Radiation Biology, Protection and Applications

(PHYS-450)

EXERCISES

Week 14

Problem 1:

Ingestion of ^{137}Cs eating reindeer meat

In reindeer meat, a concentration of 500 Bq/kg of ^{137}Cs has been measured. What committed effective dose does a person receive on eating 250 grams of this meat?

Solution:

The committed effective dose for an adult:

$E = A_{ing} \cdot e_{ing}(50)$

The ingested radioactivity:

$A_{ing} = 500\ Bq/kg \cdot 0{,}25\ kg = 125\ Bq$

The committed effective dose equivalent (CEDE) of ^{137}Cs for ingestion for an adult:

$e_{ing}(50) = 1{,}30e\text{-}8\ Sv/Bq$ (from "ORaP", Annexe 4)

Therefore, the committed effective dose is $E = 125\ Bq \cdot 1{,}30e\text{-}8\ Sv/Bq =$ **1,6 µSv**

Problem 2:

Inhalation of ^{131}I

The measured concentration of ^{131}I in a laboratory is 55 Bq/m³. What committed effective dose a person receives during 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 $V = 1.2\ m^3/h \cdot 0.25\ h = 0.3\ m^3$.

Solution:

The committed effective dose for an adult:

$E = A_{inh} \cdot e_{inh}(50)$

The inhaled activity of ^{131}I:

$A_{inh} = 55\ Bq/m^3 \cdot 0.3\ m^3 = 16\ Bq$

The committed effective dose equivalent (CEDE) of ^{131}I for inhalation for an adult:
e(50) = 7.4e-9 Sv/Bq (from "ORaP", Annexe 4)

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

Problem 3:

Inhalation of ^{7}Be due to BeO from atmosphere

Due to cosmic ray interactions with nitrogen (^{14}N) in the upper atmosphere, each cubic meter of air on the Earth has a concentration of 1 mBq/m^3 of radionuclide ^{7}Be in the form of BeO (beryllium oxide). What is the annual committed effective dose a person receives through this source?

Hint: The inhalation volume of air daily V_d =23 m^3/day or V_y=8400 m^3/year.

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

The inhalation volume of air daily:
V_d =23 m^3/day or V_y=8400 m^3/year

The inhaled activity of ^{7}Be:
$A_{inh} = 8400 \cdot 0.001 = 8.4$ Bq/year

The committed effective dose equivalent (CEDE) for ^{7}B for inhalation for an adult:
5.50e-11 Sv/Bq (from the ICRP 72, using another data sources this value vary slightly)

Therefore, the committed effective dose is E = 8.4 Bq/year · 5.50e-11 Sv/Bq = **0.4 nSv/year**