Radiation Safety – Health Physics

Neutron Spectroscopy Summer School

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: 1 kg = 1 million d/s
- Uranium 1 ton: 10,000 million d/s
- Cool Ash: 1 ton = 2 million d/s
- Fertilizer-super phosphate: 25 kg = 125,000 d/s
- ACME Funtz Paper Plate: Hot Chocolate 1 packet = 6 d/s
- Hamburger 4 oz. = 29 d/s
- Redon 198

Where Does Radiation Come From?

- Natural Radiation
  - Cosmic Radiation 28%
  - Terrestrial Radiation 28%
  - Consumer Products 10%
  - Medical Isotopes 14%
  - Medical X-rays 40%

- Man Made Radiation
  - Total Average Yearly Radiation Dose is 360 Millirem

Man Made Ionizing Radiation

- Reactor (generates neutrons)
- Neutron Experiment Stations
- Neutron Beam Tubes
Radiation Exposure

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
Health Physics Labels/Signs

- **RADIOACTIVE MATERIAL**
- **CAUTION**
  - High Radiation Area
- **DANGER**
  - High Radiation Area

>5 mrem/hr
(whole body dose rate)

>100 mrem/hr
(whole body dose rate)

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

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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

\[ \text{RADIATION INTENSITY} \propto \frac{1}{(\text{distance})^2} \]

Shielding

Different Types of Radiation Have Different Penetrating Powers

- Alpha
- Beta
- Neutron
- X-ray
- Gamma
- Lead
- Concrete
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.

Campfire Analogy

- **Airborne Activity**
- **Radiation**
- **Radioactive Material**
- **Contamination**
Contamination Control

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

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Average Dose to US Public = 360 mrem/yr

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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