# RADIATION SAFETY NEWSLETTER

UK EH&S, Radiation Safety Office    March 2001    Vol. 03, No. 01

## RSO Column

*Please note: The Advanced Radiation Safety Course is now available on-line at the EH & S Website. This course is especially for new research faculty with previous training and experience. The Laser Safety Course is also available on-line.*

*Remember, Please: When a high radiation reading is received, an ALARA Response Form is sent asking for specific information. If you get one of these forms, please fill it out completely and return promptly. The information is needed to further evaluate the reading and make any needed corrections.*

*It is imperative that the Radiation Luxel badges be returned by the due date. Badges should be worn during the assign wear period printed on each badge and should only be worn by the individual whose name is printed on the front.* ***Under no circumstances should a name be taped over and reassigned.*** *Note: Yearly Exposure Records are in the process of being mailed. Please distribute to each individual for their personal records.*

*-Bob Wilson*

## Radioactive Waste Tips

By: Fred Rawlings and Cindy Aubrey

Dry waste with < 90 day half life must be segregated from longer lived materials. Tossing some waste contaminated with tritium into a P-32 drum can transform a $200 P-32 drum into a $2500 Tritium waste drum.

The information on waste tickets allows our staff to direct your radioactive waste to the appropriate waste stream according to regulations, as well as the most cost effective disposal method. The pH is always required for aqueous liquid in section F., in order to determine if it is basic or acidic enough to designate it as hazardous waste.

Listing the constituents in section F of the waste ticket allows our staff and our coworkers in Hazardous Materials to recognize hazardous materials in the liquid container. These constituents can be described in general terms, such as 'Aqueous Buffers' instead of chemical formulas or detailed brand names, as long as it is apparent that there is no hazardous component of the mixture.

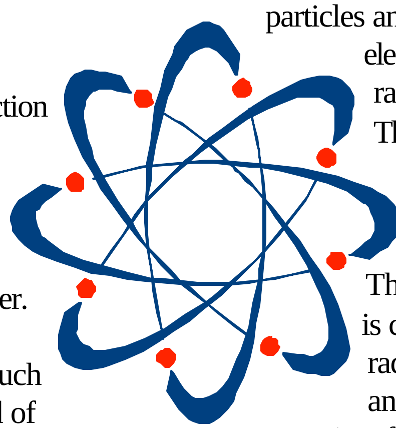
## Characteristics of Radioactive Materials, Part I

*By: Gerald Schlenker, Senior Health Physicist*

Radioactive materials have certain characteristics, such as the types of radiation(s) emitted and the rate of emission. Knowledge of these characteristics is helpful in establishing protective controls for the use of the material.

**Radioactivity**

A nuclide is an atom with a particular number of protons and neutrons in its nucleus. A radionuclide is a nuclide that has the property of spontaneously converting part of its mass into energy and emitting this energy in the form of energetic particles and electromagnetic radiation. The radionuclide emits radiation. This property is called radioactivity and the actual event is referred to as



radioactive decay, disintegration, or transformation.

For example, hydrogen-1 ($^{1}$H) is composed of one proton and one electron. This is normal stable hydrogen. $^{2}$H, (also called deuterium or “heavy” hydrogen) consists of one proton, one electron and one neutron. $^{2}$H is also stable. $^{3}$H, tritium, is composed of one proton, one electron, and two neutrons. $^{3}$H is not stable-, it is a radionuclide and a radioisotope of hydrogen.

When $^{3}$H spontaneously converts part of its mass into energy and emits this energy in the form of energetic nuclear particles, it yields helium-3, which is stable, plus energetic particles.

All radionuclides eventually decay to stable nuclides, but some undergo a series of decays before they reach the stable nuclide. Strontium-90, for example, is a radionuclide that decays into the radionuclide yttrium-90, which subsequently decays into the stable nuclide zirconium-90. This is a series decay with $^{90}$Sr being the “parent” and $^{90}$Y the “progeny” The process of radioactive decay is spontaneous and the time when a particle atom will decay is not known. However, when large numbers of radioactive atoms are present, the fraction of atoms that will decay in a given time span (the decay rate) can be specified. A quantity that uniquely identifies the rate of decay is the half-life of the radionuclide. This is the time required for one-half of the atoms present to decay. The half-life is a useful measure because no two radionuclides have exactly the same half-life. Also, the half-life is unaffected by the chemical or physical environment of the atom.

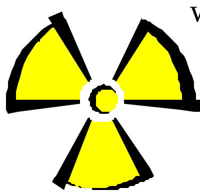
The quantity of radioactive material present at a given time is usually expressed in terms of the rate of decay at that time. For example, a vial may contain enough tritium to support $1x10^{10}$ disintegrations per second (d/s). The activity of the tritium at that time is therefore $1x10^{10}$ d/s. Two units of “activity” are the curie (Ci) and the Becquerel (Bq):

1 curie (Ci) = $3.7 \times 10^{10}$d/s. and
1 becquerel (Bq) = 1 d/s.

Thus, the vial contains $1x10^{10}$ Bq or 0.27 Ci of tritium.

**Radiation**

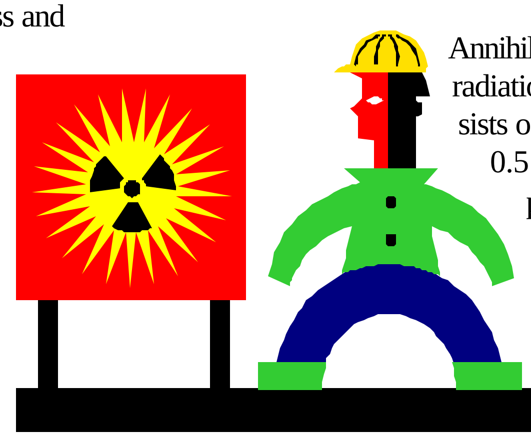
The manner in which a radionuclide



will emit radiation is well defined and quite characteristic. The term “manner” refers to the type, energy, and intensity of the radiation.

**The major types of radiation are**

**A** alpha particles - massive charged particles, identical in mass and charge with $^{4}$He nuclei, that are emitted from the nucleus with discrete energies (for example, $^{238}$U alpha particles).



**B** beta particles - charged particles that come in positive (positron) and negative (negatron) forms, have the same mass as an electron, and are emitted from the nucleus with a continuous range of energies up to some maximum energy. For example, $^{22}$Na emits positrons; $^{32}$P, $^{3}$H, $^{14}$C, and $^{35}$S, all emit negatrons.

**C** gamma rays -electromagnetic radiation emitted from the nucleus with discrete energies (for example, $^{131}$I, $^{125}$I, $^{57}$Co, $^{51}$Cr, $^{137}$Cs).

**D** x-rays -electromagnetic radiation emitted from the electron shells of an atom with discrete energies (for example, $^{131}$I, $^{125}$I).

Two other types of radiation are generated in the material surrounding the radioactive atoms rather than by the radioactive atoms themselves. These are external bremsstrahlung and annihilation radiation.

External bremsstrahlung consists of photons created by the acceleration of charged particles in the electromagnetic field of the nucleus. The photons are emitted with a continuous range of energies up to the maximum energy of the charged particle. For example, when phosphorous-32 ($^{32}$P) beta particles interact with certain materials, lead for example, significant external bremsstrahlung radiation fields can be generated.

Annihilation radiation consists of two 0.511 MeV photons formed by the mutual annihilation of a positive beta particle and an electron. For example, when sodium-22 ($^{22}$Na) positive beta particles interact with matter, annihilation radiation is emitted.

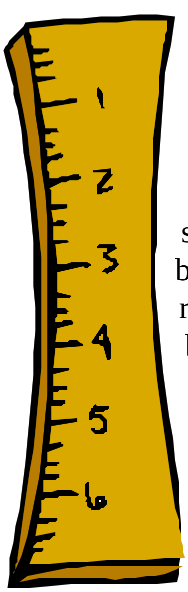
The energy of radiation is typically given in units of electron volts (eV), kiloelectron volts (keV) or megaelectron volts (MeV). The energy of a discrete radiation, such as gamma ray, may be expressed as "it emits a 1 MeV gamma ray." A similar statement for a continuous radiation, "it emits a 1 MeV beta particle," is ambiguous because it could be referring to a mean energy of the beta particle spectrum, etc. To avoid this problem, the energy must be specified in this way: "It emits a beta particle with a maximum energy of 1 MeV."

The intensity of a radiation is the fraction of all decays that emit a particular radiation. For example, every time a $^{3}H$ atom decays, it emits a beta particle with a range of energies up to a maximum energy of 18 keV. The intensity of this beta is, therefore, 100%.

*Next: Part II, Characteristics of Radioactive Materials*

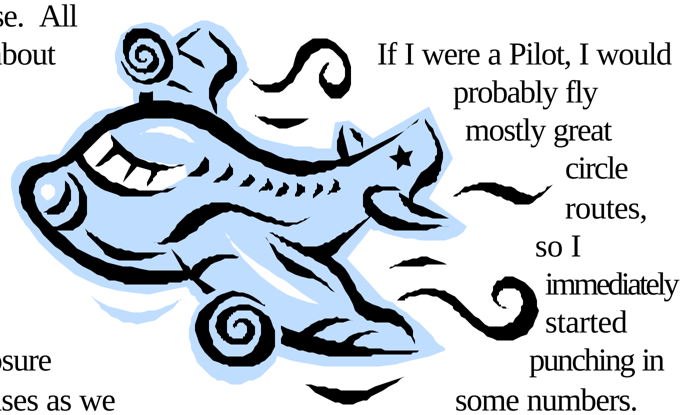
# The Five Mile High Club

*By; Fred Rawlings, Assistant RSO*





At each of our Radiation Safety Training Sessions, we lecture on the sources of background radiation that bombard each of us every day. In one short segment, we convey to the classes that galactic cosmic radiation streams down through the atmosphere to add one portion of our dose. All told, we receive about 250-300 millirem a year from background radiation just from existing on the surface of the planet.



The galactic exposure we receive increases as we increase altitude, since the layer of shielding air above us is decreasing. So, as we tell our classes, flight crews (and passengers) in planes are exposed to higher than normal radiation levels when they move above sea level, especially 30,000 feet above sea level.

When I went to the DOT website to search for *Radiation*, I thought I might get some hits on FedEx trucks dropping boxes of research materials. But when I found, *"A Computer Program for Calculating Flight Radiation Dose*," I couldn't pass it up. [www.cami.jccbi.gov/AAM-600/610/600Radio.html](www.cami.jccbi.gov/AAM-600/610/600Radio.html)

It turns out the FAA has released a computer program called CARI-5E that estimates the galactic radiation dose received on an "aircraft flying a great circle route between any two airports in the world." " Based on the date of the flight, appropriate databases are used to account for effects of changes in the earth's magnetic field and solar activity (heliocentric potentials) on galactic radiation levels in the atmosphere."

If I were a Pilot, I would probably fly mostly great circle routes, so I immediately started punching in some numbers. In June of 1994, I went from Louisville to Orlando. They don't tell you on SouthWest Airlines how high you are, (or how old the plane is for that matter), so I did some rough estimates. Seventeen minutes each to ascend and descend, at 2000 fpm, and 120 minutes at altitude.

At 31,000 feet, I got a dose of 0.71 millirem (minus the .04 millirem I would have gotten anyway at my desk). At 40,000 feet, it jumped to 1.34 millirem.

OK, so this calculator leads to some fiddling around with scenarios, but its not wasted taxpayers' money since it obviates the need for film badges to measure dose for people.

I looked up United Airlines, and they put about 35,000 of their employees in the air. At \$3 per film badge, four badges a year, that's \$420,000 a year. That's for only one airline. And, that's not counting lost badges and paperwork. With this program, their employees can look up their dose on a website for free.

At UK, we have BOTH lost badges and paperwork, so the cost for our 1200 badged people is $40,000 per year. So all of you UK Radiation Workers turn in your badges on time. And don't wear them on the plane.


References: Friedberg, W., Snyder, L., Faulkner, D. N., Darden, E. B., Jr. and O'Brien, K. *Radiation Exposure of Air Carrier Crewmembers II*, Federal Aviation Administration, Office of Aviation Medicine, Report No. DOT/FAA/AM-92/2. Available from the National Technical Information Service, Springfield, VA 22161. Order No. ADA245508 (1992).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