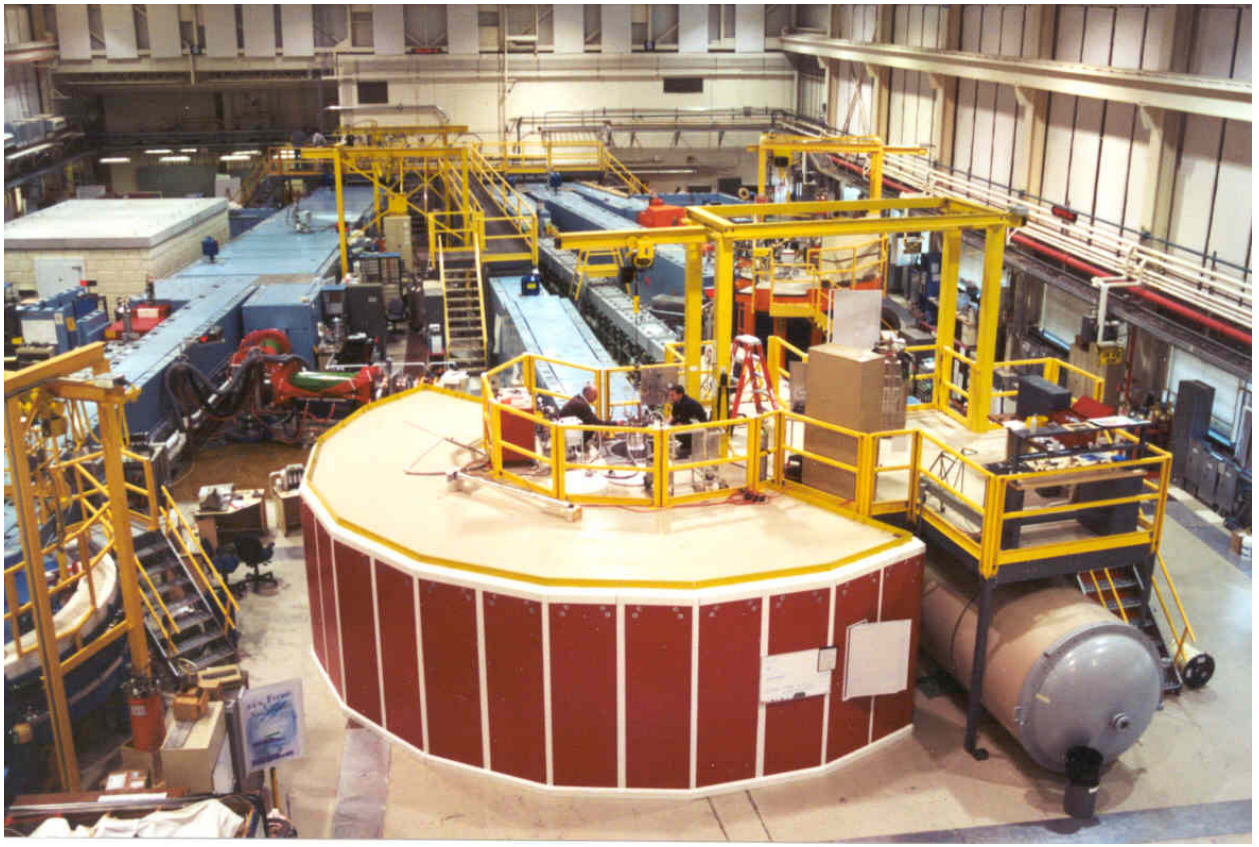
Radiation Safety – Health Physics

Neutron Spectroscopy Summer School



Tom O'Brien, Health Physicist

What is Radiation?

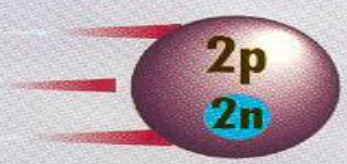
Radiation

- Energy moving through space as invisible waves

Non-ionizing Radiation

- Light, sound, heat or infrared waves, microwaves, radio waves, low frequency power line radiation

Ionizing Radiation



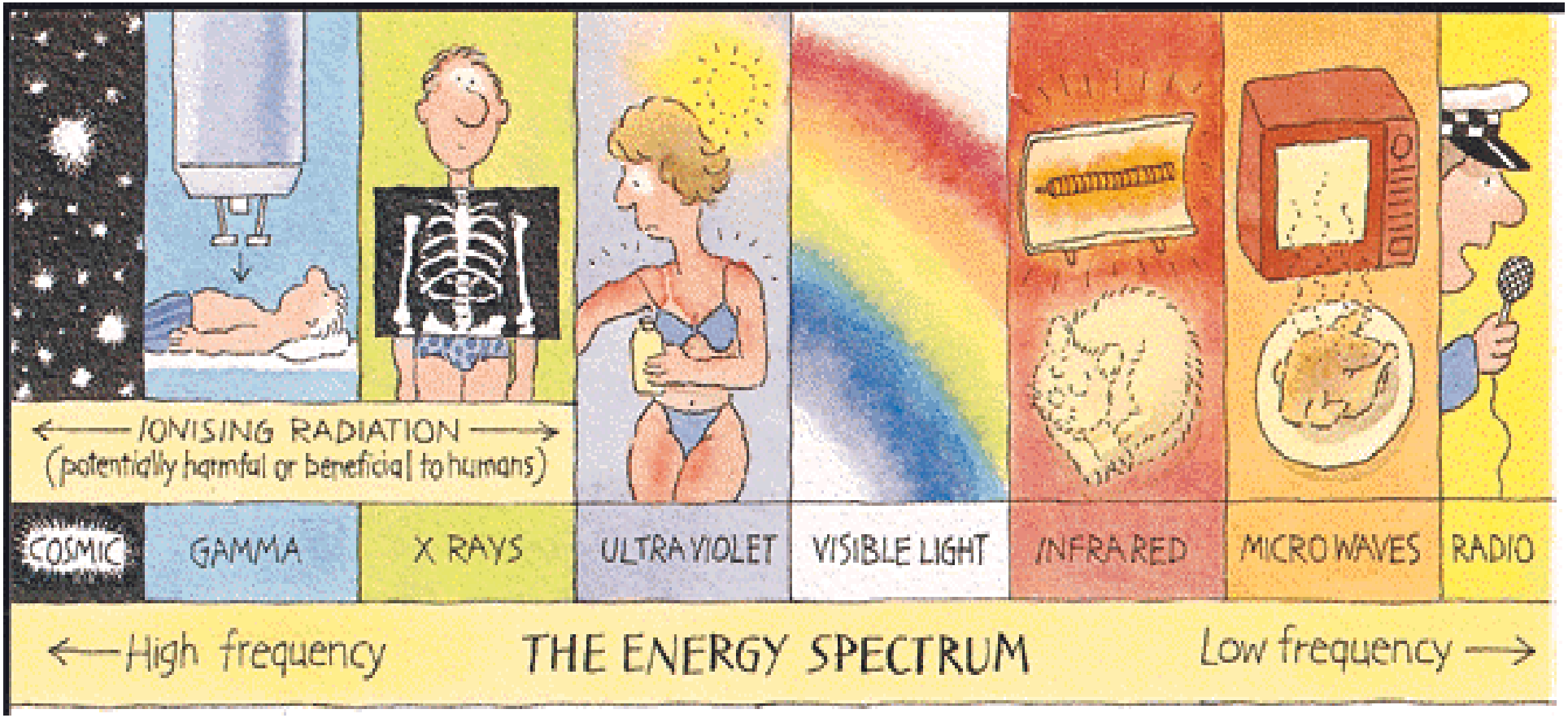
Alpha particles
(Fast moving helium nucleus)

Beta particles
(Fast moving electron)

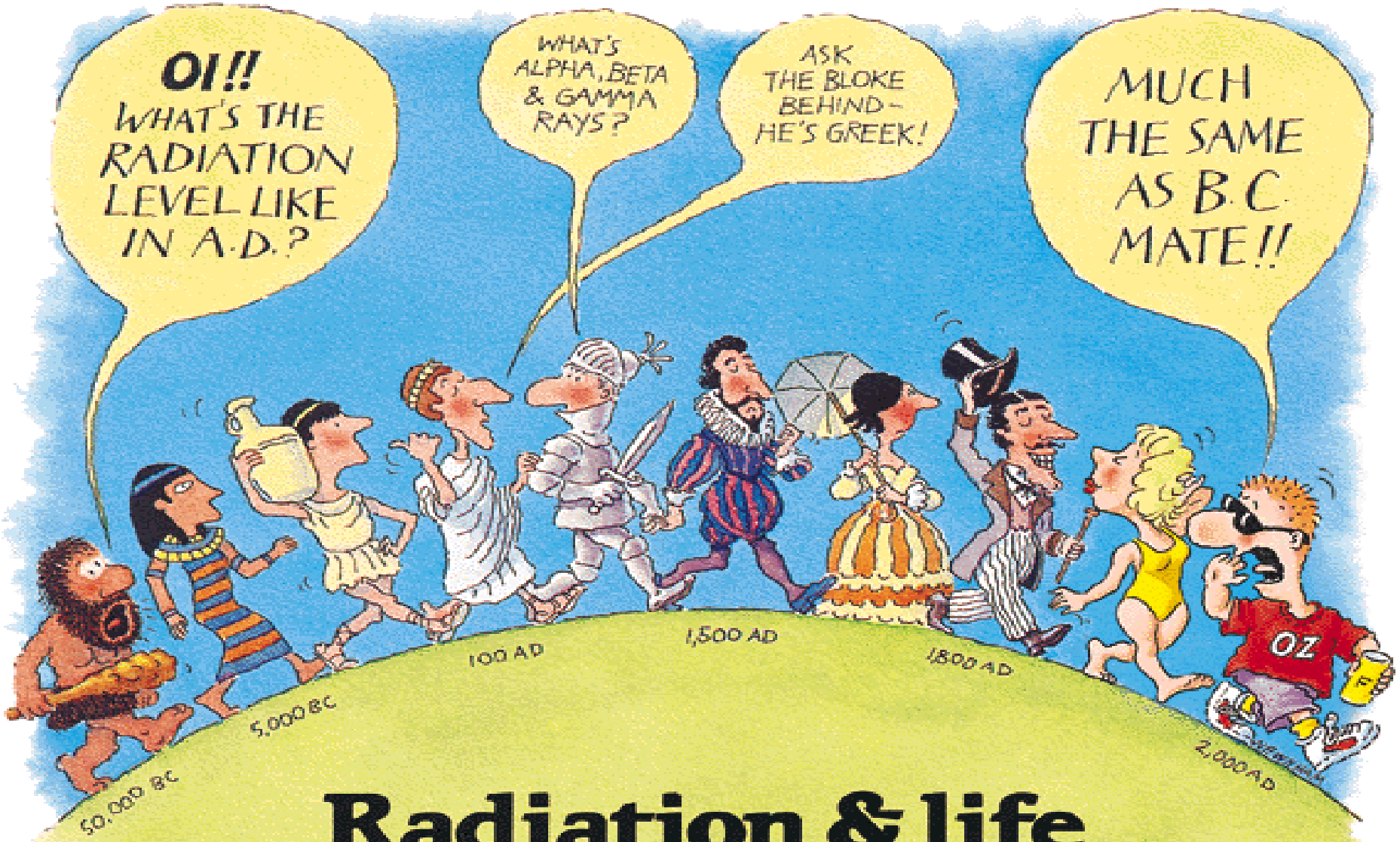
Neutrons

Gamma, X-ray

Electromagnetic Radiation: Gammas and X-Rays



THE ELECTROMAGNETIC SPECTRUM



Radiation & life

"Life on earth has developed with an ever present background of radiation. It is not something new, invented by the wit of man; radiation has always been there."

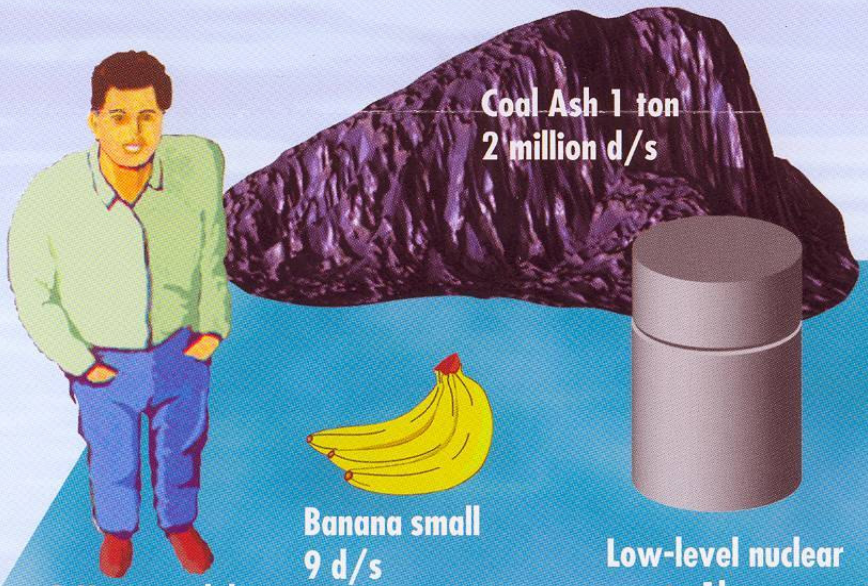
Eric J Hall, Professor of Radiology, College of Physicians and Surgeons,

How Do We Quantify Radioactivity?

Disintegrations Per Second (d/s)

- The number of atomic nuclei that decay each second

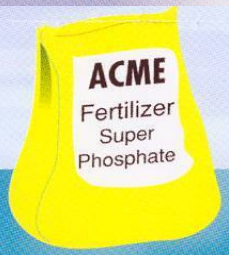
Radioactivity of Some Natural and Man-Made Materials



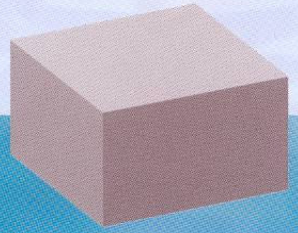
1 Human adult
3000 d/s

Banana small
9 d/s

Low-level nuclear waste 1kg.
1 million d/s



Fertilizer-super phosphate 25kg.
125,000 d/s

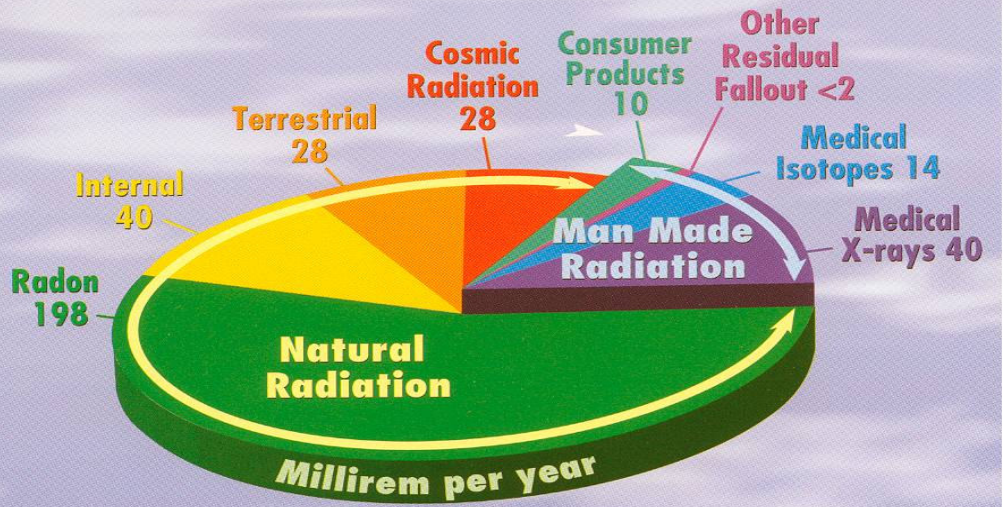


Uranium 1 ton
10,000 million d/s

Hot Chocolate
1 packet
6 d/s

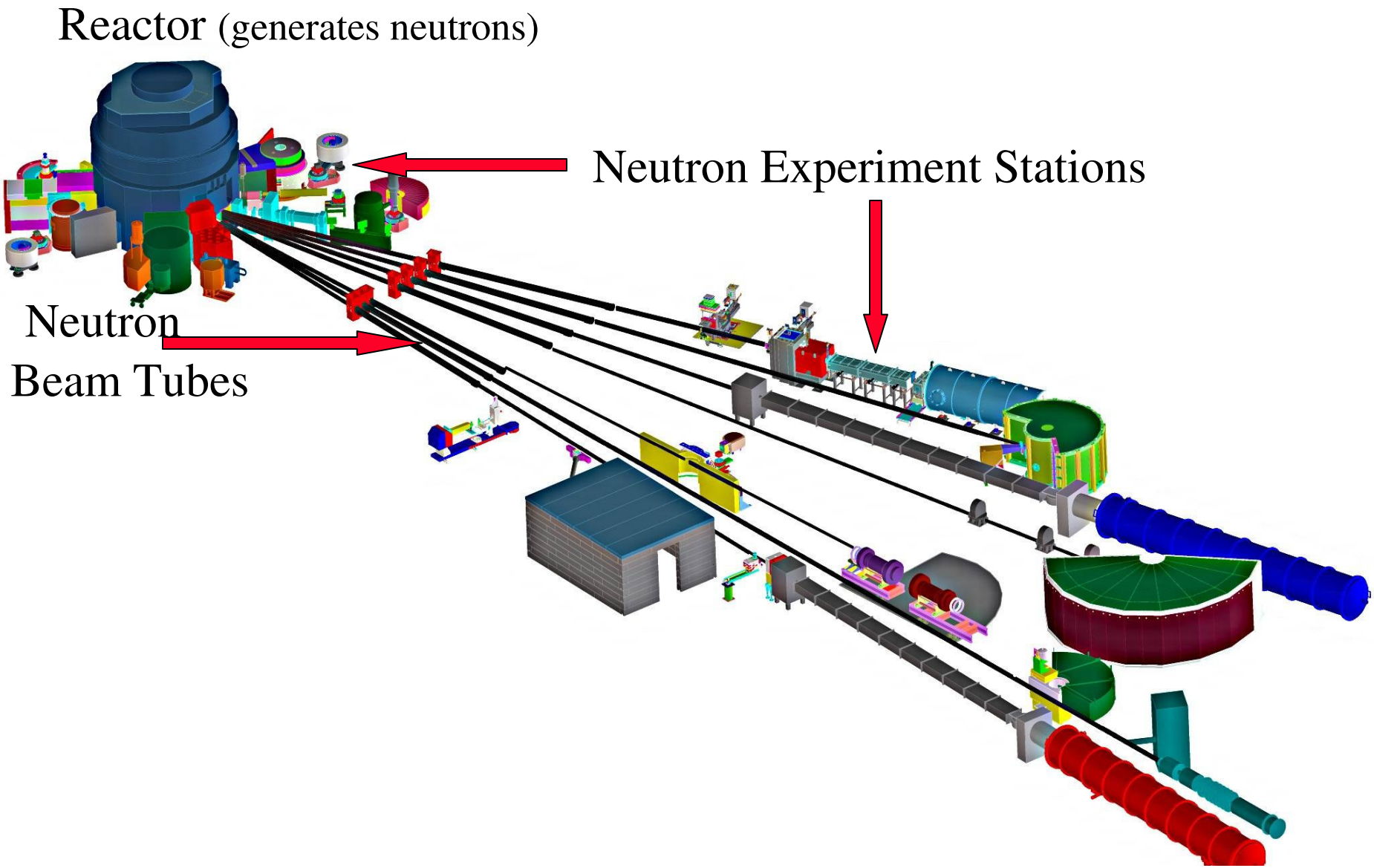
Hamburger
4 oz.
29 d/s

Where Does Radiation Come From?



Total Average Yearly Radiation Dose is 360 Millirem

Man Made Ionizing Radiation



Radiation Exposure

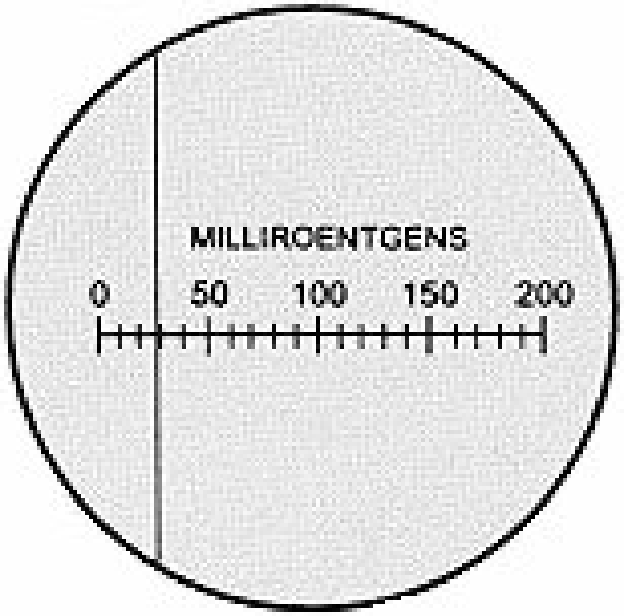
Health Physics Labels/Signs

>5 mrem/hr
(whole body dose rate)

>100 mrem/hr
(whole body dose rate)

~100,000 mrem/hr
(localized dose rate)

Radiation Dosimetry



Occupational Dose Limit = 5,000 mrem/yr

General Public Dose Limit = 100 mrem/yr

Average Dose to US Public = 360 mrem/yr

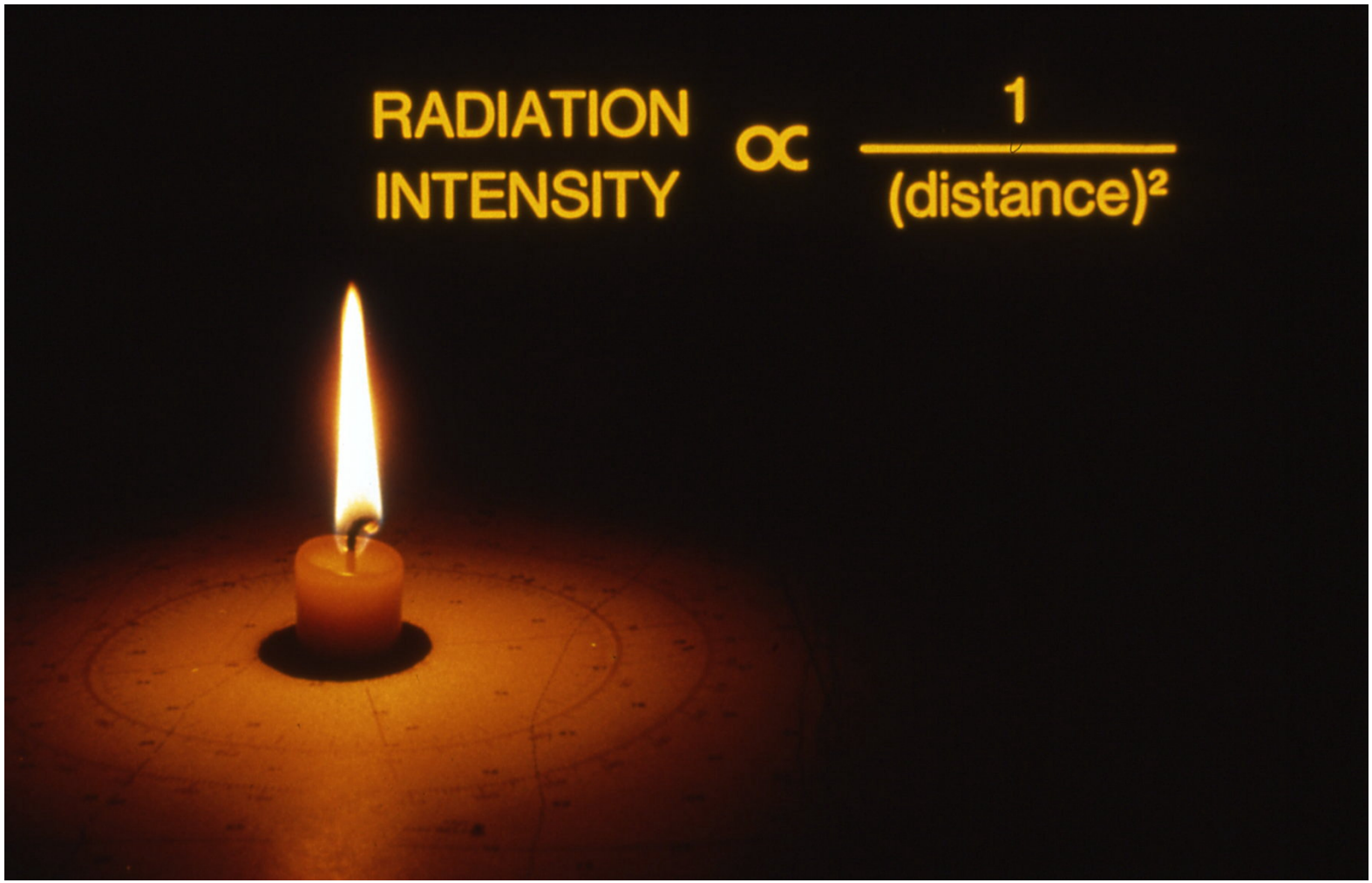
Average Dose to NIST Researcher ~ 50 mrem/yr

Time, Distance, and Shielding

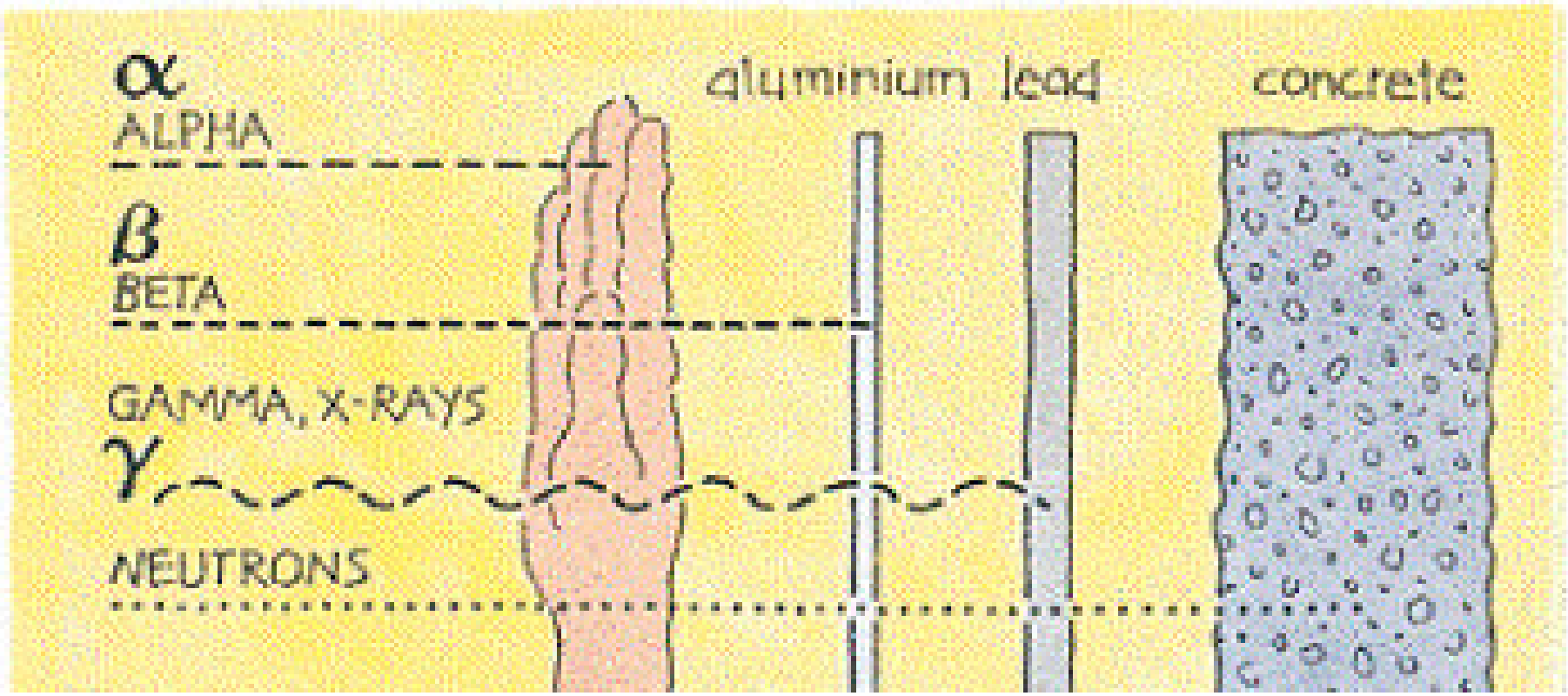
Time, Distance, Shielding...

Time	Reduce the duration of exposure
Distance	Increase distance between and the source
Shielding	Place shielding between personnel and the source

Distance – Inverse Square Law



Shielding of Ionizing Radiation



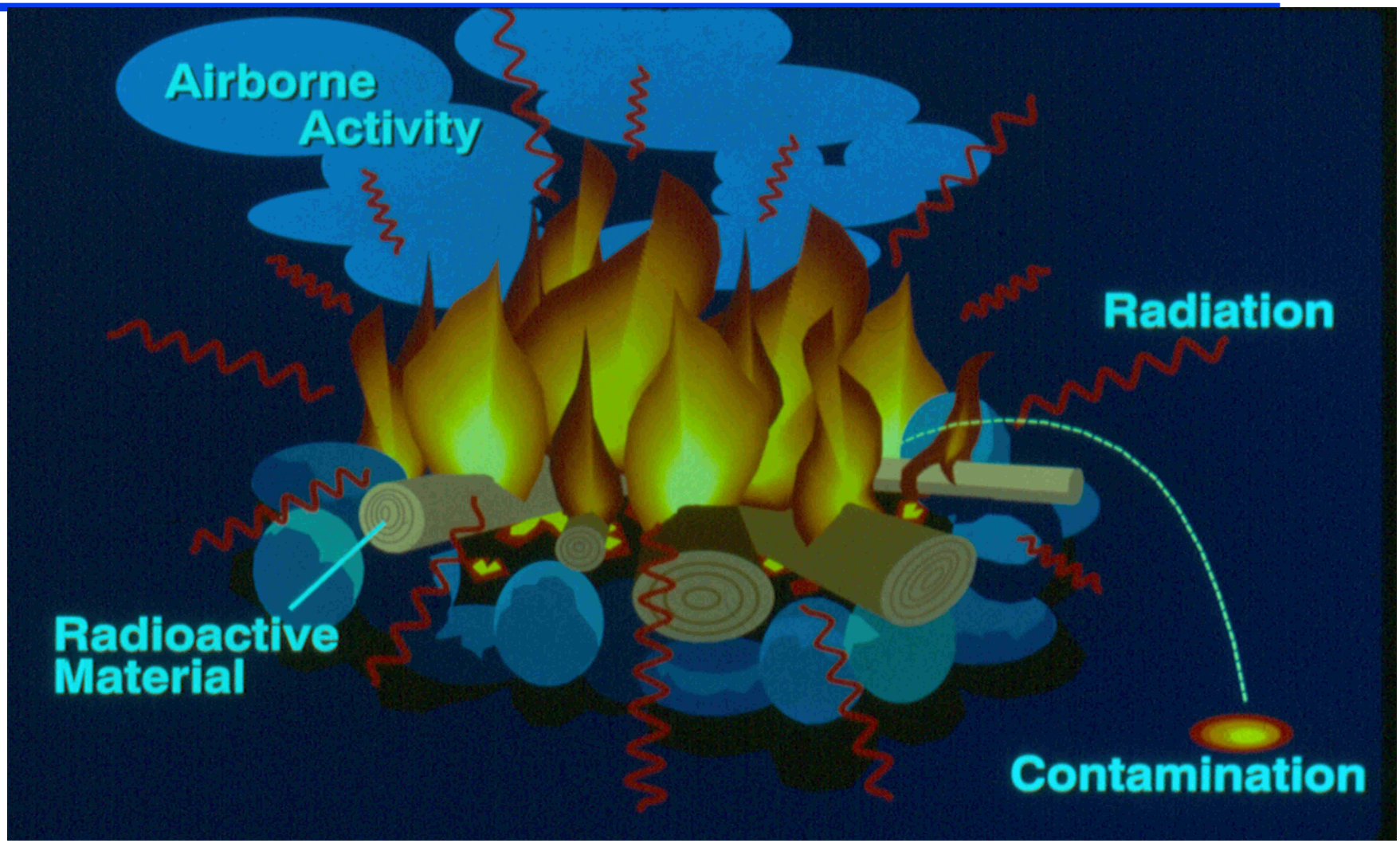
Internal Exposure

- **External exposure**
  Exposure to radiation outside body.
- **Internal exposure**
  Exposure to radiation emitted from radioactive material taken into the body by inhalation, ingestion, absorption through skin, or through an open wound.

Contamination Control

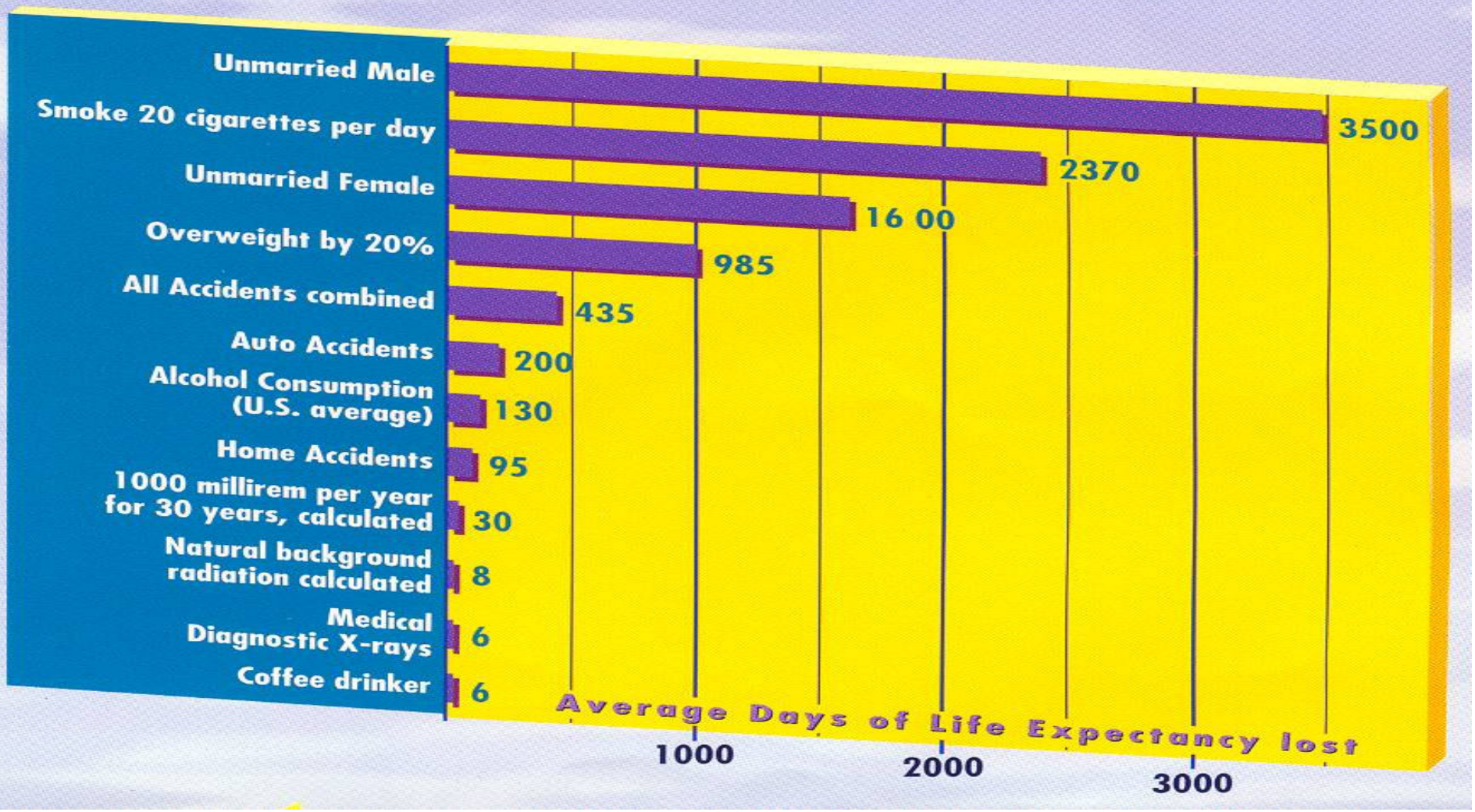
***Always monitor yourself and items you have with you when leaving a controlled area*.**

Radioactivity, Radiation, and Contamination



Health Risks from Radiation Compared with Other Situations

Estimated Loss of Life Expectancy



Ionizing Radiation - Overview

Can not see it, feel it, or smell it

- we must rely on training and equipment to protect ourselves

Relatively simple to detect and measure

- unlike chemical and biological hazards
- we can quickly assess and take action

Biological effects have been intensely studied for 50 years