Health Physics Final Exam: 10:00 AM, June 16, 2001 (Closed Book) (Room 32-109)

Problem 1: (20 points) Briefly explain the following terms:

a. roentgen
b. absorbed dose
c. dose equivalent
d. dose commitment
e. TEDE
f. radiation stochastic effects
g. collective dose
h. radioactivity
i. radiation weighting factor
j. radiation
k. radiation hormesis effects
l. Becquerel (Bq)

Problem 2: (10 points) Compute the activities in curies for 1 micro-gram of pure: a) I-131 ($T_{1/2}$ = 8 days); and b) I-133 ($T_{1/2}$ = 20 hours).

Problem 3: (10 points) 1) Find the uncollided flux through a 10 cm Al shield. The photon source is a point isotropic with 1 MeV energy is located at the contact of shield. The source strength is 3×10^{10} photons per second. Assume that the mass attenuation factor of Al for 1 MeV photon is 0.0614 cm^2/g, the specific weight of Al is 2.7 g/cm^3. 2) With the exposure buildup factor of 1.3, find the observed flux in the same case.

Problem 4: (10 points) 1) Calculate the equilibrium concentration of Rn-222 ($T_{1/2}$ = 3.82 days) in a sealed room (V= 4mX10mX20m = 800 m^3) when 1 Ci of Ra-226 ($T_{1/2}$ = 1,620 years) is stored. 2) Find the ventilation exhaust rate (m^3/hour) in order to keep the concentration of Rn-222 under 4×10^{-6} Ci/m^3.

Problem 5: (10 points) Calculate the exposure rate (r/hr) at 3 meters away from a point source of Cs-137 having source strength of 1 Ci.

Data: Cs-137: $T_{1/2}$ = 30.0 year
E_γ = 0.661 Mev (95%)
$(\mu_e)_{air}$ = 0.0035 m^{-1}.
1 R = 5.48×10^{10} MeV/kg(air)

Problem 6: (10 points) Compute ALI (annual limit of intake) of I-131 through inhalation

data: SEE(thyroid ← thyroid) = 10 MeV/kg/t (controlling)
f_{thy} = fractional uptake to the thyroid after inhalation (= 0.2)
radiological half-life of I-131 = 8.05 days
biological half-life of iodine in the thyroid = 138 days

Problem 7: (10 points) 2 measurements of particle counting were taken. Gross counting for 1-minute and background counting for 5 minutes for each measurement. At the first counting, gross and background counts were 200 and 100, respectively. At the second counting, gross and background counts were 220 and 120, respectively. Find the net count rate (cpm) with appropriate standard deviation.

Problem 8: (10 points) Based upon the "Continuous Gaussian Plume Model," for the ground-level release, the maximum atmospheric dispersion factor is given by:

$\frac{\chi}{Q}(x,y,z) = \frac{1}{\pi\sigma_y\sigma_z u}$. Assuming the average wind speed of 1 m/sec, find the maximum chi-over-cue at the distance of 1,000 meters from the center of a nuclear power plant. The horizontal and vertical standard deviations, $\sigma_y(x)$, $\sigma_z(x)$ at x=1,000 meters are 45 m, and 20 m, respectively.

Problem 9: (10 points) BF_3 counter which is filled with 100% enriched $B^{10}F_3$ gas. The pressure is 100 mmHg at 20°C. When a thermal neutron counting is 2, 000 counts for one hour, what is the thermal neutron flux at 20°C? The average thermal absorption X-section of B-10 at 20°C is 3,500 barns.