Radiation Response and Removals: Getting Down to the Nitty Gritty

Radiation Fundamentals

Tony Honnellio
Health Physicist
U.S. EPA, Region 1

EPA United States Environmental Protection Agency

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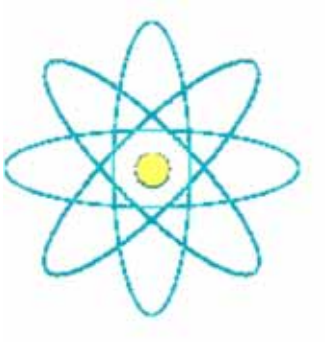
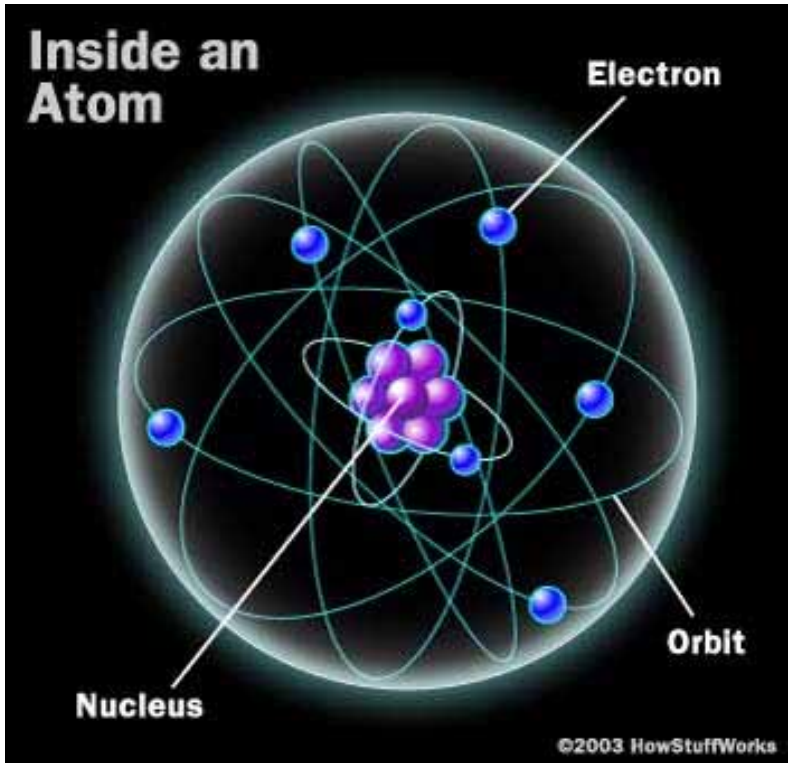
www.oscreadiness.org

Understanding the Atom



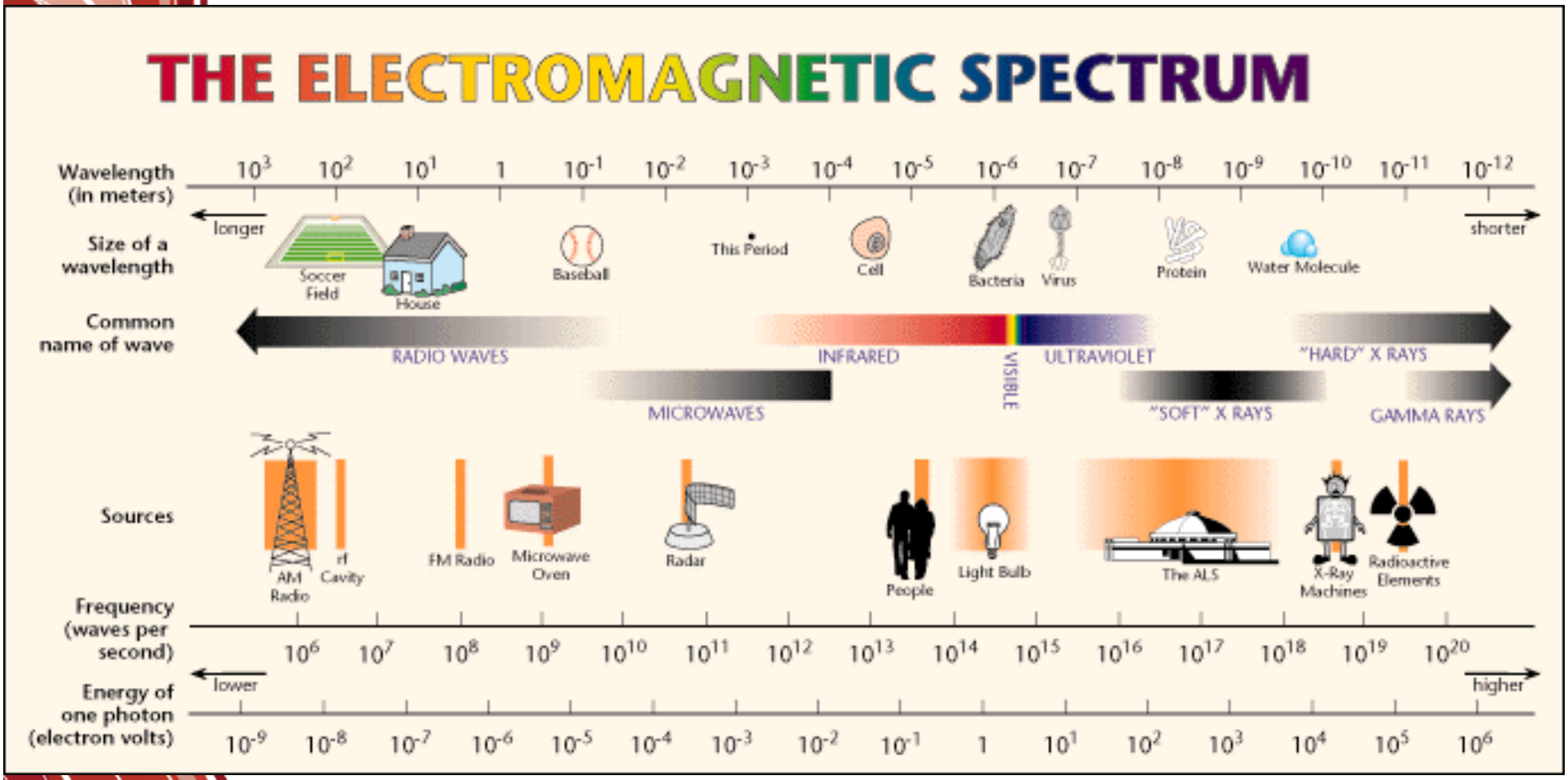
- Three key concepts
  - Size relationship between particles
  - Mostly empty space
  - Dynamic system



Radiation Overview

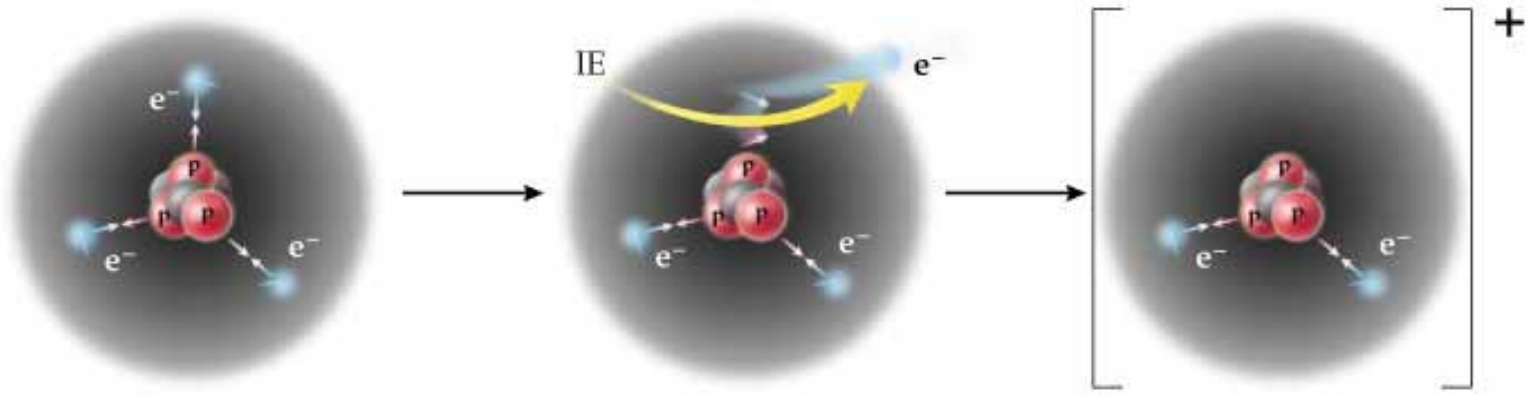
- Radiation - form of energy (particles/waves)
- Electromagnetic Radiation Spectrum -EMR
  - Radio frequency
  - Microwave
  - Infra-red
  - Visible Light
  - Ultraviolet - UV
  - X-Ray
  - Gamma Radiation

Radiation is a form of energy (particles/waves)



Ionization

- Ionization is the ejection of one or more electrons from an atom or molecule to produce a fragment with a net positive charge (positive ion).



Negative electrons cannot leave the atom unless energy is supplied to overcome their attraction to the nucleus.

Ionization energy (IE) kicks an electron out of the atom.

The resulting surplus of one proton gives the atom an overall +1 charge. The atom has been ionized and is now a cation.

Ionizing Radiation

- Particles (FAST!)
  - alpha particles (2 neutrons + 2 protons)
  - beta particles (electrons)
  - neutrons
- Waves (High Energy Light!)
  - X - Rays
  - Gamma Rays

Radiation Energy & Shielding

- Alpha Particles (+2 charge) Energy >7Mev
  - Stopped by Sheet of Paper
  - Concentrate in Bone, Kidney, Liver, Lung
  - Radon

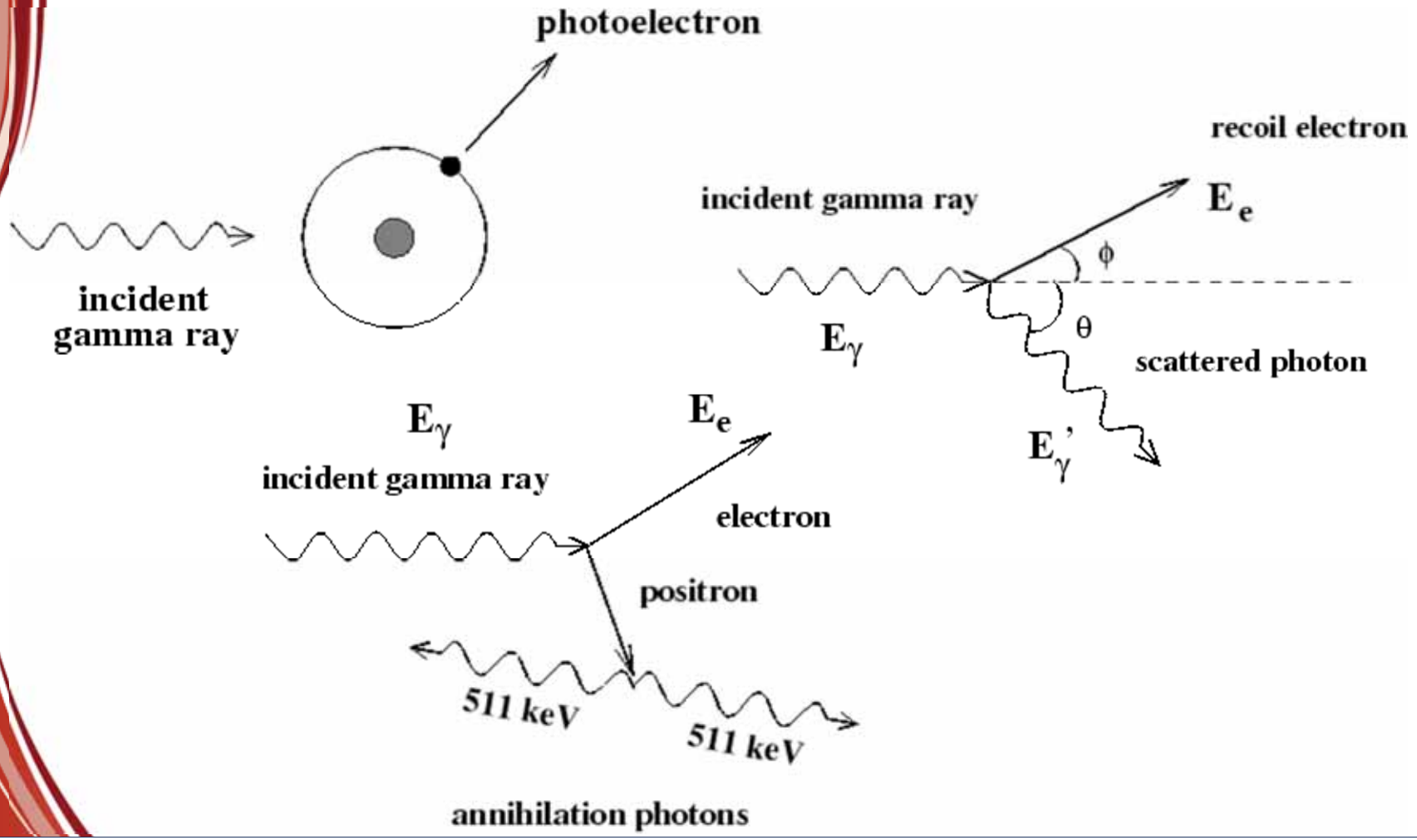
Radiation Energy & Shielding

- Beta Particles (-1 charge) Energy >4Mev
  - Stopped by 0.5” aluminum
  - Skin + Internal Hazard
- Neutrons
  - Concentrated in Reactors & Accelerators
  - Short Range in Air

Radiation Energy & Shielding

- X-Ray - Created in Atom Electron Shell
  - X-ray Tube (“Soft or Hard”)
  - Internal Hazard
- Gamma Rays - Created in Atom Nucleus
  - Similar to X-Rays except nuclear origin
  - Energy specific to radionuclide
  - Internal Hazard
  - Goes THROUGH 0.5” Steel

The Three Interactions of Gamma and X-ray's



Cadmium 109
Radioactive Decay

- 109 Cd --electron capture --> 109Ag*
  - (48p + 61n) 109Cd => (47p + 62n) 109Ag*
  - Releases 22-25 kev X-ray
- 109 Ag* --isonucleic--> 109Ag
  - (47p + 62n) 109Ag* => (47p + 62n) 109Ag
  - Releases 88 kev gamma ray

Radiation Safety Units

- RAD = Radiation Absorbed Dose
- REM = Roentgen Equivalent Man
- REM = RAD X Factor
  - (Factors X-ray=1, Alpha=20)
- Curie = 3.7E10 decay/sec (37BILLION!)
  - mCi = 3.7E7decay/sec (37MILLION)
- 1/2 life = Time required for 1/2 decay
- 109Cd =15 months, 57Co = 9 months

Biological Effects of Radiation

- Background/Natural Radiation
  - Continuous & cosmic
  - Lessened by Earth's atmosphere
  - Land vs Airplane
- Radiation interacts with living cells
  - somatic (current organism)
  - genetic (future generations)

Radiation
Dose & Time Relationship

- Total exposure important
  - High Dose & Low Time
  - Low Dose & Long Time
- Latent Period
  - Cancers
  - Cataracts
- Genetic - Birth Defects

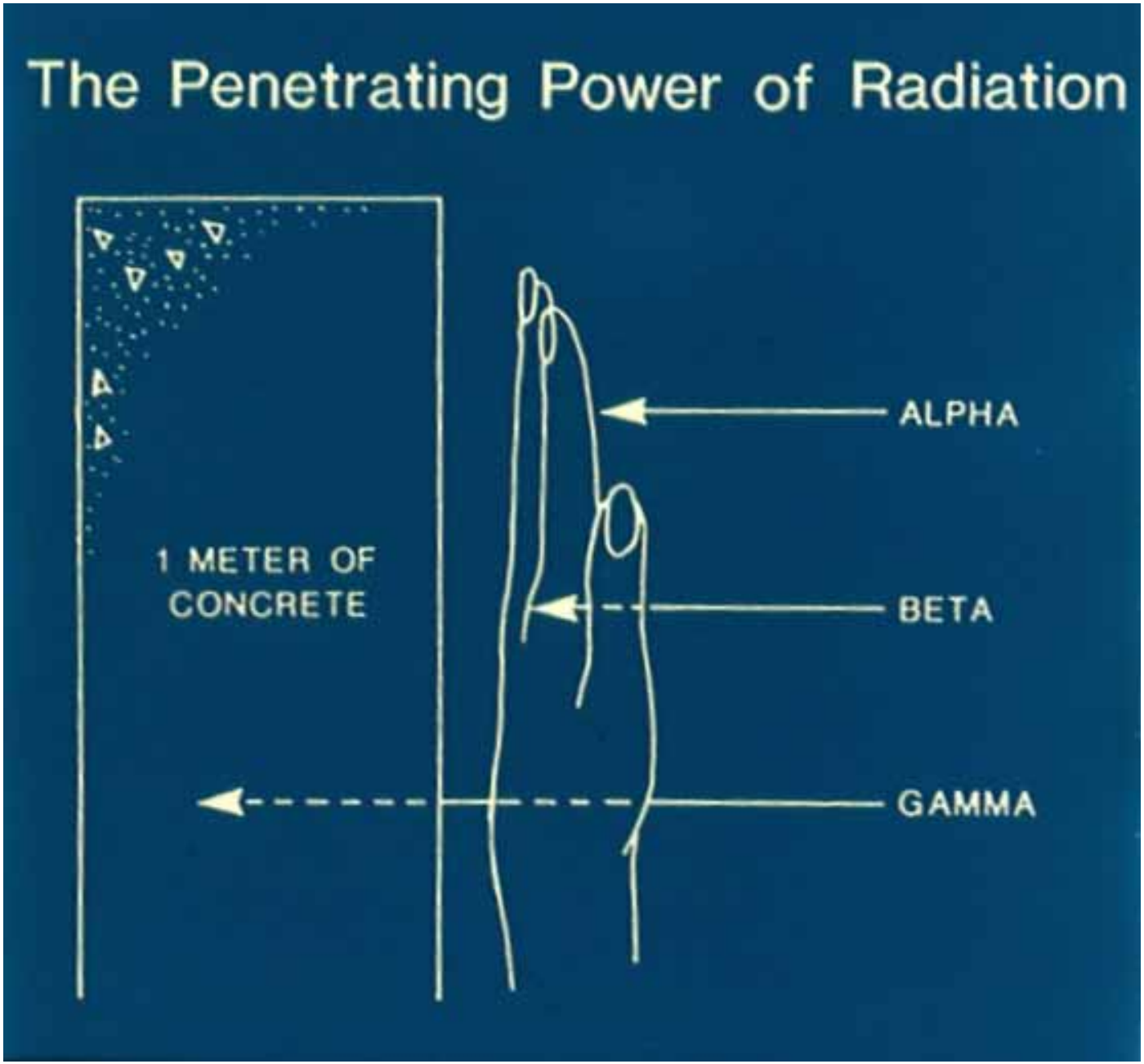
Physical Half Life

- Is the Time Required for ½ of the Mass Energy of the Radioactive Material to Decay to a Stable State.

- H-3 = 12.3 Years
- C-14 = 5730 Years
- I-125 = 60 Days

Biological Half-Life

- Is the Time Required for the Human Body to Eliminate –HALF- of an Administered Dose of any Radioactive Substance by the Regular Processes of Elimination.

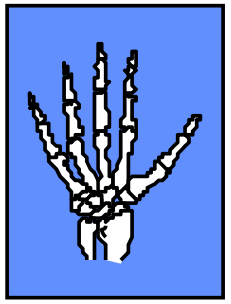

The Penetrating Power of Radiation
1 METER OF CONCRETE
ALPHA
BETA
GAMMA

Man-Made Sources

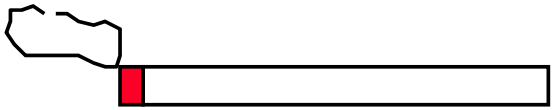
- Medical X-Rays — 35 mRem
  - CAT Scans
  - Dental X-Rays
- Nuclear Power Testing — 14 mRem
  - Fall Out
- Consumer Products — 9 mRem
  - TV
  - Microwaves
- Other — 2 mRem

Man-made Radiation

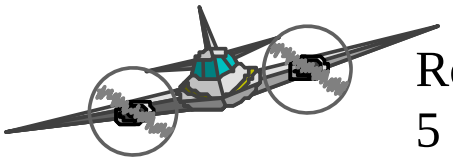
Man-made sources of radiation contribute to the annual radiation dose (mrem/yr).



Medical - 53

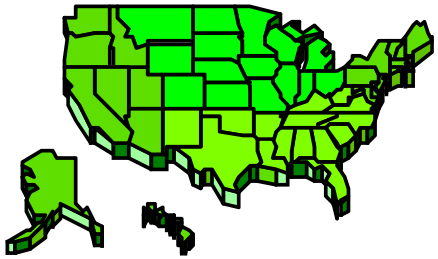


Cigarette smoking - 1300



Round trip US by air
5 mrem per trip

Building materials - 3.6
Gas range - 0.2
Smoke detectors - 0.0001

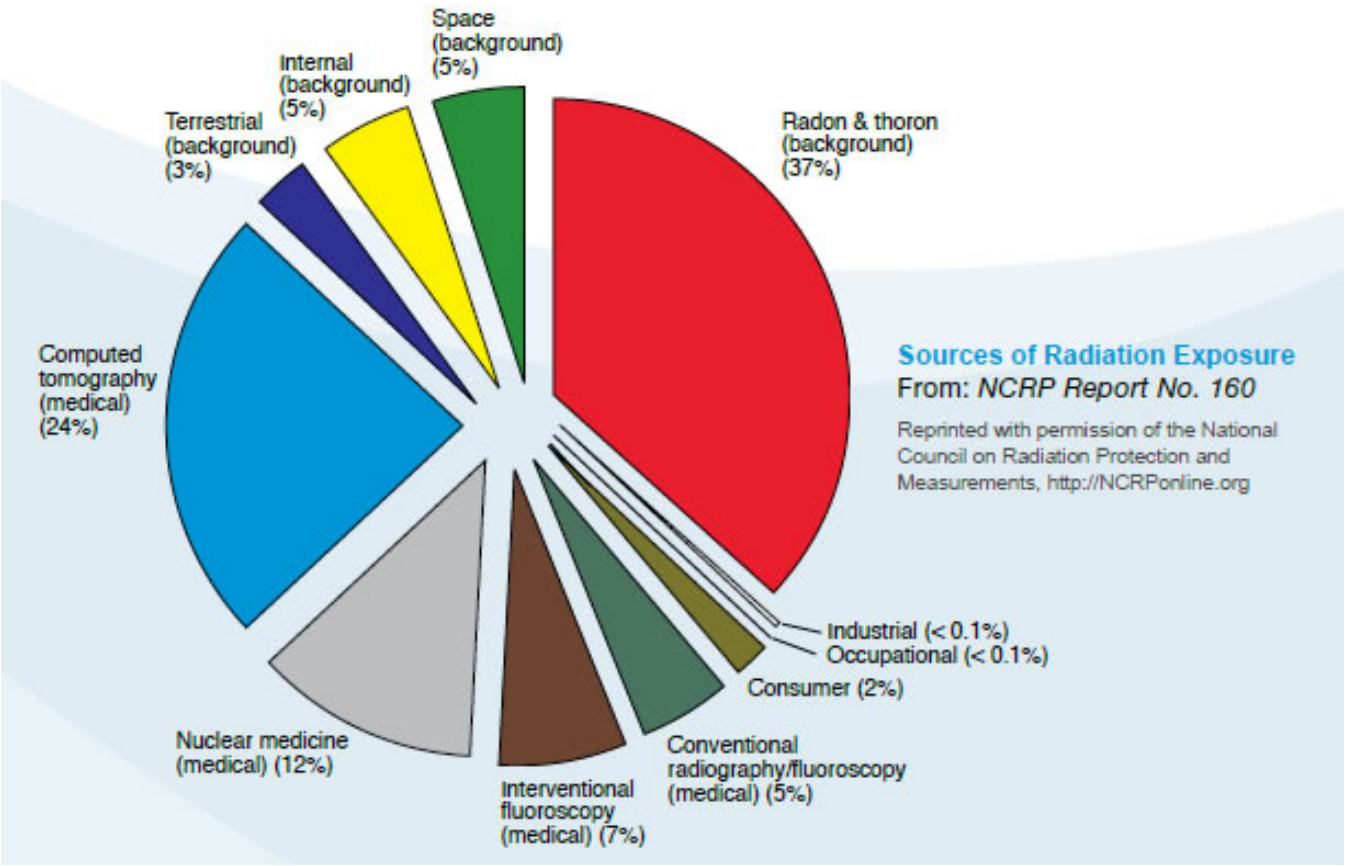


Background Radiation

- Total Background Radiation:

360 mRem… Well it used to be.

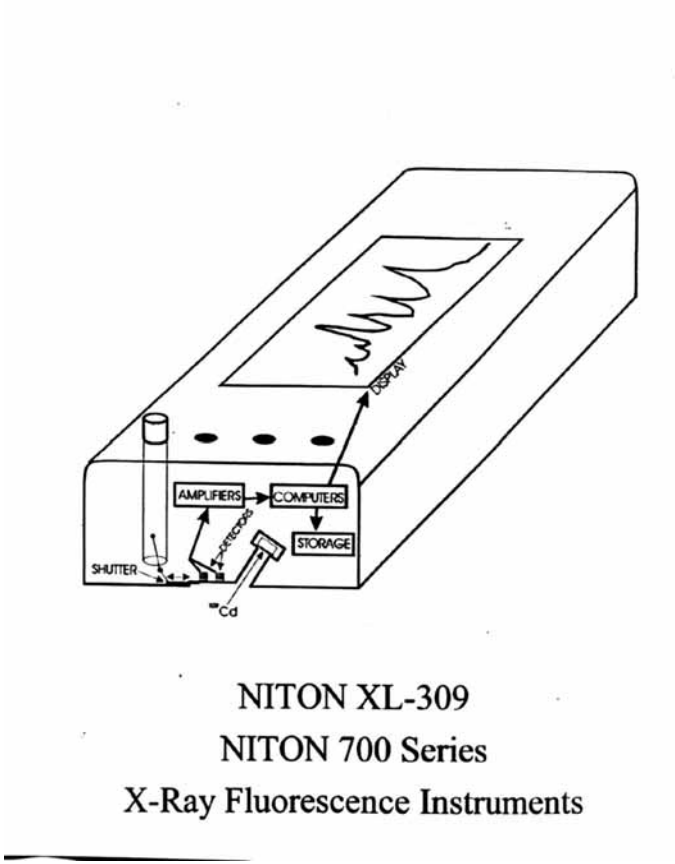
New Annual Background Dose is 620 mrem



Average annual radiation dose per person in the U.S. is 620 mrem

Calculate your estimated annual radiation dose:
http://www.epa.gov/radiation/understand/calculate.html

Exposure Calculations



NITON XL-309
NITON 700 Series
X-Ray Fluorescence Instruments

- <0.1 mREM/hr.
- X 25 hr/day
- = 2.5 mREM/day
- X 400 days/year
- = 1,000 mREM/year
- or 1 REM/year
- = 2% of reportable exposure

Safety Factors

- Time, Distance, Shielding
- Time - Limit Exposure Dose
- Distance - Maintain Safe Distance
  - Inverse square law
- Shielding - High Density Materials
- ALARA!

Questions?

Tony Honnellio
Health Physicist
U.S. Environmental Protection Agency, R1
5 Post Office Square, Suite 100
Boston, MA. 02109
617 918-1456, Cell: 617 947-4414
Honnellio.anthony@epa.gov