NE 406 Radiation Shielding

Final Project

Due May 2, 2019 (midnight)

You are to produce a first pass analysis of the shielding of a food irradiation facility.

Plan and elevation views of the geometry (i.e., VisEd xy and xz slices through the source) are given in Figures 1 and 2 below.

Note:

1. The cross is the location of the top of the source. The source is a x Curies of Co-60 line source, where x is the last 4 digits of you student number (resulting in an activity between 1 and 9999 Curies).
2. No need to model any attenuation by the source itself.
3. You can assume that each disintegration releases two 1.25 MeV photons.)
4. The walls are 11.35 g/cc lead. Use lead data from Table C.6 in the text.
5. We are interested in the gamma dose rates at the four points indicated on Figure 1 at a height of 100 cm.

Part A. Use the MCNP code to solve the problem:

Use the following guidelines:

1. Set the (0,0,0) origin at the bottom of the line source.
2. Use the contents as indicated above. Use void (material 0) for the room air.
3. Use the DE/DF response function in the public area file "DEDF". These are taken from Appendix H of the MCNP manual and result in dose rates in units of REM/HOUR.
4. Create a mesh tally with 10 cm wide divisions (in x, y, and z directions) that cover the outside (beyond the wall) area; the zmesh should be in a single mesh from the floor to 200 cm above the floor.
5. Run the problem long enough to get the fractional standard deviations in the four mesh cells containing the dose points P1-P4 below 0.02.

Part B. Check your results at the four points with the hand calculation skills from this course, using:

1. EXCEL for your calculations (or another spreadsheet)
2. Table D.3 for your response function ("AP" column)
3. Table E.5 for buildup.

Part C. (Required for NE467 students; extra credit for NE406 students.)

1. Use hand calculation to estimate the thickness of the wall (in Figure 1) below the source that would be required to reduce the dose on the other side to be below 1 mrem/hr.
2. Modify your MCNP model in Part A using this thickness, including population control in 10 divisions of this wall to get it within the 0.02 fractional standard deviation. You may use the dose point in the mesh that is centered on (-0,-130, 100) for your approximation of the dose rate.
3. In the writeup, include a description of what you did for this Part and the results.

Send your results to me by e-mail, including the following attachments:

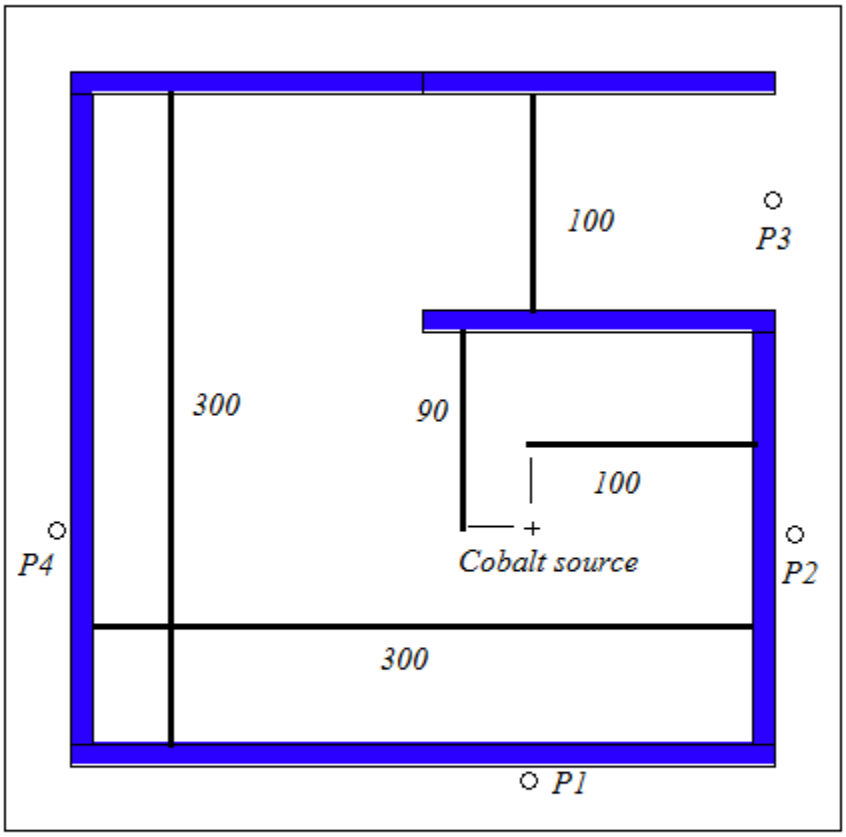
1. WORD document (in PDF format) containing a writeup of what you did with the following sections:
    a. Description of the problem
    b. MCNP analysis: Including:
        i. Description of what you did in this phase
        ii. A plot of your source-elevation dose map with logarithms dose axis (linear dimension axes)
        iii. Table of dose rates (in mrem/hr) AND FRACTIONAL STANDARD DEVIATIONS at the four points.
    c. Hand calculation for validation:
        i. Description of what you did for to get the point tallies
        ii. Results of your point tallies.
2. The MCNP input deck
3. The EXCEL spreadsheet used for the hand calculation (include the Part C calcs if you did them).
4. (If you did Part C) The MCNP input deck for that case.

Warning: The total size of the attachments should be no greater than 5 MB (combined). It will cost you 5 points if you exceed this.

Include the following statement in your email: "I did not receive or give any assistance on this exam." (I will not grade any project that does not include this.)

Figure 1. Plan view of problem geometry

Walls/ceiling/floor are 10 cm lead (density 11.35 g/cc)



Outside border is 25 cm beyond walls

Desired dose points P1-P4 are at 100 cm above the floor and 10 cm outside the wall. Except for P3, which is in the middle of the doorway.

Figure 2. Front elevation view of problem geometry