APPENDIX I

RADIATION SAFETY AWARENESS

UNIVERSITY OF NORTH FLORIDA RADIATION SAFETY PROGRAM

1. Introduction
   Radiation - is it a deadly substance or a mystical power beneficial to the world? The word radiation causes all sorts of reactions. We hear that radiation holds the cure for many medical diseases, or that the power of the atom will give an ocean of energy that can help produce our food, fuel our industries, recycle our precious minerals. We also hear about the radiation nightmare and its destructive powers. The huge nuclear mushroom clouds, people dying of cancer, and the horror of giving birth to mutated children. Which image of radiation is closer to the truth? The information provided herein is a quick look at a very complex subject. **RADIATION.**

2. RADIATION
   Radiation is a form of energy. There are two basic kinds of radiation.

   1. Particle radiation is tiny fast moving particles that have both energy and weight. These particles of radiation are similar to speeding bullets, but they are subatomic particles which you cannot see. Examples of particle radiation include alpha radiation and beta radiation.

   2. Electromagnetic radiation is a pure energy with no weight. This kind of radiation is like vibrating or pulsating waves of electrical and magnetic energy. Ordinary visible light is a form of wavelike radiation. All electromagnetic radiation travels at the speed of light. Gamma and x-radiation are examples of electromagnetic radiation.

3. Atom
   Atoms are small building blocks that make up everything we can touch. Atoms are composed of a heavy core or nucleus at the center and a cloud of electrons orbiting around the nucleus. The basic components of atoms are protons, neutrons and electrons.

4. Origin
   Gamma rays and x-rays are similar except that one comes from a different source. X-rays are caused by speeding electrons striking other electrons in a target. Gamma rays comes from the nucleus of atoms that have too much energy.

5. X-ray Radiation and Gamma Ray Radiation

To produce x-rays, electrons travel at enormous speeds and smash into other electrons, thereby giving off waves of radiation which we call x-rays.

Gamma rays are generated from the nucleus of certain atoms that have too much energy. Some atoms have so much extra energy inside that the nucleus is constantly undergoing violent shaking. The nucleus gives up this extra energy by throwing off a tiny particle of an atom and a gamma ray.

X-rays and gamma rays disturb the atomic structure so much that atoms may enter into chemical reaction with each other. These chemical reactions can cause biological damage in to the body. Damage can happen if the radiation=s energy breaks apart molecules in the cells of the human body.

6. Ionization

Ionization is an action which disturbs the electrical balance of the atoms that make up matter. Ionization means that two ions (or electrically charged particles) have been created. The electron has a negative electrical charge. The atom that remains behind has a positive electrical charge.

Ionizations can be caused by x-ray/gamma rays as well as particles of radiation. When an x-ray or gamma ray strikes an electron it gives energy to the electron, that electron is now an energetic particle of radiation. The electron causes additional ionization along its path because it hits other electrons like one billiard ball hitting another.

7. Natural Sources of Radiation

Everybody in the world receives a small amount of radiation at all times from natural radiation sources. This is called natural background radiation.

Radiation is given off constantly by naturally occurring radioactive materials all around us - in the ground, in the walls of buildings, and even in our bodies. Although many of us associate the word Aradiation@ with danger and illness such as cancer, radiation is not necessarily harmful. Burning a log, for example, gives off radiant energy in the form of both heat and light. And when you lie in the sun too long, you get a sunburn, which is a mild radiation burn. However, the hazards that come to mind when you think of radiation are most often associated with ionizing radiation.

Radioactive materials have been present on earth since it was formed. In addition, the earth is bombarded by radiation from the sun and other sources in outer space. This radiation is known as cosmic radiation. We are all exposed to naturally occurring radiation every day. In fact, natural background radiation - from soil and rocks, from the food we eat, from the houses we live in, from cosmic rays, even from our own bodies. Some radiation also comes from naturally occurring radioactive materials in bricks and concrete used in buildings. Roughly equal amounts of radiation come from cosmic radiation naturally occurring radioactive materials in the human body and naturally occurring radioactive materials found in the earth. Roughly we receive about 100 mrem/year from natural background radiation.

8. Radiation from Manmade Sources

We are exposed to man-made sources of ionization radiation through our daily activities. Example of our exposure to manmade radiation includes: medical and dental x-rays, the use of radioactive materials injected into the body for medical diagnosis or treatment, smoking, camping, fallout from nuclear weapons tests, radiation from consumer products (such as color television sets, computer monitors, smoke detectors, radium or tritium in luminous dial wrist watches and clocks, uranium contained in false teeth), radiation released by nuclear power plants and occupational exposure of workers who are near or use radiation devices on their jobs. The average person receives roughly 100 mrem/year from manmade sources of radiation. Most of which comes from medical and dental x-rays.

The average person receives an annual radiation dose of about 20 mrem per year, half from natural back ground radiation and half from manmade sources.

9. Radiation Dose (Rems)
It is possible to relate the amount of ionization caused by a beam of x-rays or gamma rays in the air to the amount of biological damage that would be caused in living tissue placed in the beam. The measure of this biological effect of radiation is the radiation dose. Dose is measured in units of rems.

10. Dose Rates (mR/hr)
It is important to know how rapidly radiation dose is being received. The measure of how fast radiation dose is being received is called the dose rate. Radiation survey meters measure the dose rate. The survey meter measures how fast the dose is being received in roentgens/time (hr) or millirems/time (hr). Thus if in a certain place, the radiation level is given as 1 roentgen/hour, this means that a person standing in that location for one hour will receive a radiation dose of 1 roentgen or 1 rem. The relationship is Dose = Dose rate x Time.

11. Radioactivity
Radioactivity is the emission of radiation from an unstable atom. Most atoms are stable and do not emit radiation. But certain kinds of atoms have large surpluses of energy. These atoms are called unstable atoms. Unstable atoms will eventually emit radiation, a highly concentrated form of energy. The radiation will carry off the surplus energy from the atom. The radiation can be in the form of particles that have weight such as beta or in the form of weightless waves of pure energy such as gamma rays. The gamma rays used in nuclear gauges come from radioactive atoms. The atoms also emit particles (alpha or beta particles).

12. Radioactive Decay
The disintegration or breaking up of an unstable atom with the emission of radiation is called radioactive decay. Most unstable atoms, emit radiation or decay only once. Once one of these atoms has given up its excess energy, it becomes a stable atom and is no longer radioactive. This is the reason nuclear sources become weaker as they age. The number of unstable atoms keeps getting smaller and smaller. Less and less radiation is emitted.

13. Activity

The strength of a radioactive source is called the activity. Activity is defined as the rate of disintegration or transformation or decay of radioactive material. The units of measure for activity are the becquerel (Bq) and the curie (Ci).

14. Harmful Effects

Prompt (acute) effects are results which can be observed within a short period of time after the radiation dose is received. Very large doses of radiation can cause serious harmful health effects within hours or weeks. The body=s natural defenses against radiation damage have developed in the naturally radioactive environment in which we live. These defenses are overwhelmed by large exposures received over a short period of time. The prompt effects most notable are radiation burns to the exposed skin and radiation sickness, which can be fatal. The severity of these immediate effects depend on the amount of radiation dose received.

15. Radiation Sickness

If a large dose of radiation is delivered to just one part of the body, like a hand, there would be localized burns, but the person would survive. However, if a large dose of radiation is delivered to the torso of the body in a short period of time, severe illness or even death can occur within a few days or weeks.

A dose of 100 rems or less delivered to the torso usually will not produce noticeable symptoms of illness. As the dose increases, symptoms such as nausea, vomiting, and perhaps diarrhea occur within a few hours after the exposure. These are symptoms of radiation sickness. The prompt effects of radiation doses greater than 100 rems are collectively known as radiation sickness. Two or three weeks later, other symptoms may appear such as loss of hair, loss of appetite, general weakness, a feeling of ill health, purple spots on the skin from internal bleeding, fever and continuing diarrhea.

Common Symptoms of Radiation Sickness

The prompt effects of radiation doses greater than 100 rems are collectively known as radiation sickness.
Skin Irritation
Nausea
Vomiting
Fever
Hair Loss
Radiation Burns
Continuing diarrhea
Gastrointestinal system effects

16. Principles of Radiation Protection

The three most important things to remember when working with or around nuclear gauges: time, distance, and shielding.

Time: The less time a person remains in the area of radiation, the less of a radiation dose that person will receive.

Distance: The intensity of radiation and its effects decrease sharply as you move further away from the radioactive source.

Shielding: Protective material placed between you and the radioactive source reduces the level of radiation passing through and thus the amount which you will be exposed.