Radiation Biology, Protection and Applications

(PHYS-450)

Solutions

Week 13

Problem 1:

Ingestion of ^{137}Cs eating reindeer meat

The ingested radioactivity:
A_{ing} = 185'000 kBq/m^2 · 1 m^2/kg · 20 kg = 3.7E6 Bq

The committed effective dose equivalent (CEDE) of ^{137}Cs for ingestion for an adult:
$e_{ing}(50)$ = 1,30e-8 Sv/Bq (from "ORaP", Annexe 5 art. 139, al. 2, et 194, al. 3)

Therefore, the committed effective dose is E = 3.7E6 Bq · 1,30e-8 Sv/Bq = **48 mSv**

This is a 'high' dose compared to annual average background, and beyond usual regulatory limits for professionally exposed personnel (20 mSv in CH). It is nonetheless below the 100 mSv limit above which we could expect observable increases in cancer rates. A government would probably ban reindeer meat consumption until this value drops below 1 mSv annual.

Problem 2:

Inhalation of ^{131}I

The measured concentration of ^{131}I in a laboratory is 55 Bq/m^3. What committed effective dose a person receives for 15 minutes light activity in this laboratory?

Hint: During light work, a reference person inhales 20 liters (0.02 m^3) of air per minute. This corresponds to 60 mins. · 0.02 m^3/min. = 1.2 m^3 per hour. The volume of air inhaled in 15 mins. is then V = 1.2 m^3/h · 0.25 h = 0.3 m^3.

Solution:
The committed effective dose for an adult:
E = A_{inh} · $e_{inh}(50)$

The inhaled activity of ^{131}I:
A_{inh} = 55 Bq/m^3 · 0.3 m^3 = 16 Bq

The committed effective dose equivalent (CEDE) of ^{131}I for inhalation for an adult:
e(50) = 7.4e-9 Sv/Bq (from "ORaP", Annexe 5 art. 139, al. 2, et 194, al. 3)

Therefore, the committed effective dose is E = 16 Bq · 7.4e-9 Sv/Bq = **1,2 µSv**