Module 2
Fundamentals of Basic Radiation

Topics Covered in This Module

- Radiation Found in the Environment,
- Types of Radiation,
- Exposure, Absorbed Dose, and Dose Equivalent.

Natural Sources of Radiation

Cosmic,

Terrestrial,

Internal,

Inhaled.

Terrestrial Radiation

crust.

In the United States, highest radiation levels found on the eastern slope of the Rockies in Colorado Plateau Area Range 75 to 140 mrem/year and average 90 mrem/year.

In the United States, lowest radiation levels found on the Atlantic Coast in the Atlantic and Gulf Coastal Plain Range 15 to 35 mrem/year and average 23 mrem/year.

Inhaled Radiation

- Primarily from Radon-222 (^{222}Rn) and its daughters.
- ^{222}Rn is released from the soil as Radium-226 (^{226}Ra) and then it decays to Radon.
  - Radium is part of the Uranium-238 (^{238}U) decay chain.
- Levels vary widely from area to area,
  - Average dose is 200 mrem/year.
- Dose may be enhanced by poor ventilation or the use of uranium containing building materials.

Types of Radiation

What is Radiation?

Radiation is the emission of energy as electromagnetic waves or as moving subatomic particles through space or through a material.

Radiation is often categorized as either ionizing or non-ionizing depending on the energy of radiated particles or waves.

Ionizing radiation carries more than 10 eV, which is enough to ionize atoms and molecules and break chemical bonds.

Particulate Radiation Vs. Electromagnetic Radiation

- Particulate Radiation:
  - Alpha Particle,
  - Beta Particle,
  - Neutron.
- Electromagnetic Radiation:
  - Photon,
  - Gamma.

Electromagnetic Radiation

Oscillating electric and magnetic fields that transfer energy to matter via photon or wave interactions.

Electromagnetic radiation includes radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays.

Charged Radiation Vs. Uncharged Radiation

- Charged Radiation:
  - Alpha Particle,
  - Beta Particle.
- Uncharged Radiation:
  - Photon,
  - Neutron.

Ionizing Radiation Vs. Non-Ionizing Radiation

IonizingRadiation:

Exposure

The sum of the charges of one sign produced by photons in a given mass of air.

The SI unit of exposure is the Coulomb/kilogram (C/kg).

The traditional unit is the roentgen (R).

1 R = 2.58 X 10^{-4} C/kg.

This unit is only defined for photons of less than 3 MeV energy in air.

Absorbed Dose

- The energy deposited in or absorbed by an object per unit mass.
- Applies to all radiation at all energies in all absorbers.
- The SI unit of absorbed dose is the Gray (Gy).
- The traditional unit is the rad.
- 100 rad = 1 Gy

Dose Equivalent

The energy deposited in an object per unit mass (D) multiplied by a

effectiveness of different types of radiation (Q).

The SI unit of dose equivalent is the Sievert (Sv).

The traditional unit is the rem.

100 rem = 1 Sv

Symbol is H, H = DQx

Recommended Quality Factors

X-Ray, Gammas, and betas	1
Neutrons	2-11
Neutrons with unknown energy	10
High Energy photon	10
Alpha particles, fission fragments, heavy nuclei	20

Conversion

For the purpose of radiation protection, it is assumed that 1 R = 1 rad = 1 rem.

- R is only defined for photons,
- The quality factor is 1 for photons,
- 1 R is actually less than 1 rad (1 R = 0.97 rad for tissue absorber).