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:

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

The ingested radioactivity:

$$A_{\text{ing}} = 500 \text{ Bq/kg} \cdot 0.25 \text{ kg} = 125 \text{ Bq}$$

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

$$e_{\text{ing}}(50) = 1.30 \times 10^{-8} \text{ Sv/Bq}$$

(from “ORaP”, Annexe 4)

Therefore, the committed effective dose is

$$E = 125 \text{ Bq} \cdot 1.30 \times 10^{-8} \text{ Sv/Bq} = 1.6 \mu\text{Sv}$$

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 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. $\cdot$ 0.02 m$^3$/min. = 1.2 m$^3$ per hour. The volume of air inhaled in 15 mins. is then $V = 1.2 \text{ m}^3/\text{h} \cdot 0.25 \text{ h} = 0.3 \text{ m}^3$.

**Solution:**

The committed effective dose for an adult:

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

The inhaled activity of $^{131}$I:

$$A_{\text{inh}} = 55 \text{ Bq/m}^3 \cdot 0.3 \text{ m}^3 = 16 \text{ Bq}$$
The committed effective dose equivalent (CEDE) of $^{131}$I for inhalation for an adult: 
\[ e(50) = 7.4 \times 10^{-9} \text{ Sv/Bq} \text{ (from “ORaP”, Annexe 4)} \]

Therefore, the committed effective dose is \[ E = 16 \text{ Bq} \cdot 7.4 \times 10^{-9} \text{ Sv/Bq} = 1.2 \mu\text{Sv} \]

**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 $V_d = 23 \text{ m}^3/\text{day}$ or $V_y = 8400 \text{ m}^3/\text{year}$.

*Solution:*

The committed effective dose for an adult:

\[ E = A_{\text{inh}} \cdot e_{\text{inh}}(50) \]

The inhalation volume of air daily:

\[ V_d = 23 \text{ m}^3/\text{day} \text{ or } V_y = 8400 \text{ m}^3/\text{year} \]

The inhaled activity of $^7$Be:

\[ A_{\text{inh}} = 8400 \cdot 0.001 = 8.4 \text{ Bq/year} \]

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 \[ E = 8.4 \text{ Bq/year} \cdot 5.50 \times 10^{-11} \text{ Sv/Bq} = 0.4 \text{ nSv/year} \]