RADIATION REVIEW

UW - Madison Safety Department **Radiation Safety Program**

30 N. Murray St. **262-8769** **April 2000**

http://www.wisc.edu/safety **NRC License: 48-09843-18**

New CORD Fee at $33.25

CORD is a 128 Fund activity. Every year we provide the UW Administration our order estimates and they calculate our budget. It was no surprise when the accountant stated, "I'm finding the CORD rate is extremely sensitive to the number of orders. A decrease from the currently budgeted 5500 orders to the proposed 4900 in FY'01 increases the rate by about $4 per order in spite of the elimination of the PA position."

CORD was established as the UW's radioactive material purchasing agent in 1978. It is required to be self-funding. We have worked to make CORD cost effective. In 1992 CORD had 5.2 full-time employees. On 1 July, there will be only 3 full-time employees. We consolidated CORD's bookkeeping functions with ordering and receiving. Salaries and fringes are the only cost CORD has. To cover this cost, the administrator recommended, "... a rate of $33.25. That's the minimum rate that would cover your costs without generating a profit."

Biochemistry Addition Phone Numbers

Persons who work in the Biochemistry Addition have a long phone number; besides the phone number in the lab, most workers have an individual extension number. When completing a website CORD order, please provide this extension number as part of the phone number. That way CORD personnel can contact you if they have questions about the order.

Semester Training Schedule

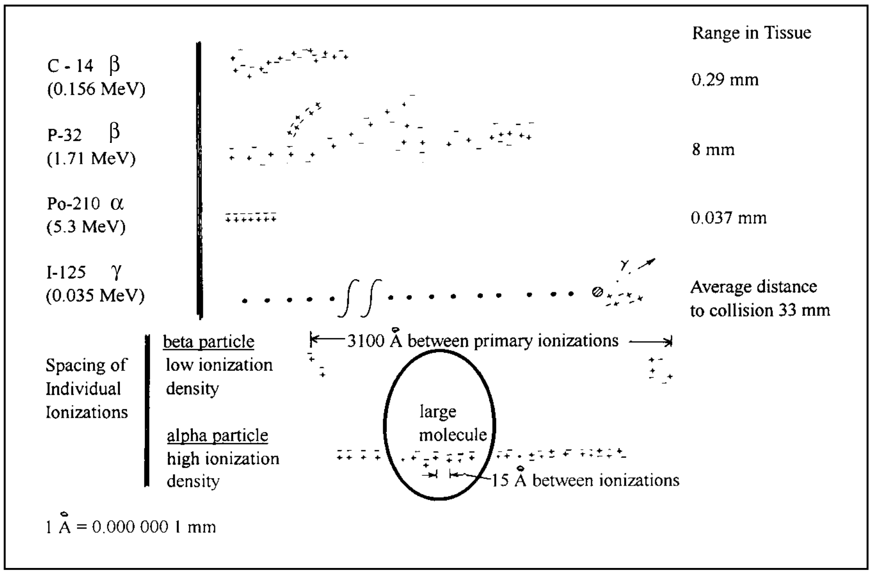
The training schedule from 15 April through 1 September at Union South beginning at 12:30: April 13, 19, 25; May 1, 12, 18, 24; June 6, 12, 23, 29; July 5, 11, 17, 28; and August 3, 9, 15, 21. There is no sign-up sheet; merely show up on one of the scheduled class dates. Booklets and schedules can be picked up at room 19, Biochemistry from 11 - 2:30. The quiz is given the last hour of the class and usually begins about 3:45 PM.

Liquid Waste Containers

Don't fill your liquid waste containers to the top; leave about 1 - 2 inches for expansion. Remember there is no charge for waste collection. An overfilled container is a potential accident.

Radiation Interactions

Radiation is energy in motion. Directly ionizing particles are charged decay particles (e.g., α and β from ^{32}P, ^{35}S, ^{210}Po, etc.) that produce ion pairs at small intervals along their path as a result of impulses imparted to orbital electrons. The impulses are exerted at a distance through electrical forces between the charged particles and the orbital electrons. An electron is held in the atom by electrical forces, and energy is lost by the beta / alpha particle in overcoming these forces. Because electrical forces act over long distances, the *collision* between a charged particle and an electron usually occurs without the two particles coming into actual contact (e.g., collision between poles of two magnets). The amount of energy lost by the charged particle depends upon its distance of approach to the electron and on its kinetic energy. In a very few instances, head-on collisions between the electron and the charged particle may occur resulting in a greater energy transfer than is normally seen. Because beta particles have the same mass as orbital electrons, they are easily deflected during collisions and thus beta particles follow a tortuous path as they pass through matter. Alpha particles interact in much the same manner, however because of their high electrical charge and relatively low velocity, they have a very high specific ionization, often on the order of tens of thousands of ion pairs per centimeter of air.



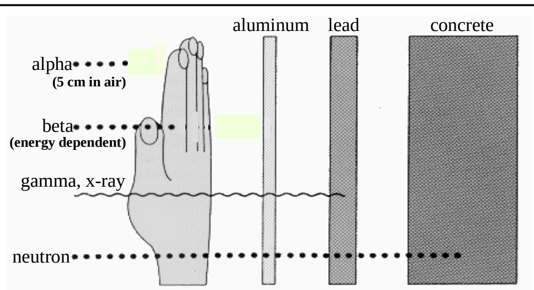
A charged particle possesses the energy required to produce ionization by virtue of its mass and motion (i.e., $E = ½mv^2$). As the radiation particles impart energy to the matter while penetrating, they lose kinetic energy and velocity decreases until they are finally stopped or absorbed (i.e., v = 0). The more energy they have to start with, the deeper they penetrate before they stop. The distance a particle travels until it comes to rest is called the range. The farthest depth of the particle's penetration in its initial direction of travel is the minimum amount of shielding thickness needed to stop the particle. The charged particles emitted from radionuclides have a limited energy range and are stopped in a relatively short distance.

In general, the range of a beta particle in air is 12 feet per MeV. Thus, the range of a ^{32}P beta particle (Emax = 1.71 MeV) is approximately 20 feet (e.g., 12 ft / MeV x 1.71 MeV = 20.4 ft). Additionally, the range of a ^{32}P beta particle in Plexiglas is approximately 0.8 cm (1/3-inch).

A major goal of radiation safety is to insure that most of the ionization that occurs from the deposition of ionizing radiation energy does not occur in either radiation workers or in the general public. However, this goal can only be achieved by carefully considering the range or penetrating power of each type of radiation and implementing a radiation-specific safety program.

Radiation which is sufficiently penetrating that it can deposit ionizing energy within healthy tissues deep in the body may damage these tissues and thus may carry more risk than radiation which can not penetrate. In assessing radiation work and a radiation lab, it is important to consider the two types of radiation hazards, external and internal.

An external radiation hazard is a type of radiation which has sufficient energy that, from outside of the body, it is capable of penetrating through the protective layer of the skin and deposit its energy deep (> 0.07 cm) inside the body. External hazards are type and energy dependent. There are three major types of external hazards: (1) x- and γ-rays, (2) neutrons and (3) high-energy ß particles (i.e., Emax > 200 keV or > 0.2 MeV). Each of these types of radiation is considered penetrating. Although high energy ß particles are capable of penetrating the skin, low energy beta particles (i.e., Emax < 200 keV) like ^{3}H, ^{14}C, ^{35}S, ^{63}Ni do not have a long range in air and do not have enough energy to penetrate the skin.



Because beta particles are not penetrating and deposit all of the beta energy within a few millimeters of flesh, it is important that you wear protective clothing (disposable gloves, lab coat), monitor the gloves frequently during your procedure and change them either when they are contaminated or periodically. Sometimes a glove may get a pinhole. For that reason, and depending upon the procedure being performed, it may be prudent to wear several (e.g., two or more) pairs of gloves, and dispose of the outer pair when contamination is detected.

The range of a beta particle depends upon the beta particle energy and the type of material it is passing through. Low energy beta particles do not penetrate. Thus, for ^{14}C and ^{35}S, a lab coat and single pair of disposable gloves will stop essentially all beta particles. For slightly more energetic (i.e., E_{max} ~ 250 keV) beta particles such as ^{33}P and ^{45}Ca, a double pair of disposable gloves will stop all beta particles. Because ^{32}P is so energetic (1.71 MeV), the best protective measures to use are shielding (1/3-inch Plexiglas) and distance (2 - 6 feet).

New Radiation Badges

During the past 10 years the UW has had 3 different vendors supplying radiation dosimeters (i.e., badges). Only one of those vendors gave us relatively good service, and during the last contract bid, they wanted $72,000 per year for that service. Of the other two vendors, one was so poor the UW canceled the contract midway through. The second vendor’s written reports are acceptable, but they have had some problems providing these exposure reports in a consistent and timely manner. Consequently the UW did not renew the contract for the period July, 2000 - June, 2001.

Rather than use another commercial vendor, the Medical School's Medical Physics Department proposed to provide dosimetry for a 10-year period. Having a UW department provide this service is a win-win situation for the UW. Not only is this cost effective, but it enhances the capabilities of that department to conduct research and provide educational opportunities for graduate students.

The transition period from our current vendor to the UW will occur over a 3-month

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period beginning 1 July, 2000. Initially, groups that receive dosimeters monthly will be converted to the UW dosimetry service. This is the smallest number of dosimeters, about 350 monthly whole body dosimeters along with about 100 collar and 100 ring dosimeters. This will enable Medical Physics to work out any ripples in their system. The groups that receive dosimeters on a quarterly basis (approximately 2000 workers) will be converted about 1 October.

There may be some confusion during this changeover as all parties involved (i.e., the badge wearer, the Safety Department, and the dosimetry provider) get used to a new system. However, we believe this change will be good for everyone.

One thing, dosimeters are expensive. The devices we will be using cost about $22 each. The UW is spending nearly $200,000 to buy an initial supply. Before any badge can be issued to a worker, it needs to be "read" to obtain a baseline for that badge. The UW is buying 2 badges for each worker so a worker can be wearing a badge while the other is being processed. Currently the cost for a lost dosimeter is only $6, essentially the cost of the two lithium fluoride chips used in the badge and the badge holder. However, the increased processing and replacement cost required for this new system means the cost that a lab group or department will need to pay for losing a dosimeter will be approximately $40. Because this charge is often paid with 144-funds, this "lost badge" charge is the exact replacement cost. For most research departments, this should not be a major issue, because most research groups are conscientious in collecting and returning dosimeters. The lost badge rate among research groups is only about 1% or perhaps 20 - 30 dosimeters per quarter.

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