

# Measures of Radiation

Activity – Events per second – alpha, beta, gamma  
Becquerel -  $1 \text{ Bq} = 1 \text{ decay/s}$

Energy exposure  
Roentgen -  $1 \text{ Roentgen} = 0.01 \text{ J/kg}$

Dose absorbed  
Gray & Rad -  $1 \text{ Gy} = 1 \text{ J absorbed /kg}$   
 $1 \text{ Gy} = 100 \text{ rads}$

Equivalent Dose – health effects on whole body  
Sievert & REM -  $1 \text{ Sv} = 1 \text{ Gy}$  (for beta and gamma, alpha is more harmful)  
 $1 \text{ Sv} = 100 \text{ REM}$   
 $1 \text{ REM} = 10 \text{ mSv}$   
 $1 \text{ Sv} = 100 \text{ rad}$

In the US, the most common measure of radiation dose is milli REM (mREM).  
Workers in nuclear plants are limited by law to a maximum annual dose of 5 REM. This is equivalent to 50 mSv or 7 chest CT Scans,

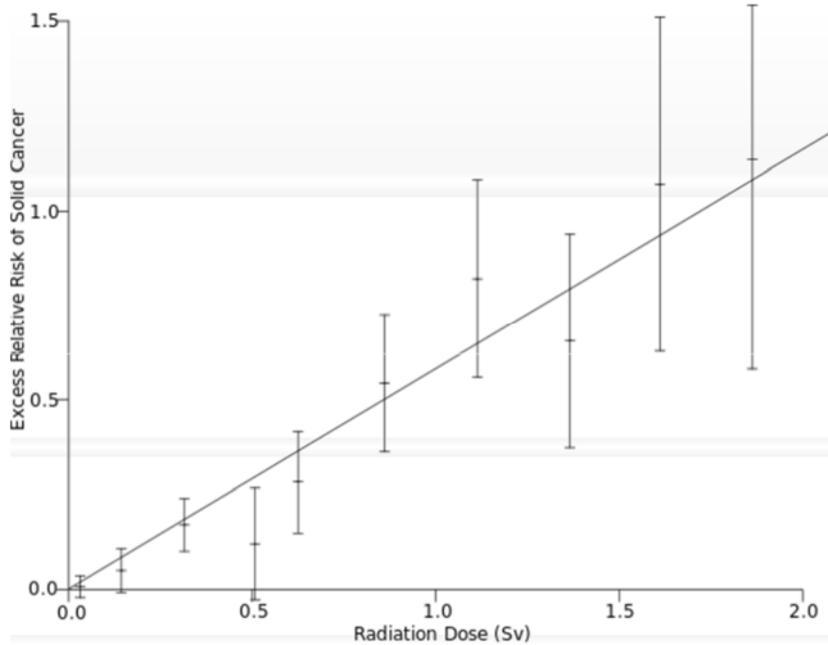
Banana Equivalent Dose – dose equal to consuming 1 banana  
 $1 \text{ BED} = 0.1 \mu\text{Sv}$  primarily due to  $^{40}\text{K}$  (beta and gamma)

$^{40}\text{K}$  contributes about 4,900 Bq (decays/s) throughout the average human life.

Burning of coal releases naturally occurring radioactive uranium, barium, thorium, and potassium into the air. Average exposure to the general population is 490 rem/year. This is about 100 times the corresponding value of 4.8 mrem/year due to nuclear power plants.

$^{131}\text{I}$  decays by beta emission, half life = 8 days

## Linear No Threshold Model



Increased risk with dose CC BY-SA 3.0

Stephen David Williams - Created the graph by using the numbers reported in the BEIR report

These numbers are based upon epidemiological studies from Hiroshima. They do not show how humans respond to much lower level doses such as the maximum 1 mSv exposure during the TMI disaster.

LNT is a simplification that is used as an upper level precautionary limit. It has now been discredited by UNSCEAR.

Worldwide, cancer risk is almost 30% without radiation exposure beyond natural background. Using LNT this would posit that each mSv of additional exposure increases your cancer risk by 0.02%. This is a very small increase.

However, in large populations it projects that many lives may be lost. This led many to project millions of deaths from Chernobyl while twenty years later we have only seen 50 deaths.