RADIATION REVIEW

UW - Madison Safety Department | Radiation Safety Office
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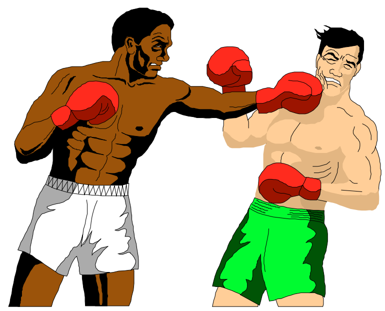
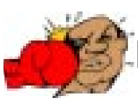
One-Two Radiation Safety Requirements



One researcher recently chastised me for being too wordy during the newsletter. Said, "I have so many demands on my time that I just want to know the basics." The basics follow the old one-two of boxing:

Perform radiation surveys

monthly

 Keep inventories current

If you want to know more, continue reading:

SURVEY
Of the two, surveys are the most important for personal safety and well being. Radiation and radioactive contamination are not detectable with your 5 senses. You need to use a survey meter to check for contamination either on your person or in your work area immediately after use. Being good is no guarantee. Working with only a small quantity does not protect the University from citations in the event of a spread of contamination from your lab.

Each PI is responsible for doing monthly surveys and documenting results in all of the labs in which they are authorized to use radioactive material. There are a few exception conditions to ease this burden. However the PI must request the exception. Examples of exceptions are found in Section IX of the University Radiation Safety

Regulations and include semiannual surveys for counting rooms and storage of nuclides, contamination limits for chronically contaminated equipment, etc.

A survey consists of a meter and wipe survey. The meter survey is a relatively cursory check to determine radiation levels and possible contamination. With a meter, the action level is 650 cpm. Counts above this value require decontamination/mitigation (e.g., disposal, shielding).

The wipe survey attempts to remove contamination. Not all contamination is easily removed, some may have leached into the surface. Depending upon isotope, the action level is either 770 cpm (^{3}H, ^{14}C, or ^{35}S) or 230 cpm (^{32}P, ^{33}P, ^{45}Ca, ^{51}Cr, ^{125}I) per 100 cm^2. Removable contamination above these limits must be cleaned up, another wipe survey performed and posted with the monthly survey results.

Inventory

Each PI is accountable for all the radioactive material they have received, used, and disposed. CORD maintains the UW's consolidated inventory (by PI and isotope) based upon the activities received minus the activities disposed. By performing frequent disposals, you can be sure that the lab's on-hand activity is kept low and the risk of losing material is low. Note that your balance for the isotope received appears on the RSR form.

Beta Skin Exposure

Most (80 - 85%) of the research work on campus uses beta emitting radionuclides. Beta particles are not penetrating. For example, a beta emitted from ^{35}S will only penetrate 0.3 mm of skin and one from ^{32}P will only penetrate 8 mm. Thus the only tissue subject to radiation damage from beta particles is the skin. Because the skin is less sensitive to radiation injury the limit for skin exposure is 50 rem per year, 10 times the limit for whole body exposure.

However, on the negative side, because all of the energy of the beta particle is absorbed within approximately ½ centimeter of flesh, the dose from even a small drop of concentrated activity may be quite high.

Table 1 lists skin exposure rate (rem/hr per µCi) estimates from commonly used beta-emitting radionuclides (^{3}H is not an external hazard, the energy is too low to even penetrate the dead layer of the skin). For example, if you had a 1 µCi drop of ^{32}P on your skin for 1 hour, the immediate square centimeter of skin would receive an exposure of approximately 6.0 rem.

Radionuclide	max Energy (MeV)	Skin Dose rem/hr per µCi
^{14}C	0.156	0.97
^{35}S	0.167	1.07
^{33}P	0.249	2.76
^{45}Ca	0.258	2.85
^{32}P	1.709	6.00

Table 1 Skin Exposure Rates from Selected Beta Emitters

Furthermore, the time needed to exceed the annual skin dose limit for just 1 µCi of ^{32}P contamination for a 1 cm^2 skin area is only about 8.4 hours.

This is the reason we require every lab that uses beta emitters to have a calibrated, thin-window GM. Without a GM, you will never know that you have skin contamination creating either a dosimetry problem or a contamination problem.

Use ___CPM___ scale only. Cal Date: __7/18/xx__
Window: _Fixed_ Beam ___⊥___ to probe center.
Battery: __O K__ Check Source: __1500__ CPM

Isotope:	C-14	Tc-99	Sr-90
Efficiency:	10%	33%	47%

@ Cs-137 energy: __2400__ cpm / mR/hr
DO NOT USE __**mR/hr**__ SCALES
UW Safety Dept. Calibration Lab 262-8769

All of the meters used on the UW are calibrated with 3 different energies of beta particles; the efficiency of the meter for each is then listed on the calibration sticker. You can use the calibration information and the count rate from your meter to estimate activity and to make a cursory estimate of skin dose.

Recall that a 10% efficiency means that the true activity is 10-times greater (i.e., dpm = cpm/eff). Table 2 below provides a conversion relationship for the meter used in this example. (You would need to make a similar table for each of your meters).

Radionuclide	GM efficiency	GM Response cpm per µCi
^{14}C	10%	220,000
^{35}S	10%	220,000
^{33}P	35%	777,000
^{45}Ca	35%	777,000
^{32}P	47%	1,043,000

Table 2 - GM Efficiency and Response

The assumption is that approximately 1 square centimeter is contaminated. This can be used to calculate maximum skin doses from contamination.

For example, a ^{32}P user detects a small contamination spot on his wrist of about 100,000 cpm after working with the ^{32}P for about ½ hour. What is the dose (in mrem) to the skin, assuming the worker spilled the ^{32}P at the beginning of the procedure? Gather the information from the two tables and plug it into the equation:

$$dose = 100{,}000\ cpm \times 0.5\ hr \times \frac{1\ \mu Ci}{1{,}043{,}000\ cpm} \times \frac{6.0\ \frac{rem}{hr}}{1\ \mu Ci} = 0.288\ rem$$

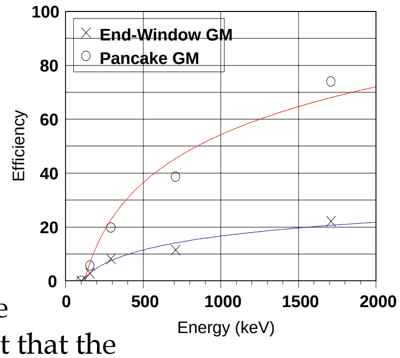
PROTECTIVE MEASURES

Because of the potential to deposit all of the beta energy within a few millimeters of skin, 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, it may be prudent to wear two pairs of gloves, and dispose the outer pair when contamination is detected.

The range of a beta particle is dependent upon the beta energy and the material it is passing through. For ^{14}C, ^{35}S, ^{33}P, and ^{45}Ca, a double pair of disposable gloves will stop all beta particles. A single pair of disposable gloves stops only about 30% of the betas. Because ^{32}P is so energetic, the best protective measures are to use distance and shielding.

GM SURVEY METERS

Not all GM meters are equal. The best kind of GM tube to get is a pancake type probe. This type of detector is approximately two times as sensitive for beta particles as the end window GM. The reason for this is probably the large surface area and the fact that the electric field inside the tube is more uniform than in the end window.



The graph compares the response of two identical meters, one with an end-window and one with a pancake probe. From the results of this graph it is obvious why the Safety Department recommends all labs have a pancake type GM probe. You can find information on purchasing GM meters and probes on the Radiation Safety Web Page, http://www.wisc.edu/safety.

Summer Training Schedule:

Two classes will be in **Rm 1, Biochemistry**: **11 and 17 June**.
Two Classes will be in the morning (8:00) at Union South**: 22 June, 6 July**.
The remainder of the classes are held at Union South beginning at 12:30. The dates are: **May 21, 28; June 5, 23; July 1, 9, 17, 23, 30; August 5, 11, 17, 25; September 2, 10, 18, 24.**
Our web page has the complete schedule.

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