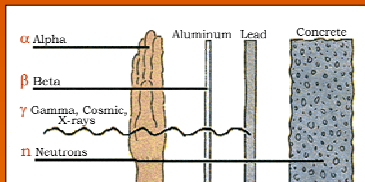


**RADIATION.** For many, the word conjures up frightening images, such as Chernobyl, Hiroshima, and deadly cancers. In reality, radiation surrounds us and most forms do not cause us harm. It is in the foods we eat and the air we breathe. We touch it, play with it, use it. On warm sunny days, we bask in it. It has the potential to destroy lives but it is also used to save lives. What is Radiation, really?

**Radiation** is the transmission of energy in the form of light, or radiant heat from a body as it undergoes internal changes. Radiation comes in many forms that fall into two categories, ionizing radiation and non-ionizing radiation.

**Types of Radiation:**

**Ionizing Radiation** is a particle or wave high enough in energy to eject a charged particle from an atom, in a process called ionization. There are many forms of ionizing radiation with varying levels of energy and penetration potential (Fig. 1). The most common are alpha particles, beta particles, gamma rays, and x-rays.



[Fig. 1] A visual comparison of the penetration potentials of different forms of ionizing radiation. Source: <http://www.uic.com.au/>

**Alpha particles** are helium nuclei. These are highly ionizing particles that are emitted from the nucleus during the decaying process of some radioactive elements. They are not very penetrating and are usually stopped by as little as a dead layer of skin. Nevertheless, if ingested or inhaled, alpha particles can be very damaging, even deadly.

**Beta particles** are highly ionizing electrons, which are emitted from the nucleus of some radioactive elements during the decaying process. These are more penetrating than the alpha particles and can usually be stopped by a layer of clothing. However, if inhaled or ingested, they can be very damaging and deadly.

**Gamma rays** are high energy waves in the electromagnetic spectrum with no charge or mass. Along with beta and alpha particles, they are emitted from the nuclei of some elements undergoing a decaying process. Gamma rays are highly penetrating and are only stopped by several feet of concrete or lead, making gamma rays potentially more harmful than the previous forms of ionizing radiation.

**Non-ionizing Radiation** includes forms of radiation such as ultraviolet light, visible light, infrared, microwaves, and radio waves. The focus of this paper will be on ionizing radiation.

**Sources of Radiation**

Although radiation is present everywhere and in everything, not all radiation is normal for a given area. Normal radiation or background radiation is defined as the dose of radiation an individual is subjected to in their daily environment, whether man-made or naturally occurring. Sources for background radiation are dependent on factors such as elevation, proximity to radiation emitting facilities, and geologic makeup of area.

Non-background radiation is anything above the "normal radiation" in a given area. Examples are smoking, cancer treatments, x-rays, and traveling in an aircraft (due to increase in elevation).

Fallout from a nuclear explosion is considered non-background radiation. Since some of the radioactive material from nuclear fallout have lengthy half-lives, over time it becomes a part of background radiation within a given environment.

[Fig.2] Right: Various Sources of Radiation. As shown, common radioactive elements such as potassium-40 are abundant not only within

There are many different units used to measure radiation. However, the internationally preferred units are the International System of Units (SI).

The Gray (Gy) is used as a measurement of how much radiation is absorbed by a body.

1 Gray = 1 Joule per kg of material

The Sievert (Sv) is used as a measurement of not only the amount of radiation that is absorbed by a given body but it also takes into account quality (Q) of the radiation that is absorbed. For example, exposure to 1 Sievert of alpha radiation is more damaging than exposure to 1 Sievert of beta radiation in any given amount of time. Highly damaging radiation has a high value for Q.

1 Sievert = 1 Gray \* Q

The Becquerel (Bq) is used to measure radioactivity or the decaying of radioactive material.

1 Becquerel = 1 disintegration per second.

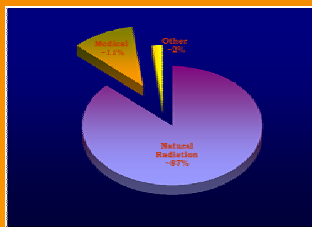
Disintegration is the transformation an element undergoes. For example, Uranium-238 decays to Thorium-234 through alpha emission.

Common Unit Prefixes	
micro (u)	10 <sup>-6</sup>
milli (m)	10 <sup>-3</sup>
kilo (k)	10 <sup>3</sup>
mega (M)	10 <sup>6</sup>

Unit Conversions	
1Bq	2.7 x 10 <sup>-11</sup> Curie (Ci)
1 Sv	100 REM
1 Gy	100 RAD**
1 Coulomb/kg	1 Roentgen (R)

\*Roentgen Equivalent Man, \*\*Radiation Absorbed Dose

Source	Type	Annual Dose (Bq)
1 Adult Human	Potassium-40	7.00 x 10 <sup>3</sup>
1 kg Coffee	Potassium-40	1.00 x 10 <sup>3</sup>
1 kg Brazil Nuts	Potassium-40	5.18 x 10 <sup>26</sup>
1 kg Bananas	Potassium-40	2.22 x 10 <sup>26</sup>
1 kg Uranium	Uranium-238	2.50 x 10 <sup>7</sup>
1 kg Granite	Uranium-238	1.00 x 10 <sup>7</sup>
Radioisotope for Medical Diagnosis	Technitium-99*	7.00 x 10 <sup>7</sup>
Radioisotope for Medical Therapy	Cesium-137*	1.00 x 10 <sup>4</sup>



[Fig. 2] Radiation Source Distribution

**Radiation in Alaska** has existed and fluctuated since the earth first formed billions of years ago. The sources that have contributed to this pool of radiation are both natural and man-made.

Radon-222 is a naturally occurring gas. It is a type of radioactive element that is produced as Uranium (an unstable element) undergoes a decaying process to a more stable element. These types of elements are abundant in areas containing granitic rock. Areas in Alaska where this occurs are:

- Seward Peninsula
- Eagle Creek (Death Valley)
- Purcell Mountain

A harbor near Point Hope was to be constructed using nuclear explosives. Although the idea was dismissed, a

hydrological study was conducted shortly thereafter (1963). The study involved the spreading of small amounts of radioactive tracer material (Cesium-137, 1.11 x 10<sup>8</sup> Bq), which was to be removed immediately after the study. Instead, the material was left at location and buried. In 1993, the frozen earth containing remnants of the tracer material was removed upon its discovery and disposed of properly.

Three underground nuclear tests (in Table below) were conducted on Amchitka Island.



[Fig.4] Map showing geographic locations of places mentioned in the poster. Source: ADEC

Project	Year	Est. Yield	Depth (m)	Purpose
Longshot	1965	80kt	716	Seismic Testing
Milrow	1969	1 Mt	1220	Seismic Calibration
Cannikin	1971	5 Mt	1790	Device Testing

A nuclear power plant was constructed (1961) and operated at Fort Greely until 1971. The majority of the material and parts were removed and disposed of, while the rest was buried on site and encased in concrete until 1997 when a leakage was detected. Cleanup and decommissioning of the nuclear power plant is still being done by the U.S. Army.

Bilibino, in the Russian far east, is the closest nuclear reactor to Alaska, making it a potential threat. As with many of Russia's nuclear power plants, Bilibino uses old nuclear reactors. Should this plant suffer the same fate as Chernobyl, a radioactive cloud could pass over Alaska with potential for accumulation in the environment and subsistence food supply.

**What can we do about radiation?** Radiation is everywhere. As a community we must educate ourselves so we can make the right choices regarding risk. To do this we should:

- Know the sources, doses, and types of radiation in our surroundings.
- Know how to protect ourselves adequately from unnecessary radiation by monitoring the background radiation levels. This can be accomplished by:
  - Operating small monitoring devices which can be purchased to monitor radon levels in homes.
  - Maintaining long-term monitoring sites at the community level (Fig.5).
  - Establishing a baseline level for gamma radiation to alert the community about sudden increases in radiation should it occur.
- If exposure is unavoidable, individuals must:
  - Use appropriate protection.
  - Distance themselves from source.
  - Limit time of exposure to source.



[Fig.5] NEWNET (Neighborhood Environmental Watch NETWORK), uses these towers to gather radiation and meteorological data. This tower is located in Barrow.

**References:**

1. <http://www.epa.gov> (2000)
2. <http://www.nei.org> (2001)
3. <http://newnet.lanl.gov> (2000)
4. <http://www.uic.com.au> (2000)
5. U.S. Department of Energy, Office of Environmental Restoration and Waste Management. (1991). Radiation in the Environment.
6. Hanson, W.C. and D.H. Dasher. (1998). Radioactivity in Alaska.
7. Shapiro, J. (1990). Radiation

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