RADIATION REVIEW

UW - Madison Safety Department
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What's in a Number?

We often receive questions from workers like, "Is this safe?" or "My meter goes off-scale when I measure this, what should I do?" The fact is, with the exception of irradiators and x-ray machines, radioactive material work at the UW-Madison is without measurable risk for injury. When good procedures are rigorously followed, exposures received by research workers are only a small fraction of normal background radiation. (The average is about 15 mrem/year).

So, if radioactive materials use is virtually without risk, what do the exposure and contamination numbers mean? These numbers or limits used in our regulations are to insure that this research work will comply with NRC rules and regulations. Let's look at some of the various numbers in use and discuss what purpose they serve.

Surveys

A survey is an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions.

Surveys are a necessary supplement to personnel monitoring which measures individual radiation exposures.

Most of the radioactive materials used by researchers are beta emitters (e.g., ^{3}H, ^{14}C, ^{32}P, ^{33}P, ^{35}S). Beta particles are emitted from the nucleus in a spectrum of energies up to the maximum possible, however the average energy of the beta particles is approximately 1/3 of the maximum energy. Beta particles with energies greater than 100 keV (e.g., all except ^{3}H) can be detected by using a thin-window Geiger counter calibrated to measure in units of cpm. The NRC has adopted the International Atomic Energy Agency (IAEA) guidance for surface contamination and the UW limits are based upon this guide.

Survey Quantities

200 μCi or more of radioactivity on a lab's inventory requires documented monthly surveys. Most labs should be doing monthly surveys of all their rooms. How else are you going to find contamination if you don't look for it?

Survey Quantities (cont.)

Because some radionuclides have been determined to be a greater (internal) exposure hazard than others, the IAEA guidance requires greater precautions for those nuclides, which are more hazardous. Thus, for some radionuclides, the NRC requires lab surveys each day a radionuclide is used. We try to avoid this requirement by placing a single stock vial order limit of 10 mCi per nuclide. This limit insures that labs using common nuclides (e.g., ^{3}H, ^{14}C, ^{32}P, ^{33}P, ^{35}S) will not be required to do these daily surveys. Because of their greater potential hazard, the IAEA has lower survey limits for some nuclides (e.g., ^{22}Na, ^{45}Ca, ^{90}Sr, ^{125}I, ^{131}I). For these nuclides, receiving more than 1 mCi requires a daily survey. We realize economics may dictate a lab buying one 25 mCi vial of ^{32}P instead of two or three 10 mCi vials or one 5 mCi vial of ^{45}Ca instead of a 1 mCi vial. The NRC requires that Radiation Safety perform a survey of these lab areas monthly and verify that the lab has done the daily surveys.

Required surveys must be documented. The daily surveys may be documented on a single sheet listing the date, areas checked, and results. The monthly surveys must be posted with a lab survey map including both meter and wipe survey results. A meter survey to check for accidental contamination on your hands/shoes and work area should be performed immediately after working with radioactive materials (and before leaving the lab for a break, lunch, etc.). This personal survey need not be documented, but should be performed to insure you don't leave the lab contaminated.

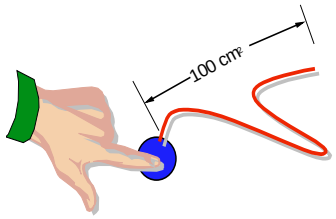
Meter Survey

650 cpm is the limit for portable survey meters. Count rates in excess of 650 cpm must be reduced. This might mean decontamination of surfaces, disposal of waste boxes, etc. The thing to remember is that the efficiency of a geiger counter is energy-dependent. In addition, the pancake type detector is more efficient than the end-window detector, as much as twice as efficient for ^{35}S. A count rate of 650 cpm from ^{32}P reflects a contamination level of approximately 1200 - 1800 dpm while from ^{35}S it reflects a contamination level of approximately 7000 - 12,000 dpm. Remember that low energy beta particles (e.g., ^{3}H, ^{14}C, ^{35}S) are not penetrating, so a higher contamination level does not result in any increased exposure.

The easiest method to identify the contaminant is to use the paper test. Simply place 1 or 2 pieces of notebook paper between the detector and the contamination. If the count rate drops significantly (e.g., from 800 cpm to 200 cpm) then the contamination is from a low energy beta such as ^{14}C or ^{35}S. If the count rate does not drop (e.g., only from 800 cpm to 700 cpm), then the contamination is from a high energy beta such as ^{32}P. Regardless of the isotope, if the meter count rate exceeds 650 cpm, the contamination must be cleaned or shielded.

Removable Contamination Survey

The removable contamination limits are 770 cpm per 100 cm^2 for low energy beta emitters (e.g., ^{3}H, ^{14}C, ^{35}S) and 230 cpm per 100 cm^2 from all other emitters. Count rates in excess of the levels in the table below must be cleaned.



The simple fact is that low risk types of radiation are less of a radiation hazard, so allowable contamination levels are higher.

The NRC guidance specifies that removable contamination be based upon a wipe of approximately 100 cm^2 (approximately 4 square inches). Because labs often use several different energies of beta emitting nuclides it makes it difficult to quantify contamination wipe results. The table's cpm/100 cm^2 values represent a cpm limit which was approximately 1/3 of the dpm limit.

Security

As you know, the UW has a security program. While the use of radioactive material in research labs is without risk for biological effects, you must understand that security is an issue which the NRC deems important. This is because the wording of the regulations is "all" radioactive material, regardless of quantity. Thus the purposes of our program which includes periodic checks of buildings are to make all PIs and workers aware of the program and insure that labs are able to secure larger (i.e., stock vial) quantities. Security can be accomplished by contacting Safety to install locks / hasps on refrigerators / freezers. Quantities can be reduced by frequently disposing radioactive wastes.

The NRC inspector checks security by walking through a building, checking whether doors posted with "Caution - Radioactive Material" are locked. If a door is open or unlocked, the inspector will enter the lab to see if it is occupied. If the lab is unoccupied, the inspector uses his Ludlum Model 3 GM with end-window detector to check for high count rates (indicating radioactive material). If radioactivity is detected and is not secured, then he checks the labs inventory to determine the actual quantity of radioactivity unsecured.

Action Levels for Removable Surface Contamination

Contamination Units	Type of Radioactive Emitter		
	Alpha (α)	β[1], γ, x	Low Risk β[2]
dpm/100 cm^2	66	660	2,200
cpm/100 cm^2	23	230	770

[1]β emitter values are applicable for all β emitters other than those considered low risk.
[2]Low Risk have β energies with E_{max} < 200 keV, e.g., ^{3}H, ^{14}C, ^{35}S.

Pregnancy Surveillance

Because the embryo/fetus may be more sensitive to effects from high (> 10 rem) radiation doses, lower radiation dose limits apply to the fetus of a pregnant radiation worker than to the adult worker: 500 mrem for the fetus versus 5000 mrem for the adult.

The Pregnancy Surveillance Program is a voluntary program. Together with the pregnant worker, the Safety Department will review her radiation exposure history, her lab's workload (type and quantity of radionuclides), and, if appropriate, provide suggestions to reduce exposure to below the 500 mrem limit or provide encouragement to keep radiation dose to the fetus low.

To inquire into this program eMail or call Leola or Sharon at 2-9180 or 2-7530, respectively.

Training

Radiation Safety training is conducted weekly at Union South. Additionally, each semester several classes are held in the morning. Refer to "Today in the Union" for the assigned training room. Except for the morning dates when training begins at 8 AM, all training begins at 12:30 PM and lasts approximately 4 hours. Training dates for March, April, May, and June are:

Morning Classes: June 22 (Mon)

Afternoon Classes: March 10 (Tue), 18 (Wed), and 26 (Thurs), April 3 (Fri), 9 (Thurs), 15 (Wed), 21 (Tue), and 27 (Mon); May 5 (Tue), 13 (Wed), 21 (Thurs), and 28 (Thurs); June 5 (Fri), 11 (Thurs), 17 (Wed) and 23 (Tues).

Effective July 1, 1998, CORD will increase the transaction fee to $27.00

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