Radiation units

(i) Rad (radiation absorbed dose)

A unit of absorbed dose of radiation. Rad is a measure of the amount of energy deposited in tissue , which is the absorption of 100 erg for each gram ,the unit rad

can be used for any type of radiation , but it dose not describe the biological effects of the different radiations due to the weighing factor of radiation type Q.

2-Rem (Roentgen equivalent man):

A unit of equivalent absorbed dose of radiation which takes into account the relative biological effectiveness of different forms of ionizing radiation, or the varying ways in which they transfer their energy to human tissue. The dose in rem equals the dose in rad multiplied by the quality factor (Q). For beta and gamma radiation, the quality factor is taken as one, that is, rem equals rad. For alpha radiation, the quality factor is taken as 20, that is, rems equal 20 times rads. Rem is essentially a measure of biological damage. Q is typically taken as 10

$$\textbf{rem} = \textbf{rad} \times \textbf{Q}$$

3-Gray (Gy):

When ionizing radiation penetrates the human body or an object, it deposits energy. The energy absorbed from exposure to radiation is called an absorbed dose. The absorbed dose is measured in a unit called the gray (Gy). A dose of one gray is equivalent to a unit of energy (joule) deposited in a kilogram of substance .
A unit of absorbed radiation dose equal to 100 rad. Gray is a measure of deposition of energy in tissue.

$$\textbf{1 Gy} = \textbf{100 rad} = \textbf{1 joule/kg}$$

4-**Sievert (Sv):**

A unit of equivalent absorbed dose equal to 100 rem . **1 Sv = 100 rem**

Sv = Gy x Q

5-Curie (Ci):

The traditional unit of radioactivity, which measure the number of decays per second, equal to the radioactivity of one gram of pure radium-226 .

1 Ci = 37 billion dps = 37 billion Bq

6- Becquerel (Bq):

The standard international unit of radioactivity equal to one disintegration per second . 1 Bq = 27 pCi

7-Disintegrations per second (dps):

The number of subatomic particles (e.g. alpha particles) or photons (gamma rays) released from the nucleus of a given atom over one second. One dps = 60 dpm (disintegrations per minute)

1 dps = 1 Bq

Sources of radiation

1-Natural sources of ionizing radiation

Radiation has always been present and is all around us in many forms. Life has evolved in a world with significant levels of ionizing radiation, and our bodies have adapted to it. Many radioisotopes are naturally occurring, and originated during the formation of the solar system and through the interaction of cosmic rays with molecules in the atmosphere. Tritium is an example of a radioisotope formed by cosmic rays’ interaction with atmospheric molecules. Some radioisotopes (such as uranium and thorium) that were formed when our solar system was created have half-lives of billions of years, and are still present in our environment. Background radiation is the ionizing radiation constantly present in the natural environment.

-Cosmic rays

The earth’s outer atmosphere is continually bombarded by cosmic radiation. Usually, cosmic radiation consists of fast moving particles that exist in space and originate from a variety of sources, including the sun and other celestial events in the universe. Cosmic rays are mostly protons but can be other particles or wave energy. Some ionizing radiation will penetrate the earth’s atmosphere and become absorbed by humans which results in natural radiation exposure.

-Terrestrial radiation:

The composition of the earth’s crust is a major source of natural radiation. The main contributors are natural deposits of uranium, potassium and thorium which, in the process of natural decay, will release small amounts of ionizing radiation. Uranium and thorium are found essentially everywhere. Traces of these minerals are also found in building materials so exposure to natural radiation can occur from indoors as well as outdoors.

-Exposure through inhalation

Most of the variation in exposure to natural radiation results from inhalation of radioactive gases that are produced by radioactive minerals found in soil and bedrock. Radon is an odourless and colourless radioactive gas that is produced by the decay of uranium. Thoron is a radioactive gas produced by the decay of thorium. Radon and thoron levels vary considerably by location depending on the composition of soil and bedrock .Once released into the air, these gases will normally dilute to harmless levels in the atmosphere but sometimes they become trapped and accumulate inside buildings and are inhaled by occupants. Radon gas poses a health risk not only to uranium miners, but also to homeowners if it is left to collect in the home. On average, it is the largest source of natural radiation exposure.

-Exposure through ingestion

Trace amounts of radioactive minerals are naturally found in the contents of food and drinking water. For instance, vegetables are typically cultivated in soil and ground water which contains radioactive minerals .Once ingested, these minerals result in internal exposure to natural radiation .Naturally occurring radioactive isotopes, such as potassium-40 and carbon-14, have the same chemical and biological properties as their non-radioactive isotopes. These radioactive and non-radioactive elements are used in building and maintaining our bodies.

Natural radioisotopes continually expose us to radiation and are commonly found in many foods, such as Brazil nuts. .

2- **Artificial (man-made) sources of ionizing radiation**

People are also exposed to man-made radiation from medical treatments and activities involving radioactive material. Radioisotopes are produced as a by-product of the operation of nuclear reactors, and by radioisotope generators like cyclotrons. Many man-made radioisotopes are used in the fields of nuclear medicine, biochemistry, the manufacturing industry and agriculture. The following are the most common sources:

Medical sources: Radiation has many uses in medicine. The best-known application is in X-ray machines, which use radiation to find broken bones or to diagnose diseases. X-ray machines are regulated by Health Canada and provincial authorities. Another example is nuclear medicine, which uses radioactive isotopes to diagnose and treat diseases such as cancer. A gamma camera (see Figure 1) is one piece of medical equipment commonly used in diagnosis .The CNSC regulates these applications of nuclear medicine, as well as related equipment. It also licenses reactors and particle accelerators that produce isotopes destined for medical and industrial applications.

Figure 1: A gamma camera used in nuclear medicine, for diagnosing illnesses

Industrial sources: Radiation has various industrial uses, which range from nuclear gauges (see Figure 2) used in the building of roads to density gauges that measure the flow of material through pipes in factories. Radioactive materials are also used in smoke detectors and some glow-in-the dark exit signs, as well as to estimate reserves in oil fields. Other applications include sterilization, which is performed using large, heavily shielded irradiators. Industrial activities are licensed by the CNSC.

Figure 2: A portable nuclear gauge

Nuclear fuel cycle: Nuclear power plants (NPPs) use uranium to produce a chain reaction that produces steam, which in turn drives turbines to produce electricity. As part of their normal activities, NPPs release small quantities of radioactive material in a controlled manner to the surrounding environment. These releases are regulated to ensure doses to the public are well below regulatoryn limits. Uranium mines, fuel fabrication plants and radioactive waste facilities are also licensed so the radioactivity they release (that can contribute to public dose) can be controlled by the CNSC.

Atmospheric testing: The atmospheric testing of atomic weapons from the end of the Second World War until as late as 1980 released radioactive material, called fallout, into the air. As the fallout settled to the ground, it was incorporated into the environment. Much of the fallout had short halflives and no longer exists, but some continues to decay. People and the environment receive smaller and smaller doses from the fallout every year.