DEPARTMENT OF CHEMISTRY SAFETY TRAINING FOR NEW RESEARCHERS

Rev: Aug 19, 2014

This is intended as an introduction to some of the safety problems and the solutions implemented in the UTK Chemistry Department. It is intended to supplement the "Chemical Hygiene Plan" and the Fall Safety lecture for new researchers.

1. THE CHEMICAL HYGIENE PLAN

OSHA has generated a policy regarding safety procedures in research laboratories, called the "Chemical Hygiene Plan". There is a large (100+ pages) document detailing what our procedures are to be under these rules. **It is available on the Web as http://web.utk.edu/~bartmess/chemhyg.html.**

All personnel (researchers, those directing the teaching labs, and anyone handling chemicals) are required to follow these procedures.

For both legal reasons and practical lab safety reasons, everyone should spend time inspecting this document.

=> Everyone handling chemicals is required to know that the "Chemical Hygiene Plan" exists (just like knowledge of the "Right-to Know" Law - see below). Inspectors may come through asking questions, and you must know the answers. See appendix 1 for these.

These procedures are in general exactly what we are supposed to being doing now: following common sense procedures, both to minimize exposure to chemicals, and to dispose of them properly. A few specifics that may be different from current procedure include:

- Any chemical with a Permissible Exposure Limit (PEL) of 100 ppm or less must be used only in a working fume hood, or with proper ventilation to keep the vapor below that limit. There is a long list of common chemicals and their PELs as an Appendix to the Chemical Hygiene Plan.

- The University will provide all employees who work with hazardous chemicals an opportunity to receive medical attention as explained in the Plan. This medical consultation and examination can occur upon (a) development of signs or symptoms by the employee of exposure to a specific chemical hazard, (b) where routine levels of exposure exceed approved levels, or (c) after an unusual event such as a spill, leak, or explosion where there is a likelihood of a hazardous exposure by the employee.

- While all chemicals require logging in and out, we are automatically handling this through the Business Office at purchasing time. However, certain chemicals require a one-time explicit "Permission to Use" form to be filled out, by the research director for each research group using them. These include the following:

Known Carcinogens

4,4'-methylene-bis(2-chloroaniline)	Methyl chloromethyl ether
2-Acetylaminofluorene	∀-Naphthylamine
Acrylonitrile	∃-Naphthylamine
4-Aminobiphenyl	4-Nitrobiphenyl
Asbestos	N-Nitrosodimethylamine
Benzidine	∃-propiolactone
Bis(chloromethyl) ether	Vinyl chloride
3,3'-Dichlorobenzidine	1,2-Dibromo-3-chloropropane
4-Dimethylaminoazobenzene	Ethyleneimine

Toxic Gases:
Arsine, Fluorine, Hydrogen cyanide, Hydrogen selenide, Phosphine

Shock Sensitive Compounds
Picramide, Picric acid, Nitrate esters (e.g.nitroglycerin), Benzoyl peroxide, Acetyl peroxide

Extremely Flammable Compounds :
Carbon disulfide, Ethylene oxide, Arsine

- Reading this HANDOUT does not constitute having reviewed the Chemical Hygiene Plan! Only a few points, dealing with situations that are appreciably different than current practice, are mentioned here. I know that this sounds like another "This will only take a little bit of your time...", but safety is important. Please look at the Chemical Hygiene plan, to see how it affects your work.

2. THE "RIGHT-TO-KNOW" LAW

Both Federal and state governments require that all employees involved in handling or being in proximity to chemicals be told of their "right-to-know" the hazards associated with those chemicals. This handout is your official notification.

The faculty member or staff person in charge of a lab (teaching or research) or chemical handling facility, is responsible for safety in that area. The person in charge should therefore describe any known hazards of a planned experiment or procedure to the person actually doing it, before the procedure is started. Nevertheless, it is obvious that it is the person carrying out the procedure who has primary safety responsibility for whatever is being done. A researcher should determine any hazards associated with an experiment before undertaking it, and take appropriate steps to minimize the hazards. If the hazards are too great, the experiment should not be performed until safe facilities are available.

For the chemically trained, here are some sources of safety data that are available to us:

ChemStores maintains a file of Manufacturer's Safety Data Sheets (MSDSs) that must be mailed by the manufacturer, along with any chemical purchased. If a chemical was bought in the last five years, there should be an MSDS for it in this file. These are supposed to describe all known safety hazards, and indicate appropriate precautions to take when using the chemical. The MSDS file is available 24 hours/day in a file cabinet in the Dry Ice Room, BU 220. Your mail room key will open this room. Some of these MSDSs are very poor, either in terms of little information, or by over-emphasizing even the smallest hazard for legal reasons (look up glucose some time!) Nevertheless,

these are probably the most complete source of safety information readily available to us.

There is now in the Chemistry Reading Room, BU 653, a shelf of books dealing with chemical safety. This is on the first row of bookshelves as you enter the Reading Room, prominently labeled "Safety". Included are:

N. Irving Sax, "Dangerous Properties of Industrial Materials," 7th ed., Van Nostrand Reinhold Co. The standard reference for safety information on chemicals. 3 Volumes.

The Sigma-Aldrich Library of Chemical Safety Data: abbreviated versions of the MSDS for all the chemicals that Aldrich or Sigma sell.

Merck Index: a more limited source in terms of coverage, but this contains many chemicals of biological, medicinal, or industrial importance. It also gives symptoms of poisoning, and has a list of tradenames for cross-reference.

Aldrich Catalog: This contains one word descriptions of any hazards associated with the chemicals listed. Often too brief to provide useful assessment of the hazards involved.

The NIOSH Toxic Substances List: mostly cross-references to legal and shipping infomation; not much use for practical lab help.

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The time to look up information on these shelves is BEFORE you use the chemicals, not after everything goes sour. Please plan ahead!

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Also, available in the Main Library:
"Academic Laboratory Chemical Hazards Guidebook," W.J. Mahn, van Nostrand, 1991; QD51.M29
"Hazardous Materials Spills Handbook," G.F. Bennett, F.S. Feates, I. Wilder, McGraw-Hill; T55.3.H3H43 1982

(The following is the University's statement covering the legalities for the Right-to-Know Law. It is here because you are required to be officially informed of it.)

HAZARDOUS COMMUNICATION RIGHT-TO-KNOW
UNIVERSITY OF TENNESSEE, KNOXVILLE , TENNESSEE

PURPOSE

The intention of the Tennessee Occupational Safety and Health Administration's (TOSHA) Hazard Communication Right-to-Know Law is to provide employees information regarding chemicals used in the work place so as to minimize hazardous exposure to the chemicals and to provide information to emergency personnel to assist in protecting the health, safety and welfare of the citizens of Tennessee.

EXPLANATION OF THE LAW

The Tennessee Occupational Safety and Health Administration Hazard Communication Right-to-Know Law requires the employer to perform the following:

1.Post adequate notification informing the employee about their rights under this law:

2.Develop a chemical listing of each of the hazardous chemicals used or stored in the work place in excess of fifty-five (55) gallons or five hundred (500) pounds, submit this listing to the Tennessee Department of Labor, and maintain the listing for a period of at least thirty (30) years.

3.Develop a library of the appropriate Material Safety Data Sheets (MSDS) which will always be accessible to the employee;

4.Develop a written document which addresses the labeling of containers, the training of employees as to the hazards of routine and non-routine tasks, and the maintaining and updating of the program; and

5.Develop a program of communication with firefighting agencies relative to the hazardous chemicals and provide a description of their location.

WRITTEN COMMUNICATION PROGRAM

Adequate notification will be posted in locations where notices are normally posted to inform the employees about their rights under the Tennessee Occupa-tional Safety and Health Administration Hazard Communication Right-to-Know Law.

Hazardous chemicals in or leaving the work place shall be properly labeled, tagged or marked in a manner which complies with the act and does not conflict with any other regulation pertaining to hazardous chemicals. Labels will identify the hazardous chemical, provide the appropriate hazard warning and give the name, address and telephone number of the chemical manufacturer or responsible party. Existing labels on containers of hazardous chemicals will not be removed or defaced. Any employee will not be required to work with a hazardous chemical from an unlabeled container except when that employee places the chemical in the portable container and he/she immediately (the same day) uses the substance. In order to enhance compliance with the law, employees affix contents identification labels to all portable containers.

A chemical listing of each hazardous chemical normally used or stored in the work place or laboratory will be compiled and maintained. This listing shall include the chemical name, the chemical abstract service (CAS) number, where applicable, and the work place where the chemical is normally used or stored. The work place chemical list will be maintained for no less than thirty (30) years. The listing will be updated annually. The list will be made available for inspection by the public during regular working hours.

A library of Material Safety Data Sheets (MSDS) will be maintained and made available to the employee on request. If the MSDS are not provided by the chemical manufacturer or distributor upon delivery of the chemical, the unit head will request a MSDS in writing from the manufacturer or distributor within five (5) business days. If the MSDS are not made available, the employee may refuse to work with the hazardous chemical without penalty. Each department will maintain a file of the MSDS of the chemicals or products used by employees of that respective department. This file will assure that the employee will have access to the MSDS as required. A back-up library of MSDS will be maintained at the Department of Environmental Health and Safety.

The employee must be informed of any known exposure to hazardous chemicals and be provided access to the work place chemical list and material safety data sheets upon request. No employee may be retaliated against for exercising his or her rights under this law. The employee may not waive any right under the law as a condition of employment.

Any student, contractor, sub-contractor, vendor, salesperson, or visitor shall be informed of any hazardous chemicals used in the areas being visited or areas where a person will be working. Notification of the presence of hazardous chemicals shall be the responsibility of the head of the department that the visitor is visiting or person providing the service. Those persons shall either be provided or required to provide their own safety and protective equipment. Any contractor, sub-contractor, vendor or salesperson, or visitor shall be required to inform the department head of the hazards of chemicals which they may be delivering or using while on campus. This request shall be made part of the bidding process for those providing services or performing construction for the University. Trade secrets will be protected but the appropriate health hazard and fire protection information must be provided by the chemical manufacturer.

The fire chief having jurisdiction will be provided a copy of the work place chemical list and the names and telephone numbers of representatives who can be contacted for information during an emergency situation. The fire chief shall be permitted to inspect the work place where hazardous chemicals are used and the MSDA file will be made available to him upon request. Approved signs will be placed on the outside of any building which contains Class A and B explosives, poison gases, water-reactive flammable solids, radioactive materials or any other hazardous chemicals in excess of fifty-five (55) gallons or five hundred (500) pounds.

The provision of the law does not apply to pesticides as defined in the Federal Insecticide, Fungicide and Rodenticide Act, although the Department of Environmental Health and Safety will be provided with an annual inventory listing of the Pesticides, Insecticides, Fungicides and Rodenticides used on campus.

LABORATORIES AND HAZARDOUS CHEMICALS

The teaching, research and other laboratory facilities are considered as the work place for many University employees and students. Therefore, such facilities are not exempt from the rules and regulations of this law. Employees working in laboratories will be provided appropriate training and will have access to the chemical inventory listing, Material Safety Data Sheets and the written program document. Students in laboratory classes of the University shall have as part of their curriculum instruction orientation to laboratory safety, including notification of the requirements of the Hazardous Communication Right-to-Know Act.

RESPONSIBLE AUTHORITY

The responsibility for assessing the hazards of working with chemicals and implementation of the appropriate protection principles rest with the department head of the respective department. Any concerns of an employee which is not satisfied after discussion with the unit head may be addressed by contacting the University, Department of Environmental Health and Safety.

The responsible authority to coordinate, audit and determine compliance of the University's program, either as individual units or campus wide, will be the University, Department of Environmental Health and Safety.

HAZARD COMMUNICATION RIGHT-TO-KNOW TRAIN ING PROGRAM

The Hazard Communication Right-to-Know Law requires the University of Tennessee, Knoxville (UTK) to inform employees about the hazards of chemicals and substances used in the laboratories, classrooms and various work places on campus. This law applies to any chemicals known to be present in the employee's work place which the employee may be exposed to under normal conditions of use or in a foreseeable emergency. Transmittal of information is to be accomplished by means of a comprehensive hazardous chemical communication program, which will include container labeling, inventory of work place chemicals, provision of Material Safety Data Sheets (MSDS) and employee training. Employees working with hazardous chemicals will be provided an educational and training program in the safe use and handling of hazardous chemicals. A new employee assigned to work with hazardous chemicals will be provided training prior to working in the area. The training will be provided either during the employees orientation, on the job by his supervisor or by personnel from the Department of Environmental Health and Safety. The training program will include procedures to be followed in case of emergency. Training will be both general for campus wide and specific for the employee's work place.

The inventory list of the chemicals used in the work place and the MSDS will be used to provide the specific training to the employees of the various departments.

After the initial training of employees, an annual refresher training program will be provided. Training records and dates will be kept on each employee receiving the training. A signed statement by the employee that he or she has attended and received the appropriate Hazard Communication Right-To-Know training will be maintained within his or her departmental files and also a copy filed with the Department of Environmental Health and Safety.

Specific training for non-routine tasks will be dictated by the situation and evaluated thoroughly in accordance with past experience and knowledge of that situation.

[End of University Right-to-Know Statement]

3. FIRE ALARMS

The fire alarms are the LOUD horns/bells - they are unmistakable. They are designed to be so loud that you can't remain in the building without aural pain. However, if you hear a repetitive beeping coming only from the control boxes (sites noted below), that is not a fire alarm, just a sensor glitch. For the latter situation, let the Main Office or the Safety Chair know, if it is during working hours.

Recent fire alarms reveal that many of the inhabitants of Dabney/Buehler ignore the alarms unless forced to evacuate. The rules are clear:

If the alarms go off, you must evacuate .

One or two minutes to stabilize or shut down a reaction, that might become a hazard if left untended, is reasonable, but you cannot just ignore the alarm because it is inconvenient. We do not plan any fire drills; if you hear the alarm, either it's real, or the State Fire Marshall is running a fire drill. In the latter case, the University gets fined if he finds people remaining in the building.

In addition, be aware that pulling the fire alarm lever will bring both the Campus Police and the Knoxville Fire Department. The latter costs the University $$$. If you determine, after pulling an alarm, that the situation is not one that requires the Fire Department, immediately call the Campus Police at 4-3114 to let them know.

If it is after hours and you do not have access to a phone, use the "blue phone" outside the 4th/5th floor entrance to Buehler. Even just pushing the button will bring a police car to the site within two minutes, we are told.

If the alarms go off after normal hours and there are no faculty around, don't ignore the situation - investigate! To find out the area where the alarms were set off, check the alarm boxes first:
- Buehler – 5th floor near the passenger elevator and main entry (“B” stairwell).
- Dabney Addition - 6th floor near vending machines and the “G” stairwell.
- Old Dabney - 6th floor near BU 674 and the”I” stairwell.

The message on the box's LCD shows what area is responsible for the alarm.

To notify people, call (1) Campus police, then (2) the sequence in the list below to inform someone, until you get hold of someone: Campus Police 4-3111

Chuck Feigerle	4-3141, (C) 865-686-2811, (H) 865-692-8778
Shawn Campagna	4-3141, (C) 609-213-2192
David Jenkins	4-8591, (C) 626-394-1161
Brian Long	4-5664, (C) 512-653-1885
Johnny Jones	4-3145, (C) 423-215-5220, (H) 423-569-8008

In addition, you should know where the nearest pull station is, relative to your research and teaching areas.

4. Spill Cleanup

If you spill more than a few mL of something, you may need special clean-up chemicals. There's vermiculite (flaky packing material) in a bag in BU 219 (the liquid nitrogen room), just outside the door to ChemStores. This absorbs liquids, but then needs to be swept up and bagged. There's also extra bicarb there for acid spills. If you use large quantities of these, let me know so I can get them replaced. For floods, there's a wet-dry vacuum in the same location. When you are done with it, clean it out and return it immediately.

5. LABORATORY HAZARD INSPECTION REPORT

Department of Chemistry Safety Committee

Room:_____ Faculty/Staff Supervisor_____ Date:_____

____ Safety Glasses not being worn Inspectors:_____

____ Smoking in the Lab ____ No Yellow Safety Notice posted

____ Drinking/Eating in the Lab ____ Yellow Safety Notice outdated

____ Fire Extinguisher: Missing[ ] Unmounted[ ] Blocked[ ] Wrong type[ ]

____ Blockage of Exit/Second exit

____ Eyewash: not operable[ ] none[ ] blocked[ ]

____ Blockage of Shower

____ Unsafe Chemical Storage: Clutter[ ]

Proximity (Acids to Bases, Redox)[ ]

Height[ ] No big solvent/corrosive bottles over 5 ft. from floor)

Floor[ ] (No glass bottles on floor)

____ Floor used as storage area

____ Cluttered hood/ rear vent blocked

____ Blockage of makeup air vents

____ Unstrapped Gas Cylinders (even if marked empty)

____ Electrical Problems: Overused outlet[ ] Bad wiring[ ] Light out in hood[ ]

____ Machine Guard / Belt Guard missing

____ Vacuum pump not vented to hood or trapped

____ Water hoses not clamped at connections/loose enough to touch hot glass.

____ No catch basin under mercury container

____ Mercury open to air

____ Untaped Dewar flask

____ View through door window blocked

____ Unlabeled solvent still

____ Unlabel chemical vials or bottles

____ Flammables/meltables piled on or near oven

____ Undated open ether cans

____ Lack of warning signs for laser

____ General Clutter

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UT Chemistry Department Safety Inspection Guidelines

This handout is intended to elaborate on many of the topics that will be involved in the lab inspection program. It is not an official safety manual; see the "Chemical Hygiene Manual" for chemical safety procedures. Some of these are problems still in search of an ideal answer; we are working on official departmental policy and answers. While you may object to many of the conditions given here, saying "We can't do research if we follow that rule..", I point out (1) if we have a bad accident and get shut down, we assuredly won't be doing research; (2) if you have the intelligence to get a Ph.D. in chemistry, you are smart enough to figure out imaginative ways to comply with the safety rules, both consistent with them in spirit and fact, and still get your research done. You are being trained as a problem solver; practice it!

Safety Glasses:

In the teaching labs, there is a state OSHA requirement to wear the Type 2 goggles (flexible, complete enclosure), that totally shield the eyes. There is no way around this. Regular eyeglasses, even with the side safety shields, are not acceptable. In the research labs we have more leeway on what is acceptable. When working with glass under vacuum, or potentially explosive or spattering mixtures, it is obviously prudent to use the best eye protection available, as well as safety shields, hood sashes, etc. For routine lab work, where exceptional hazards are not expected, the strict use of the goggles will not be enforced, but:

!!YOU MUST WEAR SOME KIND OF EYE PROTECTION AT ALL TIMES IN A RESEARCH LAB. !!

There are no exceptions to this rule. If you are not as inherently myopic as some of us, who can't find the floor if we take off our glasses, you must wear some type of eye protection. If you find the inexpensive plastic lab glasses uncomfortable, you should get a regular pair of frames fitted with flat lenses. Plastic lenses are okay; the epoxy resin that is used in plastic lenses is impervious to all organic chemicals that we tried, including chromic acid cleaning solution and 50% NaOH. Such glasses are a legitimate business expense and are tax deductible.

Please note that contact lenses can be a problem, in that they can trap organic vapors, especially solvents, and hold them against the eyes. These should be worn in and around chemistry labs only when absolutely necessary. Get a pair of frame glasses and make those your work glasses!

However, there is an increasing trend to smaller and smaller lenses in glasses, for fashion reasons. These should be avoided. Large lenses that cover as much of the eye as possible are necessary.

No Smoking in the Lab

This is an absolute rule. In addition, University policy states that smoking is permitted only in designated , well-ventilated areas. The designated smoking area in Buehler is the stairwell at the north end of the west wing (near the BU 601,501,401,301 offices).

Eating/Drinking in the Lab

Again, not allowed: this is an OSHA rule.

Fire Extinguisher

Missing [ ] Unmounted [ ] Blocked [ ] Wrong type [ ]

You should have memorized the location of the fire extinguishers in the labs where you work, as well as what type they are. In Buehler/Dabney there are three majors types available:

- CO_2: Okay for most chemical fires, but not burning metals (Na, K, Mg, etc.). Beware the blast: it can knock over flasks and make things worse.

- powder: like CO_2, don't use on metal fires, and the blast can be dangerous.

- flammable metal: These smother a burning metal fire. You pour the powder over the fire from a long tube. We are attempting to get these from the University for the appropriate labs. If you use reactive metals in your lab, let us know that you need one.

If you use an extinguisher - even just one shot - do **not** replace it on the hook. Turn it in at the ChemStores window so it gets refilled. They should have a "loaner" there to temporarily put in your lab.

Blockage of Exit

Every lab should have a second exit, ideally across the lab from the main one, for emergency exit. These should have completely clear access available. No equipment that hinders the opening of the door may be stored near these, no matter how short on space you are. This applies to both sides of the door: what the researchers in the lab next to yours do may affect your safety in an emergency. Watch out for your neighbors blocking your emergency exit.

Blockage of Shower

Yes, I know there's no drain in most labs, but if you need the shower, cleaning up afterwards is the least of your worries. Don't store stuff underneath the shower, and keep electrical cords off the floor.

Unsafe Chemical Storage

Clutter; Height; Proximity

There is a strong tendency to be a "packrat" with old chemicals, for justifiable reasons: these are money in the bank against times of low funding. However, this is also the area where we are probably the most in violation of OSHA rules, since there are strict limits on the quantities that can be legally stored in a lab. We need to differentiate between class IA chemicals (flash points below -30°C) such as ethyl ether, pentane, acetaldehyde, methyl formate, pet ether, and carbon disulfide, and the general run of flammable chemicals. For the former, technically you can have no more than one (1) gallon in a lab, and that must be in a metal can in a metal solvent cabinet. Total for all flammable chemicals of any type in one lab is legally 12 gallons. For tech grade acetone, no more than one gallon or a 1/2 day supply can be kept in a lab. These are obviously severe restrictions on research, and the inspection crew is not going to come down on you about having several cans of ether. However, the solvent safety cabinet (these are the heavy yellow metal ones with bifold doors) are a good idea for storing all your solvents. Work on your research directors to get these for you ($$$). I note that a standard size fire extinguisher in trained hands is capable of putting out a fire from one liter of spilled solvent. How much do you have stored in the lab?

A second safety point is general clutter. This is not only bad PR when guests are in the lab, but leads to accidents, due to crowding from a lack of working bench space, and increases research costs, due to re-purchasing of chemicals that you have but can't find. It is well worth a research group's time and funding to have chemicals sorted on the shelves and cataloged in a card file as to location. A

general inventory should be done yearly, both to keep the file up to date, and to check everything for leaking, corroded, or broken caps, or decomposed chemicals. Look at the contents, not just the label! Is your sodium can dry? How old is that nearly empty can of ether? This cataloging is often done alphabetically, but there is a drawback to that in terms of the proximity of incompatible chemicals: one shouldn't store oxidants on a shelf just above reducing reagents, strong acids next to strong bases, etc. Yes, they are in good bottles now, but the whole point of safety is that accidents do happen, and you must plan for them, not cross your fingers. Storing chemicals by functional groups is usually safer.

You must date all ether cans with the opening date, and be very wary of anything over three months old. These can accumulate explosive peroxides that detonate when dry. A test for peroxides (from Chemist's Companion):

Add 3 ml of the ether to 1 ml of water containing 1 mg $Na_2Cr_2O_7$ and 1 drop dilute H_2SO_4. Shake. A blue color in the organic layer (perchromate ion) indicates the presence of peroxides.

There are more sensitive tests, and methods for removing the peroxides, given in Chemist's Companion .

There is an OSHA rule that corrosives (concentrated acids and bases) cannot be stored in glass bottles more than five feet off the floor. The new plastic coated acid bottles may make this a moot point, since everyone that I've talked to says that they've never seen one of these leak when shattered, but do you want to be the first case?

We will cite labs for overcrowded shelves of chemicals: no part of the bottle can extend beyond the front of the shelf. East Tennessee has earthquakes! [Richter 3.9 in middle TN/N. AL 1988) A little more shaking, and the cleanup would be appreciable. We will also cite labs for storing chemicals in glass bottles on the floor.

Floor used as storage area

Don't. Keep the aisles clear.

Cluttered hood

Hoods are not just boxes with big fans attached, that mysteriously make all your problems disappear. Instead, they are carefully engineered devices, whose proper operation is rather easy to defeat if you don't know what you're doing, or are deliberately ignoring the rules.

Hoods exhaust the air in two places: benchtop level for heavier-than-air vapors, and at the top for lighter-than-air fumes. The back wall (on modern ones, at least) is not solid, but a baffle with an air channel behind it, that takes the heavy gases up to the top and out. The knobs that are often present on the back panel are designed to adjust the mixture of heavy and light exhaust that occurs, by varying the size of the air passage behind the back baffle.

Thus, anything that blocks airflow at the bottom of the back of the hood impedes its effectiveness. The urge to push all the bottle, beakers, etc. to the back of the hood bench, in order to have more space to work, is counterproductive. Items should be moved to the sides of the hood where there is no airflow. The back edge of the benchtop should remain clear. If you must store bottles of chemicals in the hood due to stench reasons, get shelves made for the sides of the hood. Also, one should yearly clean any dust and lint from behind the baffle, to improve airflow. This is most easily done with a bent

coathanger wiggled behind it from below.

A hood should pull between 60 and 120 cu. ft./min. of air (ca. 1-3 linear ft/sec) when the sash is down to about a foot above bench level. It is possible for a hood to pull too fast, which causes vortexing of the air inside, reducing flow up the exhaust. Also, as one walks past a hood, the draft from your passage (2 mile/hr = 3 ft/sec) can reverse the airflow from a hood that is on the slow end of the above range, pulling air back into the lab. One should move slowly around a hood! Measuring the airflow quantitatively takes elaborate equipment, but a quick qualitative device is free: tape a 1" wide by 5" long strip of Kim-wipe or Kleenex to the bottom center of the sash . If it doesn't swing in by 30 to 45 degrees with the sash at one foot high, your airflow is too low. This also provides a useful means of determining whether a hood is working from across the lab, upon first entering, since it is so easy to see. YOU are responsible for verifying that a hood is working, before you carry out any procedure in it.

Blockage of makeup air vents

Hoods only work if there is air available to them. This is called "make-up" air, and must be provided to the lab through vents of some kind. The best modern hoods (none in Buehler/Dabney) provide this partially as unheated outside air, entering the hood at benchtop level, so that only ca. 30-40% of the air going up the hood comes form the heated (expensive) lab air. Most labs (new Buehler) have a vent in the wall or ceiling to provide the fresh air into the lab. These must not be blocked! Lab design is such that this should be carefully balanced for hood exhaust by having the doors to the hall closed as well, so that all the make-up air comes from the vent, to sweep out the lab. This also keeps the lab at a negative pressure with respect to the halls, so that stenches go up the hood, not spread throughout the building. If you do have an odoriferous spill in your lab, don't open the hall doors to get rid of it; that just makes it someone else's problem. Let the lab air system handle it as it was designed to do, even if this means your clearing out of the lab for a while. The safety inspection team can't check all these items concerning airflow, other than verifying that make-up air sources are not blocked. It is to the advantage of anyone (and everyone) working in a lab, to periodically check the airflow from the make-up air vent (doors closed, a strip of Kleenex held up to the vent) to be sure that things are working properly. Just because the mechanical equipment is there doesn't mean that Physical Plant or accidents haven't fouled things up.

In old Buehler/Dabney, these is no makeup air, so that either a door or a window to the lab must remain open for the hoods to operate properly. In such a case, if there is a choice, the door or window farthest from the hoods in use should be the source of the make-up air, so that it sweeps out the lab air before it goes up the hood.

Unstrapped Gas Cylinders

All gas cylinders larger than a lecture bottle should be secured at all times with a standard strap assembly clamped to a solid benchtop, or by a similar chain assembly screwed to the bench (the Chemistry Wood Shop can provide the latter very inexpensively). "It's empty" is NOT an acceptable excuse for an unstrapped cylinder; you don't know that for sure unless there's a hole in the cylinder, so CLAMP IT DOWN! Any cylinder without a regulator attached must have the metal valve cap installed and screwed down.

Electrical Problems

Overused outlet; Bad wiring

An overused outlet is one with more things plugged into it than there are sockets: DON'T USE OCTOPUS PLUGS! There are circuit breakers associated with the outlets in your lab; do you know where they are? Do you know which outlets are on a common circuit, and which on another? Do you know how many amps a heat plate/stirrer/water bath/etc. use? It is your responsibility to be aware of these things, and not to assume that the designers of the laboratory knew in advance how much power your particular research might need, so that the lab was wired with enough capacity.

You should, at least yearly, inspect the cords and cables of all electrical appliances and equipment in your lab. Do this by (1) unplugging the cord, (2) bending it double over its whole length, and (3) looking for cracks in the insulation. If you see any, it should be replaced. The Electronics shop will do this for you. Electrical tape is **not** allowed as a fix for cords with broken insulation; the cord must be replaced.

Electrical cords should never be run across the floor, due to the hazards of spills, floods, and resultant shorting. Elevate them off the floor with a ramp of some kind. Secure them, so that people do not trip on them.

Machine Guard missing

All moving mechanical devices (with belts on mechanical vacuum pumps the principal offender) should be covered by a guard to prevent snaring of fingers, hair, etc. Again, the Mechanical Shop can install these on older pumps.

Vacuum pump not vented to hood

Ideally, the vapors that are pumped away by vacuum pumps are captured by Dry Ice/acetone or liquid nitrogen traps. This is primarily to increase the life of the pump and the oil. Nevertheless, it is not an uncommon occurrence for traps to warm up, either by accident or forgetfulness. The vent from a mechanical pump should be exhausted to a hood or similar exhaust, to prevent toxic fumes from getting into the lab air. If you are using a dry ice trap, some ether can get by these even when they are working properly. The Mechanical Shop can make a small adapter, to connect a hose to the exhaust to run to the hood.

Water hoses not clamped

Rubber or plastic water hoses should be secured to the glass nipple to which they are attached by twisted wire. They should also be attached to metal frames or stands with tape or twisted wire, if they can come in contact with hot surfaces like hot plates, baths, or heated flasks. This is especially true for things left running overnight. Day or night, hoses should be clamped at the water faucet. If you use the plastic "quick-connect" fittings for hoses, these must also be clamped securely with a joint clamp. A minor leak that is easily caught during the day can be a major disaster if water flows all night into someone else's lab. The outlet of the hose in a sink or trough should be weighted to prevent its flopping out of the basin.

No catch basin under mercury container

Mercury spills are especially insidious, in that the traditional method of cleaning them up with powdered sulfur is next to useless; the reaction is far too slow at room temperature. There will be a small (aspirator powered) mercury vacuum in the spill kit being set up in the Xerox room, plus chemicals to dust with after the macroscopic bits are cleaned up. The best cure is to have a catch basin under any container of mercury, such as manometers or MacLeod gauges. The ideal basin is the cut-off bottom of a plastic gallon milk bottle (free!).

Untaped Dewar flask

To prevent accidents from glass shards in an implosion, all Dewar flask should either be taped with strong tape like electrical or duct tape, or have the fine plastic mesh around them.

View through window blocked

Unless a lab has a specific need for being light-tight, such as a laser lab, at least half the window pane in the door must be clear of cartoons, graffiti, xeroxes, etc. We need to see into a lab in an emergency, before going charging into a situation.

[End of Lab Inspection Information]

6. OTHER GENERAL SAFETY PRACTICES:

It is always a good idea to leave a small sign next to (on the hood sash) any reaction left unattended, so in case of a crisis, your labmates can handle runaway reactions or spills. This need only be the reagent/reactants/products -on-an-arrow type description, plus your name. This could save you lost product and time, etc. This is certainly true for any reaction left overnight.

7. YELLOW SAFETY NOTICES

These **must** be posted outside all lab doors, with the pertinent information filled in. Blank ones are available in BU 601 (Bartmess' office), and at the Chem Stores window. These should be updated each semester. Emergency contact information that is missing or outdated could cost you a year of research (documented cases!).

Appendix 1. The Seven Magic Question That We All Must Know the Answers To.
(all punctuation and grammar for the questions are from the original)
The Legal Types insist that all personnel must be able to answer all these question on random demand.
"EMPLOYEE KNOWLEDGE AND IMPLEMENTATION ON CHEMICAL HYGIENE PLANS.

The following questions must be verbally answered in precise and basic language:

1. What is the objective of the occupation exposure to hazardous chemicals in the laboratory standard, 29 CFR 1910.1450?

To ensure that employees have been provided with the necessary information and training to protect themselves in regard tio hazardous chemicals.

2. What hazardous chemicals do you work with and where?

This obviously varies with the person and time. Assume that anything that comes out of a bottle or can, or that you have made, falls in this class. Chemists: you should know this before you use it. See the CHP for sources of info. Non-Chemists: see your supervisor.

3. What long and short term effects can they have on your body?

Again, chemists should learn from the sources mentioned above, and stay current .

4. How can you detect the presence, concentration level, and/or release of the hazardous chemicals that you work with?

Odor is the most common. Information from the LAN is useful for alerts concerning spills or releases. This is specific to the chemicals used.

5. What measures are or can be taken to protect you against overexposure and in the event of any emergency?

Fume hoods, sealing containers properly for routine use; Clearing the area (LAN, fire alarms) for emergencies. This is specific to the chemicals used.

6. What are the medical provisions of this standard?

The employer must provide appropriate medical screening of the employee upon an identified exposure to a hazardous substance.

7. Where is the information, such as the MSDS and the Chemical Hygiene Plan located and have they been explained to you?

MSDS: file cabinet in the Dry Ice Room.
Chem Hygiene Plan: http://web.utk.edu/~bartmess/chemhyg.html
hardcopy: Long's' Office, BU 420;
Main Office, BU 552; ChemStores, BU 230A.

Ten Fundamental Rules of Chem Lab Safety

1. If it has a chemical in it, put a label on it NOW.
(reaction, flask, bottle, waste jar.....

2. If it's broken, fix it or clean it up (and reorder) NOW.
(don't put it off or leave it for others)
electrical, mechanical, glass, chemical....

3. YOUR chemical spills are YOUR problem.
(don't open doors to disperse it; that makes it someone else's problem - let the hoods do their job.
Clean it up yourself **all the way** . NOW!)

4. It's all toxic; it's all flammable.
(except for the water from the water fountains, and I wouldn't trust that first thing in the morning.)

5. The time to plan your safety procedures and backups is not just before you open the first bottle, it's when you design the experiment, before the purchase order goes in.

6. Clamp your hoses.

7. Hot glass looks just like cold glass.

8. Take notes **now** . Then go take more notes, so others can determine what went wrong after the disaster.

9. Back up your disk NOW, back up your notebook NOW.

10. **Think Things Through** BEFORE you do anything.