

Dosimetric Calculations



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Estimating dose from a point source or activated material

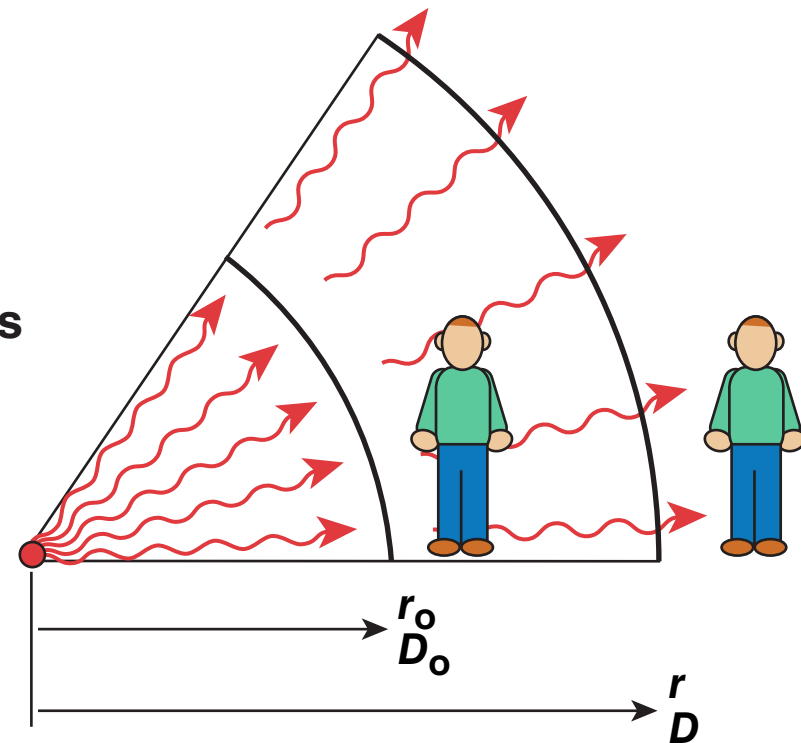
- Spherical spreading from a point source causes exposure to fall off as the square of the distance

$$\text{Dose} = \text{Dose}_o \times \left(\frac{r_o}{r}\right)^2$$

- Example $\text{Dose}_o = 1 \text{ rem}$, $r_o = 2 \text{ meters}$

Dose at 6 meters

$$\begin{aligned}\text{Dose} &= \left(\frac{2}{6}\right)^2 \times 1 \text{ rem} \\ &= \frac{1}{9} \text{ rem}\end{aligned}$$



Estimating dose from airborne tritium

- Breathing air containing tritium at **20 $\mu\text{Ci}/\text{m}^3$** for **2000 h** leads to a **5000 mrem** dose

$$\text{Dose} = \frac{A}{20} \times \frac{t}{2000} \times 5000 \text{ mrem}$$

Activity (A) in $\mu\text{Ci}/\text{m}^3$

Time (t) in hours

- **Example** Airborne activity = **160 $\mu\text{Ci}/\text{m}^3$** , exposure time = **30 min**

$$\begin{aligned} \text{Dose} &= \frac{160}{20} \times \frac{30}{60} \times \frac{1}{2000} \times 5000 \text{ mrem} \\ &= 10 \text{ mrem} \end{aligned}$$

Estimating dose from body burden

Annual limit on intake	80 mCi
Basis:	
Whole body dose	5000 mrem

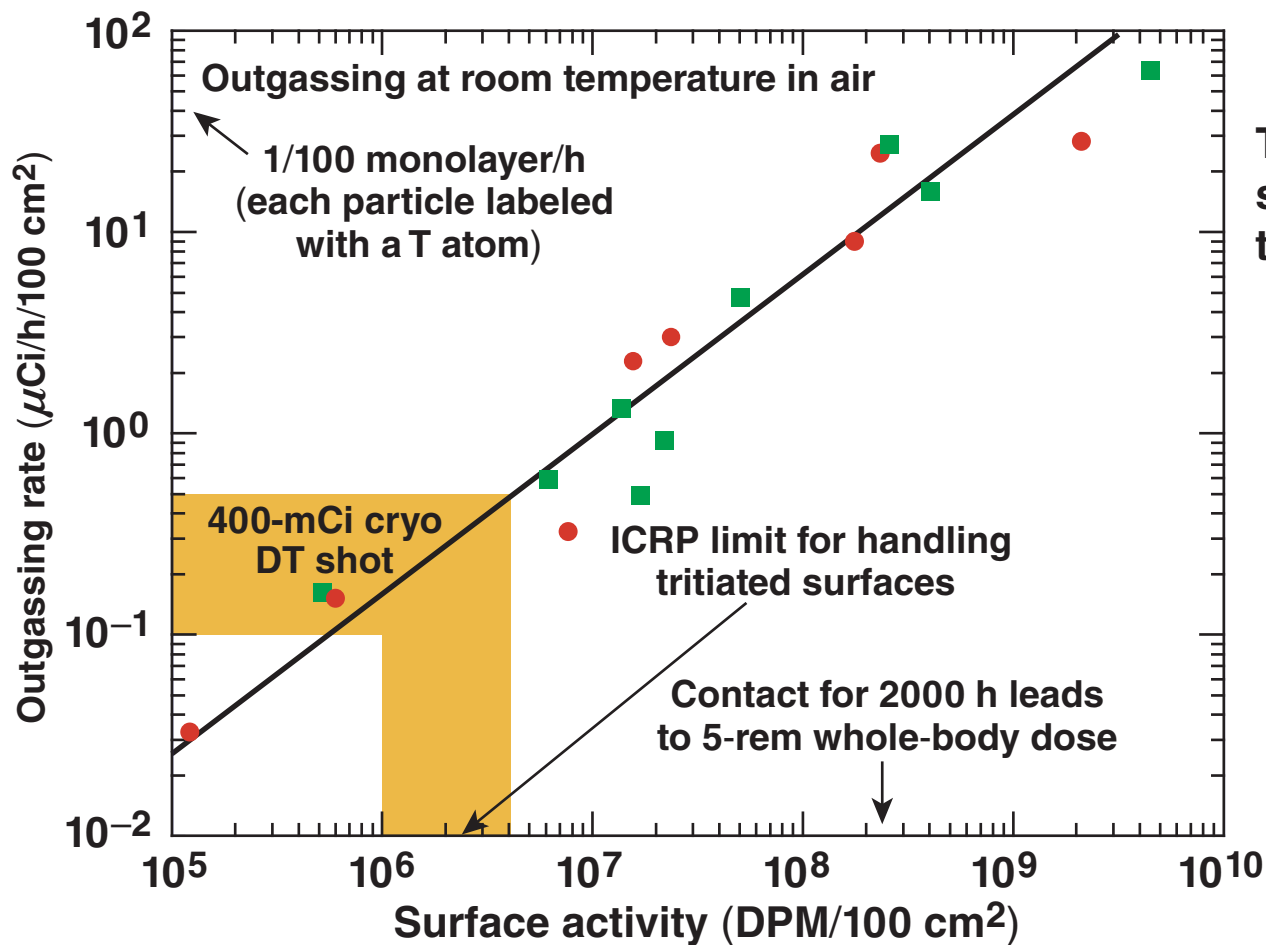
Example:

While handling 8 Ci/L water, you absorb 1 ml of water through your skin. What is your dose?

$$\text{Body burden} = 8 \left(\frac{\text{Ci}}{\text{L}} \right) \times \frac{1 \text{ L}}{10^3 \text{ ml}} \times 1 \text{ ml} = 8 \text{ mCi}$$

$$\text{Dose} = \frac{8}{80} \times 5000 = 500 \text{ mrem}$$

Chronic outgassing from tritiated surfaces leads to the spread of contamination; local ventilation reduces cross contamination and dose



Tritium contaminated surfaces present three concerns

- respiratory dose
- contact dose
- **cross contamination**

Outgassing species are “sticky”

Estimating airborne concentration from outgassing surfaces

1 m² sample with a surface activity of 10 MDPM/100 cm² is brought into a 10 m³ room and outgasses at 1 μCi/h–100 cm² for 5 hours

What is the concentration in the room after 5 hours?

Total amount of tritium released (activity)

$$\begin{aligned} &= 1 \left(\frac{\mu\text{Ci}}{\text{h}-100 \text{ cm}^2} \right) \times 1 \text{ m}^2 \times 10^4 \left(\frac{\text{cm}^2}{\text{m}^2} \right) \times 5 \text{ h} \\ &= 500 \mu\text{Ci} \end{aligned}$$

Concentration (activity/volume) in the room

$$\begin{aligned} &= \frac{500 \mu\text{Ci}}{10 \text{ m}^3} \\ &= 50 \mu\text{Ci}/\text{m}^3 \end{aligned}$$