Radiation

WHAT IS RADIATION?

Radiation can be found all around us. Radiation is energy in the form of high-speed particles or electromagnetic waves. Radiation is either **ionizing** or **non-ionizing**. Non-ionizing radiation such as microwaves and visible light does not have enough energy to alter atoms (see Figure 1).

Health effects caused by exposure to ionizing radiation is the type of most concern. This type of radiation is powerful enough to alter (ionize) cellular chemicals, disrupting normal cell functioning. Usually the cell repairs itself, but it may die or transform into a cancerous cell. Ionizing radiation comes in three main forms:

- **Alpha** particles are the slowest of the three types of radiation. They can travel only a few inches in the air. A sheet of paper or the outer layer of a person's skin easily shields them.
- **Beta** particles are more energetic than alpha particles. A beta particle can travel in the air for a distance of a few feet. Beta particles can pass through a sheet of paper but may be stopped by a sheet of aluminum foil or glass. Alpha and beta particles are in the ultraviolet range of the electromagnetic spectrum (see Figure 1).
- **Gamma** rays, unlike alpha or beta particles, are waves of pure energy and are a form of x-ray. Gamma rays travel at the speed of light through air or open spaces. Gamma radiation can be very penetrating and requires concrete, lead, or steel to stop it**.**

HOW IS RADIATION MEASURED?

Because radiation and its effects are diverse, there are several ways of measuring it. We may measure the actual energy in the air, or absorbed or released by a substance. We may also measure the radiation based on how much biological damage it does. The following units are used in the United States:

- The **roentgen** is a measure of *exposure*—the amount of radiation energy (in the form of gamma or x-rays) in the air.
- The **rad** (radiation absorbed dose) is a measure of *absorbed dose*—the amount of energy actually absorbed by some material, such as human tissue.
- The **rem** (roentgen equivalent man) is the measurement we are most concerned with. It is a measure of the actual *biological effects* of radiation absorbed.
- The **curie** (Ci) is a measure of radioactivity. One curie of radioactive material will have 37,000,000,000 transformations of atoms (disintegrations) in one second.

HOW MUCH IS ONE REM?

To get a feel for the radiation dosage of a rem, compare it with other common dosages. We receive radiation from radon gas in our homes and drinking water, from outer space, from radioactive elements in our own bodies, and from medical X-rays. Since common human dosages are less than one rem, a more practical unit of measurement is the millirem (1/1000 of a rem).

Average doses include:

Source	Dose (millirem)
Chest x-ray	10
Mammogram	30
Cosmic rays	31 annually
Human body	39 annually
Radon in household	200 annually*

The U.S. government has set maximum acceptable levels for radiation exposure at 2 rems (2,000 millirems) per year for occupational exposure and 0.1 rem (100 millirems) per year for general public exposure.

* U.S. average

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Figure 1. Electromagnetic Spectrum of Different Types of Energy

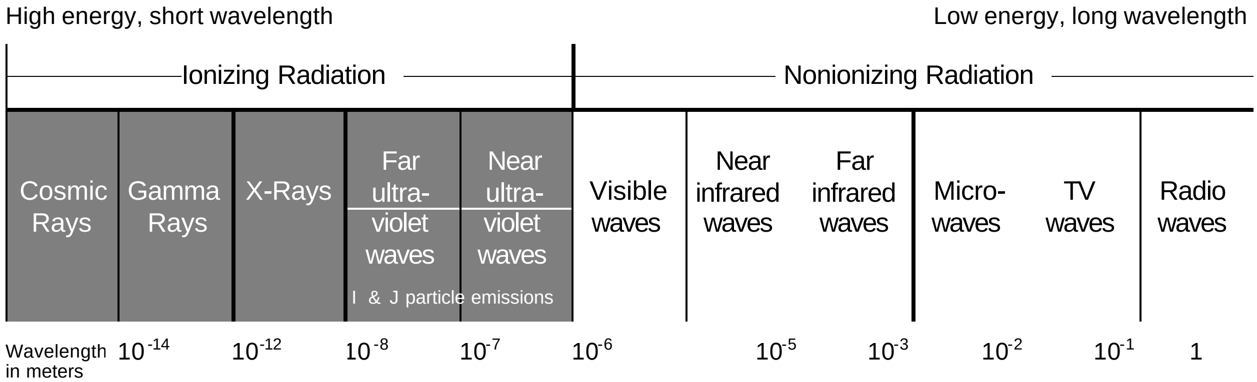

Figure 1. This electromagnetic spectrum represents different types of energy traveling as electromagnetic waves that differ in their wavelength (distance between each peak or trough) and energy content. Cosmic rays, gamma rays, x-rays, and ultraviolet radiation have a high enough energy content to alter atoms into positively or negatively charged ions. This is called ionizing radiation. The other forms of electromagnetic radiation do not have enough energy content to form ions and are called nonionizing radiation. Alpha and beta particle emissions are not electromagnetic waves or rays. They are listed on this chart for illustrative purposes, approximating their relative radioactivity. Adapted from: Miller, *Living in the Environment*, Seventh Ed., 1992.

(This information adapted from a 1996 backgrounder prepared by the Environmental Health Center, Washington, D.C.)

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