

RADIATION REVIEW

UW - Madison Safety Department
103 N. Lake St. 262-8769

Radiation Safety Program
July 1995

Universal Meter

Labs should use a survey meter for contamination surveys after each procedure and for required monthly surveys. The best meter for beta emitters is a thin-window (pancake-type) GM detector with a speaker while a NaI detector is best for low-energy gamma (LEG) emitters. If a lab uses both beta and gamma emitters, they usually buy 2 meters; one for beta and one for gamma. We recently purchased a meter which is sensitive to both types of radiation. It is a Ludlum Model 3 (with model 202-2 cpm dial) and a Model 44-21, β - γ Sandwich Detector that is both a beta scintillator and a NaI (LEG) scintillator. It is more sensitive for $^{14}\text{C}/^{35}\text{S}$ than a GM, about equally sensitive to ^{32}P and about 10% less sensitive for ^{125}I . The cost of this meter, \$765, is about the same as the cost of an Eberline E-120 with HP-260 (pancake) probe and speaker. If you will be using both beta and gamma or desire enhanced sensitivity for low-energy beta emitters like ^{14}C , ^{35}S , ^{33}P , we recommend you consider this system.

Beta Particle Decay

Most research on campus uses beta emitters such as ^3H , ^{14}C , ^{32}P , ^{33}P , ^{35}S , and ^{45}Ca . The energy of these beta particles is usually listed as the maximum energy

possible for the decay, E_{max} . However, remember that fewer than 1% of the beta particles are ever emitted at E_{max} . In beta decay, the beta particles are emitted in a spectrum of energies from essentially 0 keV to E_{max} . The majority of the particles are emitted at approximately $1/3 E_{\text{max}}$. Thus, for ^{32}P , $E_{\text{max}} = 1.71$ MeV while the most likely / most probable energy (E_{mp}) of these betas is 0.57 MeV (570 keV); for ^3H , $E_{\text{max}} = 18.6$ keV and $E_{\text{mp}} = 6.2$ keV; and for ^{14}C and ^{35}S , $E_{\text{max}} \gg 160$ keV and $E_{\text{mp}} = 53$ keV.

Contamination Prevention

Contamination is the single biggest potential problem when using radioactive tracers. It is prudent to consider everything that comes into contact with radioactive materials to be contaminated.

Many labs use eppendorf pipettes and pipette tips. When initially bought, some of these pipettes had auto eject mechanisms to help remove the pipette tip. If the ejector breaks, labs may be reluctant to discard a \$300 piece of equipment, so workers often take the tips off by hand. This can lead to contamination. A microdrop of radioactivity may remain on the pipette tip and can contaminate the workers' gloves when they remove the tip.

Contamination (cont.)

Cross contamination occurs when the worker next handles a sample tube with those contaminated gloves. Before long, the entire work area may be contaminated.

A solution to this problem is to have a thin-window GM on hand and operating when working with beta emitters. After every instance when handling samples or pipette tips, check gloved fingers and the palm of your hand for contamination. If detected, replace the glove with an new, uncontaminated one. Other solutions include: use a small piece of absorbent paper when removing the pipette tip, use pipettors with broken ejectors for non-radiation work, designate a functioning pipette with an ejector for radiation work.

Small Spill Notification and Decontamination Techniques

When a small spill occurs in the lab: confine the spill, secure the area, notify others in the lab (and your PI), and devise a plan to decontaminate the spill. If you need assistance, call Radiation Safety at 262-8769. Each lab has a phone list of Radiation Safety personnel to be used for daytime and after-hours problems. Locate this list and use it if needed.

Workers ask how to decontaminate spills and whether there is special decontaminating solutions. The decon-taminating solution used often depends on the isotope involved. Remember the principle involved in decontamination is to first surface the contamination with some surfactant (e.g., high phosphate soap, etc.) and wipe it up with absorbent material. Count-Off[®] is good, but it is also expensive. Some of the more modern cleaners (e.g., Dow Bathroom Cleaner[®]) may also work well. Additionally, for spills of ³²P, ³³P, and ³⁵S, dilute acids (e.g., acetic acid or vinegar) are effective. The only caution when using reactive chemicals is to be careful and insure no reaction will occur which will produce an airborne (vapors, gases, dusts, etc.) radio-active hazard.

For spills, first identify and delineate the contaminated area. Except for ³H which can be

detected by using an LSC, use a thin-window GM and mark all contaminated areas, that is, areas with count rates above 650 cpm/100 cm². Select the appropriate decontaminant, pour some on the spill, wait one or two minutes, wipe off, throw wipe in radioactive waste container and re-survey.

If count rates decrease but are not below 650 cpm/100 cm², continue decontaminating until 650 cpm is reached. With tile floors, often the tile may be cleaned to 100 - 200 cpm, while the cracks still show 2,000 - 4,000 cpm. At this point, covering the area with plexiglas shielding may be appropriate.

Radioactive Waste

Many labs hold their waste for decay and disposal to normal trash. At one time Radiation Safety may have encouraged this type of disposal to save space in the waste facility. Now we **do not** encourage decay disposals for several reasons: (1) it often leads to inventory and accountability problems, (2) ambient radiation levels in the lab are in-creased, (3) there is a risk of losing materials.

Requirements for decay disposal are complex. Documentation for each container must include: isotope, date box was sealed, date package surveyed (must be 10 half-lives between these two dates), make/model/SN of meter and type of probe used in survey, background count-rate (cpm), package count-rate (must be less than 100 cpm for disposal as ordinary trash), deface all yellow/red radioactive warning labels. Additionally, CORD must be informed quarterly of any decay disposals using a Waste Disposal form.

Why do all that work when Safety will take your radioactive solid, liquid, and animal wastes free (there is a \$6 or \$30 per case processing fee for sewer disposable and non-sewer disposable LSC vials)? The lab seals and labels the box, writes the activity disposed on the Radioactive Waste Disposal form (just as you would need to do for a decay disposal) and calls Safety.



CORD Fee

All orders for radioactive materials are assessed a CORD fee. Many view this fee as anathema. The Safety Department has continually lobbied, albeit unsuccessfully, to have the CORD function funded from University funds. CORD is a benefit because of the volume discount on radiochemicals obtained from the vendors and the savings to researchers from not having to comply with package receipt and survey regulations.

This fee is currently \$23 per item. It pays the salaries and fringe benefits of approximately 5 workers. Unfortunately, this fee doesn't meet expenses and CORD is losing about \$20,000 annually. We will try to absorb this loss by reducing the CORD workforce rather than raise the fee and will attempt to do current tasks with reduced staff. The alternative would be a fee increase of at least \$3.

Liquid Scintillation Counters (LSC)

Many researchers analyze radiation samples on LSC. These systems are highly efficient in quantifying low-energy beta emitters (e.g., ^3H , ^{14}C , ^{35}S , ^{45}Ca , ^{33}P) and some gamma emitters (e.g., ^{125}I , ^{51}Cr). However, as with any piece of equipment, users must understand how the LSC operates.

An LSC is simply a multichannel analyzer with 4000 channels. Radioactive decay produces an electrical pulse that is proportional to the decay energy (e.g., the pulse from a 1,700 keV ^{32}P beta particle is about 100 times bigger than the pulse from a 18 keV ^3H beta particle). In each channel the LSC stores a number corresponding to the number of (energy) pulses (counts) detected. The output of the system is the sum of the counts in a selected energy region.

Some LSCs select the regions of interest by entering the keV range of interest. Others offer several options (channel or keV). For Packard Tri-Carb 1600 and 1900 systems, a user selects energy regions. The channels correspond to energy in 0.5 keV increments; that is, each of the 4000 channels are $\frac{1}{2}$ keV wide, and the system can detect energies from 0 to 2000 keV. If you are using a Beckman, the channel option is usually

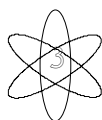
the default option. Beckman uses 1000 channels and the energy is related to the channel by the equation:

$$\text{Channel \#} = 72 + 280 \log_{10}(E_{\text{max}})$$

where E_{max} is in keV. Thus, the maximum channels for ^3H , $^{14}\text{C}/^{35}\text{S}$, and ^{32}P are 427, 686/691, and 977, respectively.

Recently we have seen unusual results from many LSCs used for contamination surveys. In one instance, a lab was counting for ^{32}P with negative results, but many samples exhibited between 100 - 500 cpm in the tritium (^3H) channel and the lab did not use any ^3H .

^3H can not be detected with a geiger counter and has a low (approx. 30 - 40%) efficiency in a LSC because the beta is emitted with very low energy, E_{max} 18.6 keV and $E_{\text{mp}} = 6$ keV. Unfortunately, the energy region between 0 - 6 keV is where all system noise (e.g., chemiluminescence, electronic noise, etc.) pulses occur. High counts in this lower region may indicate that the lower level discriminator is set too low, has drifted too low, there may be some contamination, or perhaps the coincidence gate used to reduce this noise is not functioning properly. At the Safety Department, we often set the lower level window to 2 keV. This may reduce ^3H counts by about $\frac{1}{4}$, but it also reduces system noise. The corresponding lower channel in a Beckman would be about channel 150 (e.g., count ^3H between 150 and 430; $^{14}\text{C}/^{35}\text{S}$ between 150 and 690; and ^{32}P between 150 and 980).



8 Sep - 8 AM	3 Nov - 8 AM
13 Sep - 8 AM	9 Nov
21 Sep	16 Nov
28 Sep	24 Nov - 8 AM
5 Oct	30 Nov
13 Oct - 8 AM	6 Dec
19 Oct	12 Dec
26 Oct	20 Dec

Training

The table lists Radiation training dates through Christmas. All radiation worker training classes will be conducted in Biochem Rm. 1B beginning at 12:30 PM except for those dates indicating 8 AM. Call Radiation Safety at 2-8769 or 5-5241 or go to Biochemistry, Room 19 to get a copy of the *Radiation Safety for Radiation Workers* booklet before the training class.

Videos

The Safety Department has many training videos dealing with various Radiation Safety topics. We recently received several very good (Hughes Institute) short (10 min.) VHS tapes you may find useful. If you would like to view any of the videos dealing with radiation and radiation safety call 2-9748 and ask for Abdul.

Radiation Badges

We have a new dosimetry contract. To keep costs down, we will review each lab's use of materials. Labs using low energy betas (^3H , ^{14}C , ^{35}S , ^{45}Ca , ^{33}P) or small quantities of ^{32}P may be asked to discontinue dosimetry. Our goal is to remain within 10% of 2170 whole body and 970 rings quarterly. When a radiation worker leaves, or stops using radiation, call Sharon (2-7530) to drop their badges. Lost and late whole body badges will cost the lab \$6.00, while rings cost the lab \$2.00.

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