RADIATION REVIEW

UW - Madison Safety Department | Radiation Safety Program
30 N. Murray St. 262-8769 | August 2000
http://www.fpm.wisc.edu/safety | NRC License: 48-09843-18

Dosimetry Change

Radiation dosimeters (i.e., radiation safety badges) are provided free of charge to radiation workers who expect to handle external hazards (i.e., ^{32}P) in quantities exceeding 1 mCi. Currently the service is contracted with an outside vendor. The UW will be changing the dosimetry provider about 1 October. As part of the change, the Safety Department will no longer be responsible for exchanging dosimeters, rather we will only administer the program. This change will provide more responsive, expert service and it will save researchers' money. This is because 1/2 of the salary for the person who was processing dosimeters was paid from your CORD fees. By changing the program CORD saves approximately $15,000 a year. **Because there will not be a dosimetry person, we set up an email account for you to use: dosimetry@fpm.wisc.edu. Use the email address for any dosimetry questions you have. We have included blank application and lost badge forms on our Radiation Safety web site.**

Training (through 31 December)

The training schedule from 1 August through 31 December includes 2 morning (8 AM) classes at Union South (1 Sept, 2 Oct). The remainder of the classes are held at Union South beginning at 12:30 on August 3, 9, 15, 21; September 7, 13, 19, 25; October 6, 12, 18, 24; November 3, 9, 15, 27; and December 7, 13, 19. There is no sign-up; merely show up on one of the class dates, booklets can be picked up at room 19, Biochemistry from 11 - 2:30. The quiz is given the last hour of the class (usually beginning about 3:45 PM).

Get Your Own Radiation Review

If you would like to receive your own copy of the Radiation Review newsletter, email your name and campus address to rnorth@fpm.wisc.edu or call Ralph at 2-1524.

Radiation Safety Basics

We have always contended that, in practice, radiation safety is merely the application of a few basic procedures like wear good gloves, use a meter, dispose of waste frequently, etc. I thought we could take a minute to look at the safety behind some of these.

WEAR 2 PAIR OF DISPOSABLE GLOVES

Disposable, protective gloves are worn in laboratories to protect you from potentially hazardous compounds and to reduce the risk of ingesting or absorbing these compounds as a result of contaminated hands. Hand-to-mouth procedures are risky. Workers should always remove protective gloves and wash hands before leaving the lab for breaks, etc. With radioactive material work, 2 pair of gloves are normally worn and the outer pair is frequently checked for radioactive contamination and changed as needed.

Additionally, protective gloves are capable of stopping many low-energy beta particles. The range of a beta particle depends upon the beta particle energy and the type of material it is passing through. Most beta emitters deposit all of the beta energy within a few millimeters of flesh. Low energy beta particles are very short range and do not penetrate the skin's protective layer. 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. It is important that you wear protective clothing (disposable gloves, lab coat, safety glasses), 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) pair of gloves, and dispose the outer pair when contamination is detected.

Remember betas are true particles, they do not penetrate very deep in matter. Most beta particles used on campus require no shielding outside of protective clothing. Low energy beta emitters (i.e., E_{max} < 200 keV), specifically, ^{3}H, ^{14}C, ^{33}P, ^{35}S, and ^{45}Ca will not penetrate disposable gloves. Because a few ^{32}P beta particles can penetrate to a maximum depth of 8 mm in tissue, ^{32}P and other high-energy pure beta emitters are usually shielded using Lucite or plastic.

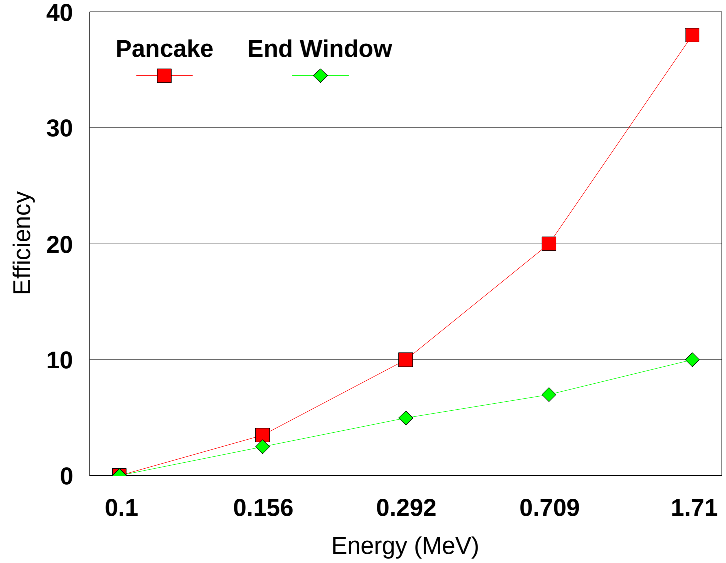
USE 1/3 INCH PLASTIC / LUCITE TO STOP HIGH ENERGY BETA PARTICLES

None of the pure beta emitters used on campus will penetrate more than 1/3-inch of lucite or plexiglass. For the majority of beta emitters (^{3}H, ^{14}C, ^{33}P, ^{35}S, ^{45}Ca, etc.), no shielding at all is required, but for ^{32}P additional shielding is useful. The maximum range of ^{32}P beta particles in lucite is only 7 mm (0.27 inches). Thus 1/3 inch of plastic can be use to stop the beta particles.

Do not use lead to shield pure beta emitters (e.g.,^{32}P). While lead will stop the beta particles, some relatively high-energy x-rays are produced in the lead, so using lead changes radiation producing a skin dose into one producing a whole body dose. With lead, the number of these x-rays produced is almost 5% of the number of betas emitted, so if 100 microcuries (222,000,000 beta particles per minute) are shielded with lead, approximately 11,100,000 x-rays per minute are produced with energy ranging up to 1.7 MeV. Gamma rays are more penetrating than beta particles. The thickness of lead required to stop them is related to the energy of the gamma ray. For example, 1/8" of lead will stop nearly all (>99.99%) of the 35 keV gamma-rays from ^{125}I while 2½" of lead will only stop 99.9% of the 1000 keV gamma from ^{86}Rb.

PANCAKE GM DETECTORS ARE BETTER

We use Geiger counters for detecting beta emitters. There are two types of GM detectors, end-window and pancake tubes. As you can see from the graph, the pancake tube is better at detecting beta particles than an end-window. This is due to several factors. First, the pancake tube covers about 3 times the area that an end-window covers, so it can detect more contamination per unit area in one pass. The electronics inside the tube also make detecting more efficient. A listing of good survey meters is on the Radiation Safety Office web page (http://www.fpm.wisc.edu/safety/Radiation/meters.pdf). We recommend that a lab buying a new meter system or replacing a detector purchase a pancake detector.



6-FOOT RULE

Radiation intensity decreases with distance. For x- and γ rays, the exposure at 2 feet is 1/4 (25%) the exposure at 1 foot and at 6 feet the exposure is 1/36 (3%) the exposure at 1 foot. The unshielded exposure at 1-foot from a 5 mCi vial of ^{51}Cr is 0.82 mR/hr and at 6-feet it is only 0.022 mR/hr. Thus, to reduce your exposure when you do not need to handle your samples (e.g., thawing, mixing, spinning, etc.), stand back about 6 feet.

Remember, the beta particles from low energy beta emitters (^{3}H, ^{14}C, ^{33}P, ^{35}S, ^{45}Ca, etc.) only travel a maximum of 20 inches in air [and less than 0.02 inches in plastic], and most of the beta particles travel less than 8 inches in air.

DOSE @ 2" FROM STOCK VIAL

Within their range, the inverse square law can be applied to high-energy beta particles. For small (i.e., point) sources, the law can even be used at close distances. If the count rate 1/2-inch (1 cm) from a vial / tube of ^{32}P is 40,000 cpm, then at 2 inches it will only be about 2500 cpm. Thus, even at short distances such as handling vials / tubes, distance can be used with several pair of disposable gloves to reduce skin dose.

HOW MUCH RADIATION IS 1 MREM?

Many workers ask what the correlation is between the radioactivity they are working with and their radiation exposure. When they use a meter they get a lot of clicks on the speaker and they believe they are being exposed. First let me tell you, it is not that easy to correlate the two. Second, the quantities and types of radioactive material used by most researchers do not present any measurable radiation dose, regardless of the number of clicks. Lets look at this based upon the types of radiation (e.g., beta, gamma) used in research. *(Continued on page 4)*

Gamma rays are emitted from nuclides such as ^{51}Cr and ^{125}I (^{86}Rb emits both a beta particle and a gamma ray). Exposure here is pretty easy to determine. Even though all UW survey meters are calibrated to respond in count-per-minute (cpm) units, each survey meter has a calibration sticker, which indicates the conversion factor for gamma-ray exposures. This is stated: "@ Cs-137 energy: xxxx cpm / mR/hr." On Geiger counters, this value will often be in the vicinity of 2000 cpm / mR/hr. To determine exposure to you, simply hold the detector where you would be standing, measure the number of cpm indicated and divide by the conversion factor. Thus, if your meter reads 1000 cpm from an 125I stock vial, the exposure is approximately 0.5 mR/hr and you would need to stand at that spot for 10 hours to receive a 5 mrem dose. This is a very small dose, about what you receive from natural background every week. A milliroentgen-per-hour is nearly equivalent to a mrem-per-hour. Limits for whole-body exposure for radiation workers is 5000 mrem per year and for pregnant workers is 500 mrem for the gestation period. Remember to make the measurement where you are standing since gamma ray exposure is a whole body exposure.

Beta particles are emitted from nuclides such as ^{3}H, ^{14}C, ^{33}P, ^{32}P, ^{35}S, and ^{45}Ca. Most of the beta particles used here are not external hazards. In fact, only ^{32}P is of concern for beta exposure and, for ^{32}P, that absorbed dose is only to the first 5 mm of tissue. To estimate this skin dose, again refer to the calibration sticker and your meter's efficiency for ^{32}P. Suppose, for example, the efficiency is 20%. The ^{32}P skin dose is 60 mrad/hr per microcurie (1 millirad ≈ 1 millirem). Thus, if a spot on your gloves reads 50,000 cpm, this is equivalent to about 250,000 dpm and, because 1 microcurie = 2,220,000 dpm, is about 0.1 μCi. This will deliver a dose rate of about 6 mrad/hr (.1 μCi * 60 mrad/hr per microcurie) to the skin directly under the glove (Beta radiation is not a whole body exposure). If you are wearing 2 pair of gloves, the dose would be less, perhaps 4 mrad/hr. For this reason we remind workers to always have a meter turned on when working with radioactive materials and frequently check your gloved hands for contam-ination.

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