radius of 2m from the centre of the drum.

Calculations:

Photon flux on the surfaces of the drum and at 2m

Dose rates on the surfaces of the drum and at 2m
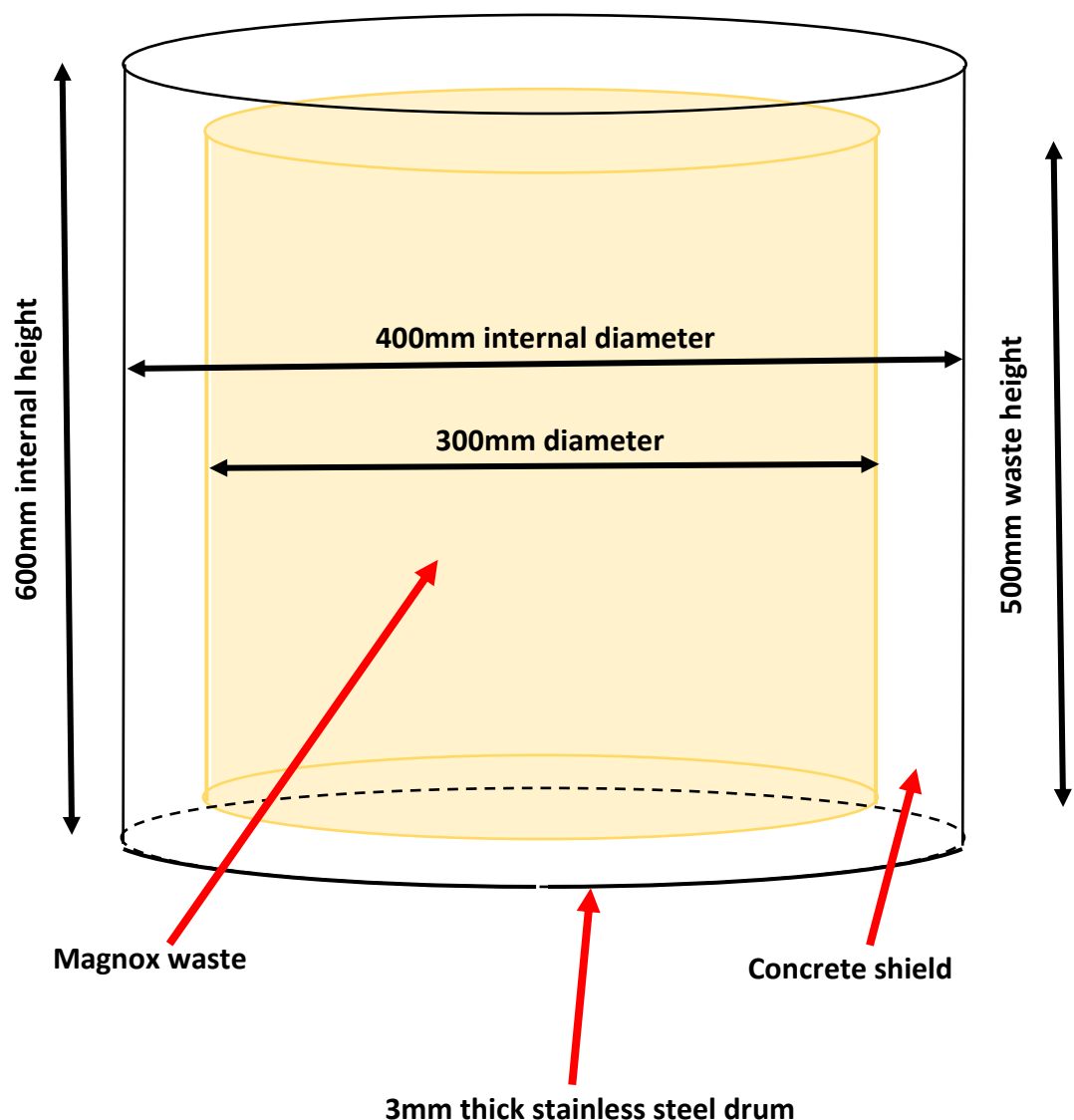
Materials definitions are required for:

Magnox – use magnesium of reduced density 0.87 g/cm^3

Concrete – use definition of "Ordinary Concrete" in the PNNL Compendium (PNNL-15870)

Stainless steel – use the definition for 304 stainless steel in the PNNL Compendium (PNNL-15870)

Air – use the definition for dry air "near sea level" in the PNNL Compendium (PNNL-15870)

Sources: Various, but start with ^{60}Co

Tally photon surface fluxes averaged over:

       a. The lid of the drum
       b. The base of the drum
       c. Combined over both lid and base of drum
       d. The wall of the drum
       e. At a distance of 2m

Tally dose rates over the same surfaces. Use ICRP-21 photon flux-to-dose conversion factors in Table H.2 of Appendix H of the MCNP manual.

Additional Shield

Place an additional shield 300mm to the right of the axis of the waste drum.

The shield is 25mm thick and made of lead (density 11.3g/cm^3). It is 800mm square and symmetrically located parallel to the axis of the drum, with its centre line opposite the mid height of the drum.

Place a tally sphere of diameter 200mm 1m away from the axis of the drum, opposite its centre.

The arrangement is shown in the diagram below.
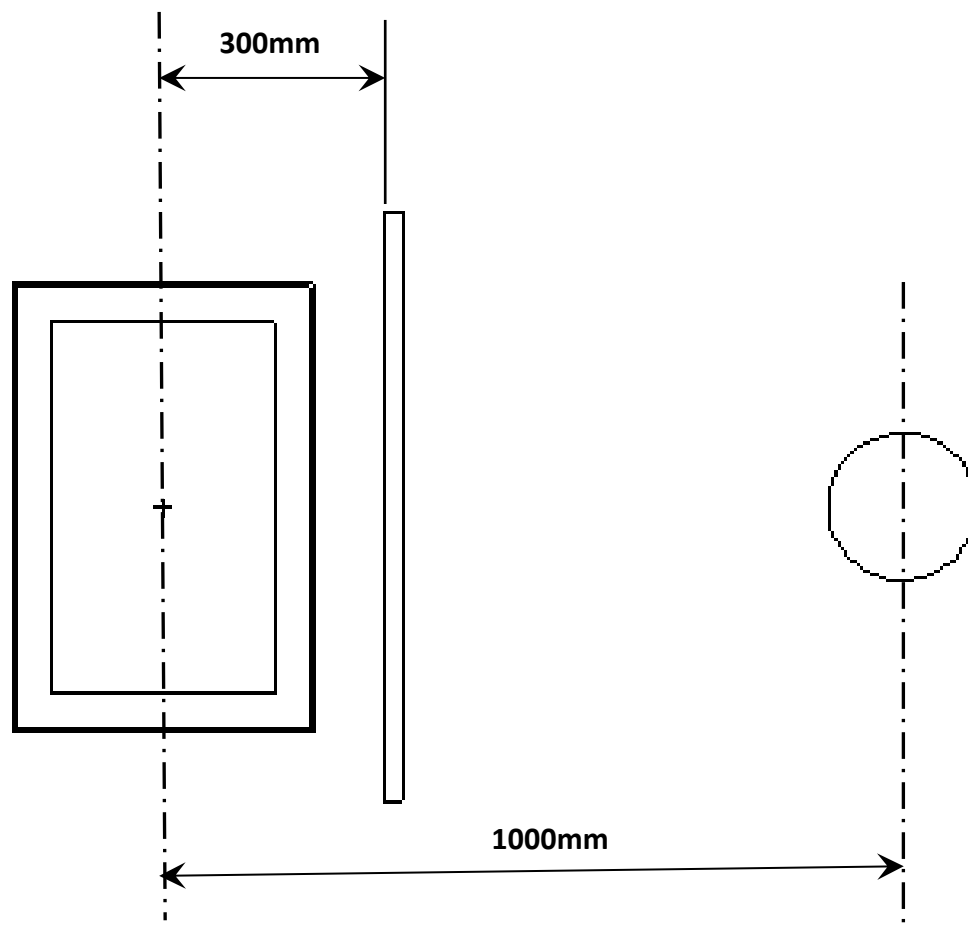
Tally the dose rate in this tally sphere. Compare the results with the dose rates on the surface of the drum. Hint - you may need to run the simulation for longer.

Place a point detector (F5 tally) at the centre of the tally sphere. Compare the result with the track length result (F4).

Splitting/Russian Roulette

Then make the lead shield 15cm thick and run again. The F4 (track length) tally will not easily converge to a satisfactory answer.

Split the shield into a number of slabs (e.g. 8) and use splitting/Russian roulette. Try using importances of 2, 4, 8, 16 etc. to keep the population constant through the shield.

These may not be suitable values for IMP:P. Try different ones to see what works best.