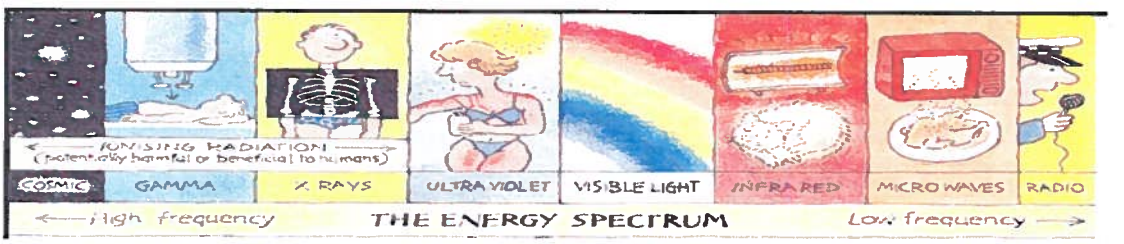
Radiation Safety & Protection Training
Blood Bank Irradiator Staff

What is Radiation?

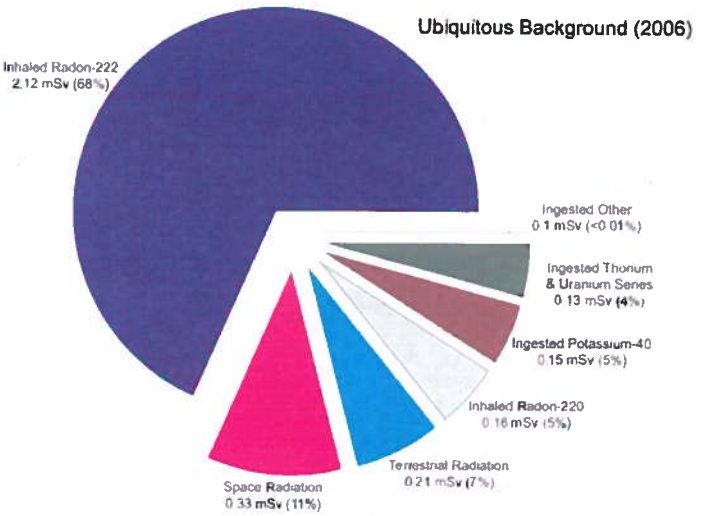
Radiation can be generally defined as the transmission of energy in the form of electromagnetic waves (EM) or fast moving particles. There are several types of EM waves which we encounter daily, each of which manifests themselves in different ways. Some EM waves can be perceived by the human sensory system. For example, we feel radiant energy in the form of heat, and our eyes detect different colors of visible light. Other forms of EM waves like x-rays are undetectable by our sensory system. A spectrum of EM waves is displayed below in terms of wave frequency and energy.



Radiation from the high end of the energy spectrum, (X-rays and above) possesses enough energy to remove electrons from atoms or molecules. Termed ionizing radiation, these high energy EM waves have sufficient energy to break molecular bonds and potentially produce biological damage. Fast moving particles such as electrons, neutrons, and α-particles are also capable of ionizing matter. For simplicity we will from here on use the term "radiation" to categorically combine all forms of ionizing radiation. The two most common forms of radiation that will contribute to the occupational exposure of medical personnel are x-rays and γ-rays. Although radiation may produce damage to living tissue, it is a crucial component for modern medicine, in the diagnosis and treatment of disease.

Sources of Radiation Dose

Life on earth has evolved in an environment while continuously exposed to natural sources of radiation. Scientific investigation has determined that the average person in the US receives a radiation dose of about 300 mrem/year from natural background sources. The pie chart below breaks down the different sources of background radiation. As can be seen, the overwhelming majority of background radiation exposure is from radon gas, which comes from the radioactive decay of uranium, naturally present in soil. The amount of cosmic radiation exposure is dependant on your elevation, among other factors. A person residing at sea level receives roughly half the dose as a resident of Denver, Colorado, for example. Radioactive elements incorporated in our body also contribute to natural our background radiation dose. The level of natural exposure varies around the globe, at some locations, natural background radiation exposure exceed the average levels by a factor of 10 and sometimes even by a factor of 100.



Occupational Exposure

As radiation workers, our main concern is the exposure we receive occupationally. The blood bank has a gamma irradiator which is used to inactivate T lymphocytes to prevent transfusion-associated graft-versus-host disease (TA-GVHD). Exposing the center of the blood product to a radiation dose ≥25 Gy (2500 cGy) will prevent T lymphocytes from proliferating in an immunocompromised transfusion recipient. This radiation field is self-contained within the irradiator. When operating properly, the irradiator poses no risk to operators or surrounding personnel.

Cesium-137 is the radiation source incorporated within the irradiator. The source has an activity level of greater than 3,500 Ci. This source, unshielded is considered a high hazard. If the shielding were to become compromised an exposed individual would reach the maximum allowable radiation dose limit within 16 seconds. It would take only 33 minutes of exposure to reach a dose level that would cause certain death.

Historical occupational dosimetry records and real time continuous dosimetry monitoring of the Blood Bank area have demonstrated that individuals working around the irradiator have not received any measurable dose above background levels. Personnel receive a dose less than 100 mrem/year, the public dose limit established by regulatory agencies.

In order to assure a safe working environment the hospital has increased controls to the Blood Bank area. Only individuals whom have been deemed trustworthy and reliable have unescorted access to the Blood Bank. Constant surveillance and radiation monitoring are in place to prevent unauthorized access, removal, or use of the irradiator.

Annual preventative maintenance and calibrations are conducted by the manufacturer under supervision of the blood Bank staff. Routine quality control must also be performed to assure safe use. Control checks include canister rotation, timer checks, door interlocks, and emergency power tests. If annual or routine tests fail notify the blood bank supervisor and remove irradiator from service until corrective actions are taken.

Radiation Protection

All areas of possible radiation exposure are required to be posted with appropriate warning signs and emergency contact information. The irradiator is posted with a caution radioactive material sign. Emergency contact information is posted on the Blood Bank doors. A notice to Employee sign is posted in the work area as well. This notice outlines the regulatory responsibilities of staff, the hospital, and the regulatory agency. If you have any question regarding this notice please speak with the Radiation Safety Officer.

There are three concepts in basic radiation protection.

TIME

If you decrease the amount of time you spend near the source of radiation, you will decrease the amount of radiation exposure you receive.

DISTANCE

The farther away you are from a radiation source, the less exposure you will receive. The radiation protection practice of maximizing distance follows the inverse square law. (i.e. doubling the distance between yourself and the source of radiation decreases your exposure by a factor of four)

SHIELDING

Shielding incorporated around a radiation source will decrease your exposure. In the Blood Bank, the irradiator is self-shielded. Under normal operations the amount of radiation which penetrates the shielding is minimal.

It is important that personnel implement all three radiation safety practices, when working around radiation. For more information regarding radiation or radiation safety, you can contact the Blood Bank supervisor, the RSO, or Krueger-Gilbert Health Physics, Inc.