

QUESTION 10

An accidental airborne release of approximately 2 kg of “nominally pure” plutonium has occurred. The plume is predicted to drift offsite and pass over a nearby town. Assume that the material is released in a particulate form, is assigned to inhalation class ‘Y’, and has the isotopic mixture shown in the table below.

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- The DCF for external exposure to plutonium is 2.8×10^{-3} rem/h per g/m^2
- The DCF for Pu inhalation (Class Y, 1 micron AMAD) = 330 rem/ μCi (alpha) inhaled
- The f_1 value for Class Y plutonium is 1.0×10^{-5}
- The breathing rate is 20 l/min
- The resuspension factor is 10^{-5} m^{-1} .

Isotope	Weight %	Specific Activity (Ci/g isotope)	Total Activity (Ci isotope/g Pu mix)	Major radiations				
				Alpha (MeV)	Beta (MeV)	Photon Energy (MeV)	Photon Yield (%)	Spontaneous Neutrons (n/g-s)
Pu-238	0.04	17.10	0.007	5.49	–	0.017 0.099 0.150 0.77	11 0.008 0.001 0.00005	2600
Pu-239	93.3	0.06	0.056	5.15	–	0.017 0.039 0.052 0.129 0.375 0.414 0.65 0.77	5 0.007 0.020 0.005 0.0012 0.0012 0.00008 0.00002	0.03
Pu-240	5.99	0.23	0.014	5.16	–	0.017 0.65	11 0.00002	1000
Pu-241	0.28	103.00	0.288	–	0.021	0.145	0.00016	–
Pu-242	0.04	0.004	0.000002	4.9	–	–	–	1700
Am-241	0.30	3.44	0.01	5.5	–	0.017 0.060 0.101 0.208 0.335 0.37 0.663 0.722	37 36 0.04 0.0006 0.0008 0.0004 0.0005 0.0003	1.10
Pu (mix)	100		0.09 (alpha Ci) 0.38 (total Ci)	4.9-5.5	0.021	0.06		62

POINTS

- 10 A. Assuming that the initial plume has passed, give **two** (2) actions which could most **significantly** reduce the dose to the downwind population during the first week following the accident. **Number your answers. Only the first two will be graded.**
- 20 B. The EPA recommends relocation of the general public based on a 1st year Protection Action Guide (PAG) of >2 rem TEDE. Assume the estimated dose received by residents who were outdoors during the initial plume passage ranges from 1.5 to 2 rem CEDE and the estimated additional dose these residents are likely to receive during the first year after the accident is 1.3 rem CEDE. Specify:
1. The meaning and intent of the PAGs, and
 2. Your recommendations with respect to relocation of the population. **Justify your answer.**
- 20 C. To assess the offsite surface deposition of plutonium you equip field teams with portable hand-held thin-crystal sodium-iodide-based single channel analyzers. These monitors may be calibrated to detect either the 17 keV or the 60 keV photons emitted from material involved in this release. Given that the emission ratio of the 17 keV to 60 keV photons is approximately 2.5, answer the following:
1. State two advantages of each energy calibration?
 2. State which photon energy you would recommend under the following two conditions. Why?
 - a. Dry paved road surfaces.
 - b. Agricultural field following an extended rain.
- 30 D. Calculate the internal dose from plutonium ground depositions for an individual who walks for one hour on soil contaminated at a level of $100 \mu\text{Ci}/\text{m}^2$. **Show all work, and state any assumptions.**
- 20 E. Applying default assumptions from the facility's emergency plan, you estimate that a radiological worker who responded to the accident received a total effective dose equivalent of 4.8 rem. Is further refinement of this dose estimate necessary? If so, what action would you take to refine the dose estimate?