Radiation Safety Newsletter

Now is the start of a new academic cycle. It is a time of new workers coming into the lab as well as the return of many other workers after the summer break. This is a good time for each lab / research group to familiarize all workers with their research activities and safety procedures. We will use this edition to discuss come common safety concerns. The *Prudent Practices in the Laboratory* (National Academy Press, 1995) describes four fundamental principles that underlie safe work practices:

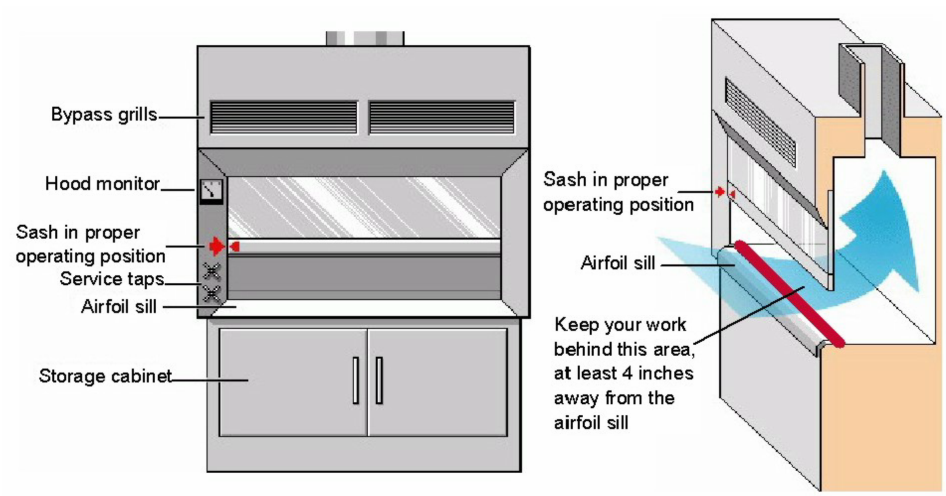
- ✓ Plan ahead – determine the potential hazards associated with an experiment before beginning it.
- ✓ Minimize exposure to chemicals – do no allow laboratory chemicals to come in contact with the skin.
- ✓ Do not underestimate risks – assume that any mixture of chemicals will be more toxic than its most toxic component.
- ✓ Be prepared for accidents – know what specific action to take in the event of an accidental release of any hazardous substance, know the location of all safety equipment and the nearest fire alarm and telephone, and know what telephone numbers to call and whom to notify in the event of an emergency.

Fume Hood

A fume hood is the most important component used to protect laboratory workers from exposure to hazardous chemicals and agents, especially those that produce vapors, gases, or dusts, that are used in the laboratory. Fume hoods provide ventilation to carry away airborne contaminants, and exhaust them outside of the building. The fume hood's sash will also provide shielding to protect the user, and containment for small fires and explosions.

To provide this protection, the fume hood must have an adequate face velocity (measured at the work opening) to ensure the proper removal of toxic materials. The currently acceptable standard is 100 feet per minute (fpm) with a vertical sash opening of at least 18 inches. Fume hoods are checked annually and labeled with appropriate use, flow rate and sash height.

Fume Hood Features and Functions



- *Fan and Stack* - directs effluent upward at high velocity from roof.
- *Fan outside of building* - ensures that duct work inside building is under negative pressure.
- *Light* - located outside of hood or is explosion proof.
- *Baffles* - provides air flow through face. Put adjustable baffles in center position.
- *Sash* - provides mechanical protection for user.
- *Bypass* - provides constant face velocity independent of sash position.
- *Airfoil* - prevents dead space at front of hood, helps protect user from small spills.

Although Risk Management and Safety checks and marks each fume hood, how can you be sure your fume hood is functioning properly? A simple way to monitor your hood's operation is to do a tissue test to be sure air is moving into the hood. Tape a strip of tissue to the edge of the sash. The tissue fluttering into the hood indicates air flow. This is only a qualitative test for hood function (i.e., air moving or not moving). To properly evaluate a hood's performance, only a calibrated velometer will give you an accurate quantitative measurement of face velocity. If your ventilation system is modified in any way, call Safety to re-test your hood

Remember, air flow rate / velocity usually *decreases* as you raise the sash. Some basic steps to insure an optimum airflow rate include:

- ✓ Keep the sash as low as possible.
- ✓ Maintain air flow pathways front to back.
- ✓ Keep work more than 15 cm (6 inches) behind sash opening. Quantitative fume hood containment tests reveal that the concentration of contaminant in the breathing zone can be 300-times higher from a source located at the front of the hood face than from a source placed at least 6 inches back. This concentration declines further as the source is moved farther toward the back of the hood.
- ✓ Place equipment as far to the back of the hood as practical without blocking the bottom baffle. Keep heaters more than 30 cm (12 inches) behind sash opening.
- ✓ Close sash when not in use and keep fume hood exhaust on at all times.
- ✓ If possible, position the fume hood sash so that work is performed by extending the arms under or around the sash, placing the head in front of the sash, and keeping the glass between the worker and the chemical source. The worker views the procedure through the glass, which will act as a primary barrier if a spill, splash, or explosion should occur.
- ✓ Avoid opening and closing the fume hood sash rapidly, and avoid swift arm and body movements in front of or inside the hood. These actions may increase turbulence and reduce the effectiveness of fume hood containment.
- ✓ Do not use large pieces of equipment in a hood, because they tend to cause dead spaces in the airflow and reduce the efficiency of the hood. Separate and elevate each instrument by using blocks or racks so that air can flow easily around all apparatus.
- ✓ Do not modify fume hoods in any way that adversely affects the hood performance. This includes adding, removing, or changing any of the fume hood components, such as baffles, sashes, airfoils, liners, and exhaust connections.
- ✓ Do not intentionally evaporate liquids in a fume hood unless this is part of a chemical process. The EPA prohibits the evaporation of wastes.
- ✓ Do not use your fume hood to store hazardous waste nor as a storage cabinet for surplus chemicals. If you have waste, contact Safety for collection.

Lastly, a biosafety cabinet is not a chemical fume hood. Their motors are not explosion-proof and a biosafety cabinet should never be used for working with flammable chemicals. If you are working with volatile toxic chemicals, special care needs to be taken because some biosafety cabinets do not eject exhausted air from the building; they merely filter the air to remove airborne microbes. Chemical vapors and gasses easily pass through the filter and are dispersed back into the room.

Radiochemical Storage

You say the tritiated leucine you bought for $1500 in 1985 and put in the freezer is nearly as good as it was when you placed it there 10 years ago? Not likely.

Chemical decomposition occurs naturally during storage of compounds. However, compounds labeled with radioisotopes typically decompose faster than their unlabelled counterparts. The ***shelf-life,*** the time during which a labeled compound may be used with confidence and safety, is important to both the user and the supplier. The purity at which a radiolabeled compound ceases to be of use depends greatly on the application. With radiochemical decomposition, it is important to consider the molar specific activity (e.g., MBq/mmol or mCi/mmol) because the molar specific activity gives an appreciation of the extent of labeling of a compound. Decomposition may be accelerated by free radicals produced from the radioactive decay energy and the observed decomposition rates of radiochemicals are more pronounced with compounds of high molar specific activity.

Isotope	Typical Observed Decomposition Rates
^{3}H	1 - 3 % per month
^{14}C	1 - 3 % per year
^{32}P	1 - 2 % per week
^{35}S	2 - 3 % per month
^{125}I	5 % per month

Recommended storage conditions are normally included in the leaflet accompanying each item. Even slight deviations from these conditions may result in more rapid decomposition. In general, compounds should be stored at low temperatures in the dark and liquid solutions should be stored unfrozen at concentrations less than 37 MBq/ml (1 mCi/ml). Where instability dictates that solutions be stored frozen, it is best to avoid freeze-thaw cycles.

Radiochemical Decomposition Rates

Amersham Pharmacia Biotech has a very interesting publication, "Guide to the Self-decomposition of Radiochemicals". Suggesting that long term storage of long half-life compounds may simply result in a degraded product. Radiochemicals can decompose by at least 4 modes:

- Natural decay is most likely the least important for ^{3}H and ^{14}C decomposition simply because the percent of radioactive atoms decaying per month is so small.
- In primary decomposition, the ionizing radiation interacts with molecules of labeled compound surrounding the decaying nucleus. Here the higher the specific activity, the greater the primary decomposition. One can add unlabelled (carrier) or other solvent to reduce the specific activity or increase the number of non-labeled molecules near each labeled molecule.
- Secondary decomposition arises from the interaction of (for example) free radicals created by the radiation with labeled molecules. This is the most difficult decomposition mode to control and is easily influenced by environmental conditions.
- Chemical and microbial decomposition also act on a radiochemical independently of radioactive decay.

While every radiochemical is shipped with specific storage instructions, there are a few principal guides that will help minimize decomposition.

1. Optimize storage conditions for chemical stability - storage conditions suitable for good chemical stability (e.g., correct pH, storage under inert gas, etc.). As much as possible, keep radiochemicals in the dark and protected from the adverse effects of any nearby chemicals.
2. Store at low temperatures - Solutions of radiochemicals should be stored cold but unfrozen (e.g., aqueous solutions at +2^{o}C, ethanol solutions at -20^{o}C). Compounds of very low chemical stability should be stored at -140^{o}C (the vapor above liquid nitrogen); compounds in their natural physical state should normally be stored at -20^{o}C.
3. Dilute the specific activity - a compound at high specific activity will decompose faster than at lower specific activity.
4. Store as solutions - this effectively disperses the labeled molecules, decreasing the effect of secondary decomposition
5. Add radical scavengers or other stabilizers - when compatible with the use, adding a radical scavenger (e.g., 2 - 3% ethanol added to an aqueous solution) can lead to an increased shelflife.
6. Avoid reopening of vials, and warming/cooling cycles - if a radiochemical is to be used over several weeks/months, it is best to have it subaliquoted in a number of vials, keeping those to be used later in the refrigerator or freezer until required.

Lab Surveys

Performing general lab contamination surveys should be a part of your procedure every time you work with radioactive materials. Since the majority of your processes look for very small amounts of radiation that has been tagged to your sample, it does not take much contamination to alter your results. When you also consider that one drop of most radioactive substances contains literally millions of atoms of the radioactive material, it would not take much to dramatically alter your results or contaminate the lab, your equipment or yourself. A little contamination goes a long way, and a little thought save a lot of decontamination time.

After preparing your procedure, setting down plastic-backed absorbent paper or using shielding, if necessary, reviewing the written instructions or SOP, readying waste receptacles, getting your radioactive materials ready to start, remember to consider how contamination could be spread while you are working. When in doubt, consider the area/item to be contaminated.

When working:

- Have all the items you could need available without having to walk across the lab to get them.
- Use a dedicated pen or pencil and paper pad.
- Have absorbent towels/paper available to quickly contain spills.
- If you are using an isotope you can detect with your Geiger counter, turn your meter on before you start, so it will be readily available to monitor yourself or your equipment during the procedure. Set your monitor in a position that allows you to monitor your hands without having to touch the monitor and check your gloves before you pick up the meter. Nothing throws a survey off like a contaminated monitoring instrument.

When you are done working:

- Put all equipment that is known to be contaminated in the sink where it is to be decontaminated and decontaminate those items first.
- Next monitor your hands, then remove your gloves and wash your hands and then monitor your hands again.
- Then, put on a clean pair of gloves and clean the work area itself.
- Survey the work surface using the meter, taking care to not contaminate the detector. If you are working with S-35, P-33 or Ca-45, do not cover the detector. Even saran wrap will reduce your meter efficiency by 50 – 75% of the unshielded value. Turn the speaker on and survey slowly (1" – 2" per second), listen to the speaker. The needle on the dial responds much more slowly than the speaker, so if you do not have a speaker, allow time the meter time to react to the contamination. Remember we are usually talking about less than one drop of contaminant.
- After metering, take swipes of known or suspected contaminated areas and count them to give yourself a starting value.
- Use lots of absorbent paper to clean bench tops and other items that cannot be placed in the sink. Remember, do not contaminate your hands.
- When decontaminating, once an area is cleaned, use clean paper towels to prevent spreading possible contamination from counter A, to shelf B, and so on.
- When you think you have the area cleaned, monitor your hands, remove your gloves, wash your hands, and monitor them again. Now survey the work area again with the meter, noting any hot spots.
- Now take swipes of the areas you swiped previously, areas you think might be contaminated, and include a swipe or two from areas you are pretty sure are not contaminated. This will check the progress of decontaminating the known spots, check the suspected spots, and verify the clean spots.
- When the area shows no removable contamination (per the Rad Safety Manual), you are done.

Areas where contamination 'likes to hide' include:

- any and all handles of doors, fume hoods, equipment, refrigerators, etc.
- phones (seemingly even if they don't ring)
- computer keyboards and equipment control buttons
- your fingers, even if wearing gloves

I am speaking from experience on all of these pointers, it only takes once cleaning up incidental contamination and you will recognize these as very helpful.

Dosimeters

The Radiation Safety Office is having difficulty in collecting radiation badges back at the end of each wearing period. We had about 20 dosimeters that were not returned to us recently and declared as LOST dosimeters. They mostly belong to students who graduate and/or leave Auburn University for some reason. We are being charged for each lost dosimeter and at the same time there is a issue of exposure lost. Please remember to return your badge to us if you know you are not going to use it anymore. For all your dosimetry questions, please don't hesitate to call Sevgi Kucuktas @ 844-6238.

Contaminated Lab chairs

If you work in a lab, you know that the material you work with can sometimes be spread and result in contamination of non-lab equipment (e.g., telephones, computers, etc.). We recommend all workers wear disposable gloves (as well as lab coat, safety glasses) when working with hazardous material and to remove the disposable gloves and wash their hands before handling other equipment so they can avoid the hand-mouth and transdermal cross contamination routes. Contamination can also be spread, through laboratory furniture, specifically your chair.

Think of it this way. You are probably working with hazardous and toxic substances and maybe even radioactive materials. Much of this is liquid in nature, some may be powders. Often persons are working with very small volumes. It is just possible that these same substances can dribble onto your chair and, if the chair is porous (e.g., fabric covered with sponge seat), it is possible to cross contaminate yourself or one of your coworkers when they use the chair. It is best to have a lab chair that is as easy to decontaminate as any other piece of laboratory equipment.

When buying laboratory furniture, get furniture / counters that are easily cleaned; laboratory chairs and stools should be covered with non-fabric materials that are impervious to spills and can be easily cleaned. If using radioactive materials remember to use a meter to survey your chair when you survey your work area at the end of a procedure. When you periodically clean your work area, remember to clean your chair as well.

We have been told that Federal granting agencies may make impervious lab chairs a condition of the research grant if it involves certain biological and pathological agents. The easiest solution is to insure all furniture in the lab is impervious. Remember, when getting new furniture, specify impervious coverings.