RADIATION REVIEW

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

30 N. Murray St. **262-8769** **July 1999**

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

University of Rochester Contamination Incident

I read a nice article about a ^{32}P spill at Rochester. Excerpts include: "This spill took place ... on Wednesday. Immediately following the spill, the researchers attempted decontamination but ... failed to properly monitor decontamination efforts and left the spill area and room unposted and unattended." "The most highly contaminated areas were associated with what appeared to be liquid residue ... In the vicinity of the fume hood. ... (and) could not be measured because the survey instrument would not register more than 500,000 cpm."

It seems strange that the only spills you hear about concern ^{32}P. Probably because ^{35}S spills often go undetected. The things to remember: (1) Always have a GM nearby when working with beta emitters. (2) Always survey the immediate area when work is completed. (3) If you have a spill and clean it, meter the area.

The most likely scenario for this spill is that the worker simply wiped it clean and figured it was decontaminated. You can not see contamination, only a meter survey and wipe test will verify decontamination efforts. The UW's meter action level is 650 cpm.

Moving

Labs often move from one building to another. Radioactive material can not be transported in vehicles by movers. The Department of Transportation requires shipping papers for all "Hazardous" materials. The paperwork is different for radioactive waste than for radioactive materials. You will also need to do final surveys on the old labs and add the new labs to your listing on CORD. For assistance in moving the radioactive material and updating CORD, call Jeff Orwin at 2-3278.

X-ray Machine

Do you have a new device in your lab capable of producing x-rays (e.g., electron microscope, x-ray diffraction, bone densitometer, cabinet x-ray machine)? The State requires that all such devices be registered with the Department of Health and Family Services. Contact Arnold Jansen, 2-9608. He will do the paperwork and will perform any radiation surveys you desire.

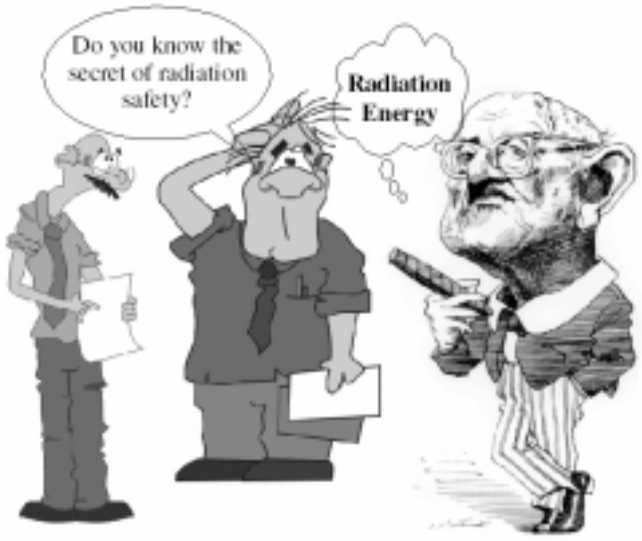
Radiation Safety

Many people may think that radionuclide work is complicated. For example, there are over 50 radionuclides routinely used on campus and perhaps at least 100 - 150 common research nuclides. Each of these nuclides emits one or several different types of radiations at different energies, decaying with a different half-life. But, you don't have to try to memorize facts, rather understand the underlying system. The key is radiation energy. Once you know that, the rest is application of a few basic principles. The table describes range (or penetrability) of the common beta particles and gamma rays.

Nuclide	Half-Life	Radiation	Energy, MeV	Shielding	Efficiency
^{3}H	12.3 yr	ß-	0.0186	none	40% - LSC
^{14}C	5730 yr	ß-	0.157	none	10% - GM
^{32}P	14.28 day	ß-	1.709	1/3" Lucite	45% - GM
^{33}P	25.3 day	ß-	0.249	none	15% - GM
^{35}S	87.2 day	ß-	0.1674	none	10% - GM
^{45}Ca	162.7 day	ß-	0.258	none	15% - GM
^{51}Cr	27.7 day	ϒ	0.32 (9.8%)	1" lead	10% - LEG
^{86}Rb	18.66 day	ß- ϒ	1.774 1.076 (8.8%)	2½" lead	45% - GM
^{125}I	60.1 day	ϒ	0.0355	⅛" lead	50% - LEG

Beta particles are true particles. Therefore, 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; ^{32}P will penetrate to a maximum depth of 8 mm in tissue. Any other pure beta emitter routinely used (e.g., ^{32}P) is shielded using a Lucite or plastic. This is then related to the ease of contamination detection. Because ^{32}P is higher in energy than ^{35}S, it is easier to detect.

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. Thus ^{125}I gamma at 35 keV only requires ⅛" lead while the 1000 keV gamma from ^{86}Rb requires 2½" lead.



An example of applying this to an unknown isotope: Consider ^{36}Cl. This decays by pure beta emission, maximum energy 0.709 MeV. Shielding is done with Lucite, ¼" should be sufficient. Detector efficiency, about 30% with a GM.

Another example, consider ^{22}Na. The literature indicates this is a beta/gamma emitter; emitting a positron (β+) 90% of the time with a maximum energy of 0.545 MeV and a gamma ray of 1.274 MeV. All positron radiation also results in two 0.511 MeV photons, however, shielding the 1.274 MeV gamma will also shield most of the annihilation photons. Shielding is done with lead, about 2 ½ - 3" should be sufficient. Detector efficiency, about 25% for the 0.545 MeV beta with a GM.

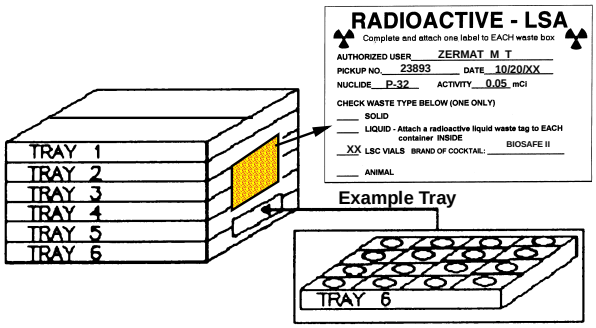
Waste

Continuing with radioactive waste collection we will describe LSC, stock vial, and lead pig collection. Chapter 5 of the Radiation Safety for Radiation Workers describes all waste disposal alternatives.

LIQUID SCINTILLATION COCKTAIL VIALS

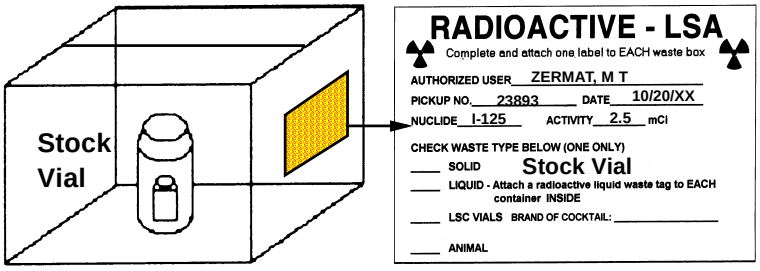
Although sewer disposable LSC solutions (e.g., Scintisafe Econo 2, BioSafe II) containing ^{3}H or ^{14}C only (< 1.85 kBq / g [0.05 µCi / g]) or 10-$T_{1/2}$ decayed nuclides may be poured directly to the sewer, Safety Department pick up is the easiest and safest disposal method because instead of opening the vials, the lab simply repackages the vials in cases or similar boxes (see figure). Flammable cocktails (e.g. toluene, xylene, pseudocumene, etc.) must be kept in their original counting vials for pickup by Safety. If you generate these cocktails in bulk, request an exception to store these in larger containers.

Regardless, when disposing of LSC vials, always keep flammable cocktails separated from sewer disposable cocktails. Labs are encouraged to use sewerable LSC cocktail. Keep vials separated by size and type (e.g., plastic, glass, 5 ml, 20 ml, etc.). Place vials upright in trays. Preferably package vials in full cases (e.g., 20 ml vials - 500 / case, mini-vials - about 1700 / case). On each box / case write the LSC cocktail brand name and any biological or chemical hazard that might make disposal via the sanitary sewer inappropriate. Although sewerable LSC cocktail is processed at no charge to the PI, there may be a per case processing fee for organic cocktails based upon the storage and processing costs. Unless specifically stated on your CORD internal requisition (e.g., Purchase of radioactive material and processing of LSC vials), you cannot charge organic vial processing to your CORD internal requisition account that is used to purchase radioactive materials. Call CORD for information if you anticipate using organic cocktails.



STOCK VIALS AND LEAD PIGS

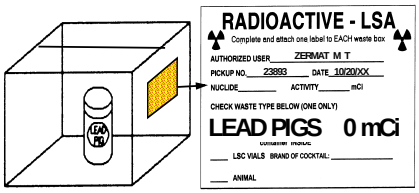
Empty stock vials should be disposed of as if they were radioactive solid waste. Stock vials with residual gamma and / or high-energy beta (^{32}P) emitters must be shielded (e.g., use lead pigs). Call Safety to arrange a special pick-up for any unused stock vials. Write the activity and radionuclide on each stock vial / lead pig used for shielding. Stock vials should be packaged singularly or a few together in small boxes (see figure) to reduce exposure when handling the box. Label the box with a radioactive waste sticker.



Do not mix lead pigs with solid radioactive waste. Lead is accepted in waste boxes only when needed to shield very hot, concentrated wastes and in small boxes only. Lead is decontaminated (if necessary) and recycled by the UW. Meter lead pigs with a sensitive survey meter to verify that the pig is not contaminated. If the pig is contaminated it must be labeled as contaminated and packaged separately.

LEAD PIGS (Cont.)

Pack uncontaminated pigs in a small box weighing less than 12 kg (25 lbs). Write "Lead Pigs" on both the box and on the Radioactive Waste Disposal form. Put out with other radioactive wastes. To prevent the spread of contamination, place any contaminated lead pigs in a plastic bag, then separately pack contaminated pigs in a small box. Identify the nuclide and write "Contaminated Lead" on the box.



Training

Radiation Safety Training is held weekly. Unless otherwise noted, all classes begin at 12:30. From 1 July to 20 August, classes will be in Room 125 Biochemistry. The class dates are: 1, 9, 15, 21, and 27 July; 2, 10, 18 August. Thereafter classes will be at Union South. The class schedule through 31 October is: 26 Aug; 9, 15, 21, 27 Sept; 5, 13, 21, 29 Oct. In addition several morning classes will be offered. These classes are at Union South and begin at 8 AM, current schedule is 7 Sept and 7 Oct. Our web site will always have the schedule.

UW-SAFETY DEPT.
30 N. MURRAY ST. 53715-2609

(608)262-8769