# Dosimetric Calculations

**Walter Shmayda**
**LLE Radiation Safety Officer**
**University of Rochester**
**Laboratory for Laser Energetics**

# 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

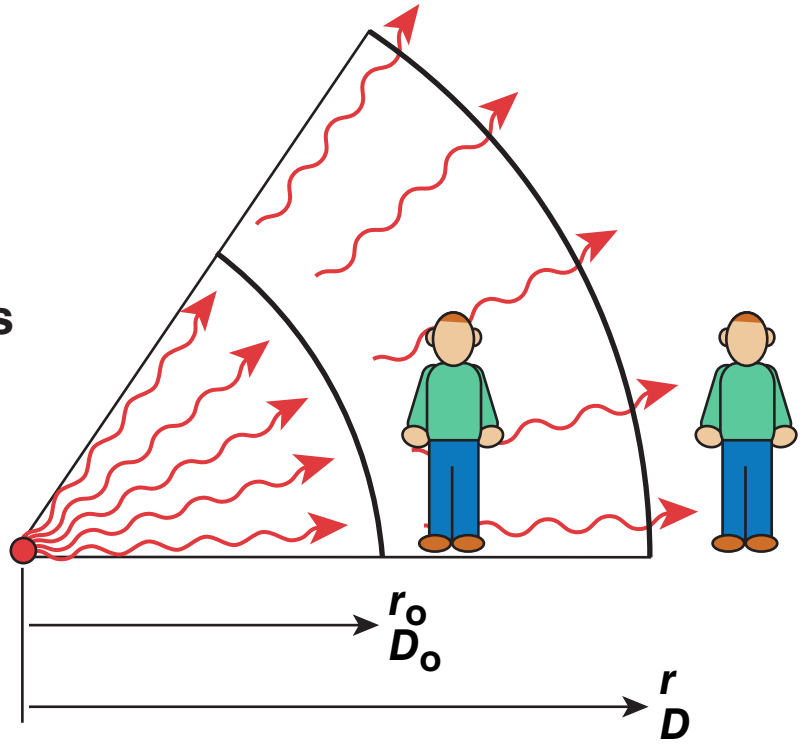
$$\text{Dose} = \text{Dose}_o \times \left(\frac{r_o}{r}\right)^2$$

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

Dose at 6 meters

$$\text{Dose} = \left(\frac{2}{6}\right)^2 \times 1\,\text{rem}$$

$$= \frac{1}{9}\,\text{rem}$$




E16024a

# Estimating dose from airborne tritium

- Breathing air containing tritium at 20 $\mu$Ci/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 $\mu$Ci/m$^3$

Time ($t$) in hours

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

$$\text{Dose} = \frac{160}{20} \times \frac{30}{60} \times \frac{1}{2000} \times 5000 \text{ mrem}$$

$$= 10 \text{ mrem}$$

# Estimating dose from body burden

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

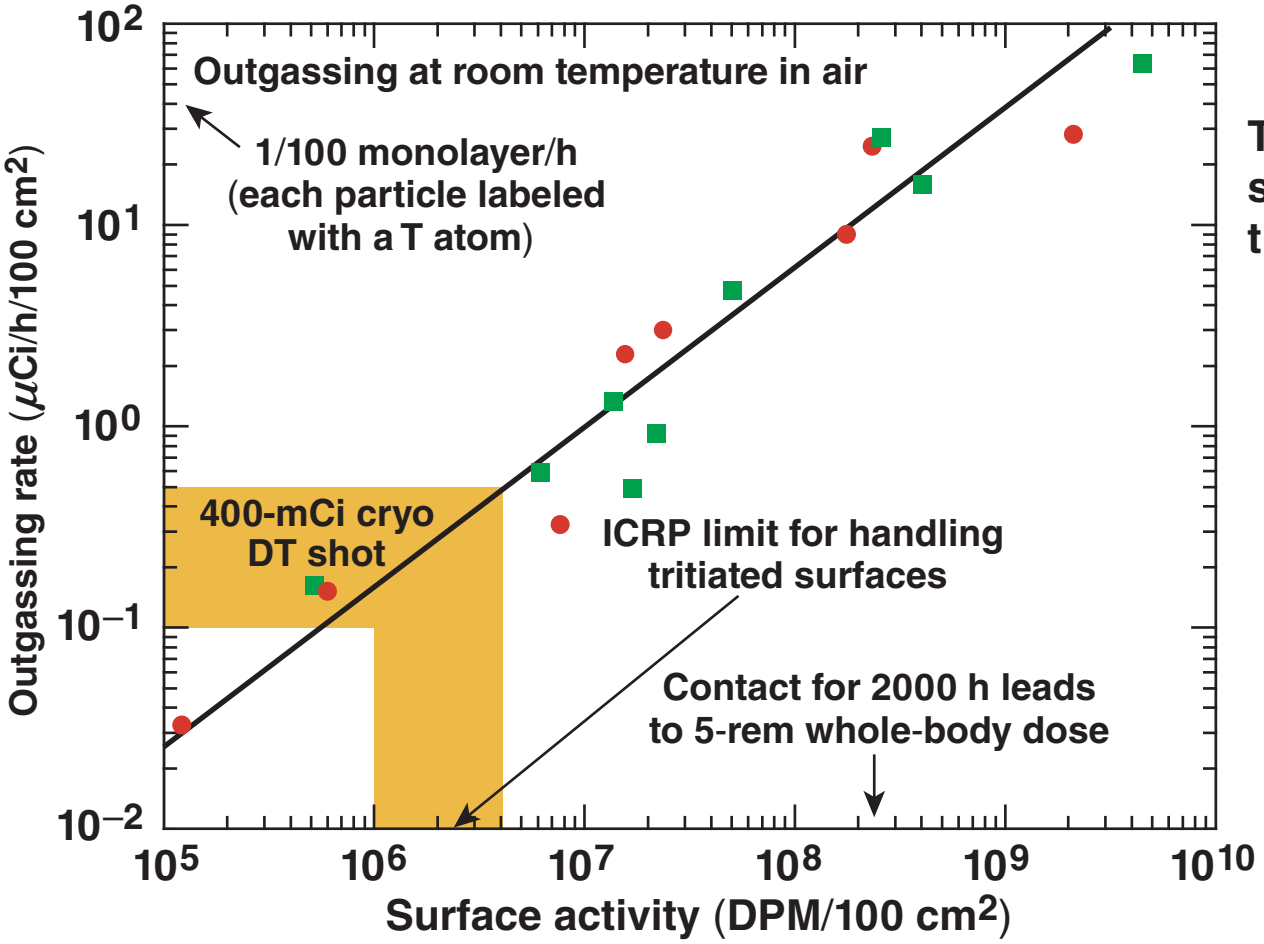
**Example:**

**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




E13737b

**Tritium contaminated surfaces present three concerns**

- respiratory dose
- contact dose
- cross contamination

**Outgassing species are "sticky"**

# Estimating airborne concentration from outgassing surfaces

UR LLE

1 $m^2$ sample with a surface activity of 200 MDPM/100 $cm^2$ is brought into a 10 $m^3$ room and outgasses at 1 $\mu$Ci/h–100 $cm^2$ for 5 hours

**What is the concentration in the room after 5 hours?**

Total amount of tritium released (activity)

$$= 1\left(\frac{\mu\text{Ci}}{\text{h–100 cm}^2}\right)\times 1\ \text{m}^2 \times 10^4\left(\frac{\text{cm}^2}{\text{m}^2}\right)\times 5\ \text{h}$$

$$= 500\ \mu\text{Ci}$$

Concentration (activity/volume) in the room

$$= \frac{500\ \mu\text{Ci}}{10\ \text{m}^3}$$

$$= 50\ \mu\text{Ci/m}^3$$