Radiation Awareness Training

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Purpose

This training is intended for Clemson University Faculty, Staff or Students who do not work directly with radioactive materials or radiation producing devices. It will provide a general understanding about radiation, its risks, and uses on campus.

Radiation workers receive a much longer version of this presentation followed by an in-person session.
Radiation is energy. It can come from unstable atoms or it can be produced by machines. Radiation travels from its source in the form of energy waves or energized particles.

There are actually two kinds of radiation, and one is more energetic than the other. It has so much energy it can knock electrons out of atoms, a process known as ionization. This *ionizing radiation* can affect the atoms in living things, so it poses a health risk by damaging tissue and DNA in genes. While there are other, less energetic, types of *non-ionizing radiation* (including radio waves, microwaves—and visible light), this presentation is about ionizing radiation.
As scientists studied radioactivity more closely, they discovered that radioactive atoms are naturally unstable. In order to become stable, radioactive atoms emit particles and/or energy waves. This process came to be known as *radioactive decay*. The major types of ionizing radiation emitted during radioactive decay are alpha particles, beta particles and gamma rays. Other types, such as x-rays, can occur naturally or be machine-produced.

Scientists have also learned that radiation sources are naturally all around us. Radiation can come from as far away as outer space and from as near as the ground that you are standing on. Because it is naturally all around us, we cannot eliminate radiation from our environment. We can, however, reduce our health risks by controlling our exposure to it.
Types of Ionizing Radiation

Alpha particles (α) are positively charged and made up of two protons and two neutrons from the atom’s nucleus, as shown in the illustration at the right. Alpha particles come from the decay of the heaviest radioactive elements, such as uranium, radium and polonium. Even though alpha particles are very energetic, they are so heavy that they use up their energy over short distances and are unable to travel very far from the atom.

The health effect from exposure to alpha particles depends greatly on how a person is exposed. Alpha particles lack the energy to penetrate even the outer layer of skin, so exposure to the outside of the body is not a major concern. Inside the body, however, they can be very harmful. If alpha-emitters are inhaled, swallowed, or get into the body through a cut, the alpha particles can damage sensitive living tissue. The way these large, heavy particles cause damage makes them more dangerous than other types of radiation. The ionizations they cause are very close together--they can release all their energy in a few cells. This results in more severe damage to cells and DNA.
Beta particles (β) are small, fast-moving particles with a negative electrical charge that are emitted from an atom’s nucleus during radioactive decay. These particles are emitted by certain unstable atoms such as hydrogen-3 (tritium), carbon-14 and strontium-90.

Beta particles are more penetrating than alpha particles but are less damaging to living tissue and DNA because the ionizations they produce are more widely spaced. They travel farther in air than alpha particles, but can be stopped by a layer of clothing or by a thin layer of a substance such as aluminum. Some beta particles are capable of penetrating the skin and causing damage such as skin burns. However, as with alpha-emitters, beta-emitters are most hazardous when they are inhaled or swallowed.
Types of Ionizing Radiation

**Gamma rays** (γ) are weightless packets of energy called photons. Unlike alpha and beta particles, which have both energy and mass, gamma rays are pure energy. Gamma rays are similar to visible light, but have much higher energy. Gamma rays are often emitted along with alpha or beta particles during radioactive decay.

Gamma rays are a radiation hazard for the entire body. They can easily penetrate barriers, such as skin and clothing that can stop alpha and beta particles. Gamma rays have so much penetrating power that several inches of a dense material like lead or even a few feet of concrete may be required to stop them. Gamma rays can pass completely through the human body easily; as they pass through, they can cause ionizations that damage tissue and DNA.
X-rays - Because of their use in medicine, almost everybody has heard of x-rays. X-rays are similar to gamma rays in that they are photons of pure energy. X-rays and gamma rays have the same basic properties but come from different parts of the atom. X-rays are emitted from processes outside the nucleus, but gamma rays originate inside the nucleus. They also are generally lower in energy and, therefore, less penetrating than gamma rays. X-rays can be produced naturally or artificially by machines using electricity.

Literally thousands of x-ray machines are used daily in medicine. Computerized tomography, commonly known as CT or CAT scans, uses special x-ray equipment to make detailed images of bones and soft tissue in the body. Medical x-rays are the single largest source of man-made radiation exposure. X-rays are also used in industry for inspections and process controls.
Radiation can damage living tissue by changing cell structure and damaging DNA. The amount of damage depends upon the type of radiation, its energy and the total amount of radiation absorbed. Also, some cells are more sensitive to radiation. Because damage is at the cellular level, the effect from small or even moderate exposure may not be noticeable. Most cellular damage is repaired. Some cells, however, may not recover as well as others and could become cancerous. Radiation also can kill cells.

The most important risk from exposure to radiation is cancer. Much of our knowledge about the risks from radiation is based on studies of more than 100,000 survivors of the atomic bombs at Hiroshima and Nagasaki, Japan, at the end of World War II. Other studies of radiation industry workers and studies of people receiving large doses of medical radiation also have been an important source of knowledge.
Scientists learned many things from these studies.

The most important are:

• The higher the radiation dose, the greater the chance of developing cancer.

• The chance of developing cancer, not the seriousness of the cancer, increases as the radiation dose increases.

• Cancers caused by radiation do not appear until years after the radiation exposure. Some people are more likely to develop cancer from radiation exposure than others.
Radiation can damage health in ways other than cancer. It is less likely, but damage to genetic material in reproductive cells can cause genetic mutations, which could be passed on to future generations. Exposing a developing embryo or fetus to radiation can increase the risk of birth defects.

Although such levels of exposure rarely happen, a person who is exposed to a large amount of radiation all at one time could become sick or even die within hours or days. This level of exposure would be rare and can happen only in extreme situations, such as a serious nuclear accident or a nuclear attack.
Determining Radiation Limits

Current science suggests there is some risk from any exposure to radiation. However, it is very hard to tell whether a particular cancer was caused by very low doses of radiation or by something else. While experts disagree over the exact definition and effects of “low dose,” U.S. radiation protection standards are based on the premise that any radiation exposure carries some risk.
Radiation can only be used at Clemson University in rooms that are clearly marked with one of the following signs:
Radiation

Any tools or equipment used with radioactive materials, such as pipets, centrifuges or glassware, must be labeled with a smaller version of this sign and will be kept separately from non-radioactive versions.
All work with radioactive materials will be performed in clearly marked areas, and any waste generated will be placed in separate containers.
It is the responsibility of the radiation workers in the area to ensure they keep the work area free of contamination. This is accomplished by performing daily and weekly surveys whenever radioactive material is used.
Radiation

If you suspect an unsafe condition involving radiation or any other hazard, please contact the lab manager. The Office of Research Safety is always available to answer any questions or concerns you may have.
References:

http://www.epa.gov/radiation/docs/402-k-10-008.pdf