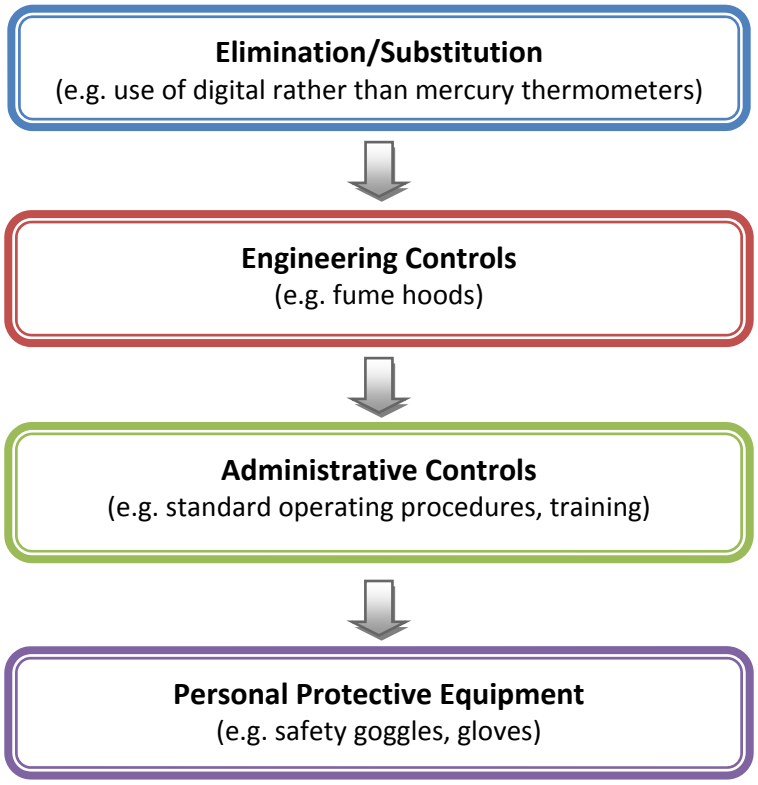
HAZARD MANAGEMENT

Once the hazards have been identified and evaluated, appropriate control measures can be implemented in the workplace. Control is defined as the adjustment or regulation of an operation to: meet a standard or guideline, reduce or prevent the release of contaminants, and contain a hazard. Management of hazards in the laboratory will often involve a combination of the following strategies (provided in order of effectiveness):



Elimination/Substitution

Eliminating the use of a toxic substance is generally the best form of control. If elimination is not practical, many toxic materials have suitable substitutes which are less harmful. For example, water-based products are generally less harmful than solvent-based products.

Engineering Controls

Engineering controls are considered the first line of defence in the laboratory to reduce or eliminate an individual's exposure to hazardous chemicals. These controls include changing the process, isolation, ventilation, and source modification to reduce the amount of contaminants released into the workplace. Examples in a laboratory include fume hoods, local exhaust ventilation, and proper storage facilities.

Administrative Controls

Administrative controls include the use of management involvement, training, job rotation, reduction of exposure time, preventative maintenance, and housekeeping in an effort to control worker exposures.

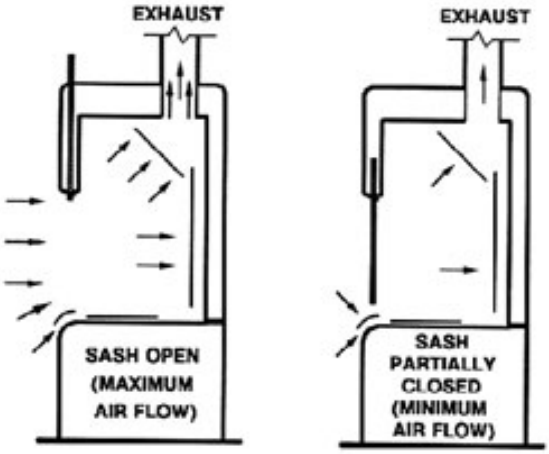
Personal Protective Equipment (PPE)
Personal protective equipment involves the use of devices (e.g. gloves, eye protection, protective clothing, and respirators) designed to protect individuals from hazards in the workplace.

CONTROLLING CHEMICAL EXPOSURE

ENGINEERING CONTROLS

Fume Hoods
Fume hoods are the most common and effective engineering controls in place to protect laboratory personnel against exposure to hazardous materials. A fume hood is a ventilated enclosure that provides local exhaust and allows chemicals to be handled safely if the hood is used properly and its limitations are understood. Refer to the University Laboratory Fume Hood Standard provided in the manual.

The fume hood is attached to an exhaust system that draws air and contaminants away from the operator and out to the external environment, minimizing the risk of worker exposure to contaminants and release of contaminants into the room. Access to the interior of the hood is through an opening which is closed with one or more sashes to vary the opening into the hood. Work that involves hazardous materials which are toxic, volatile or harmful shall be conducted in a fume hood.



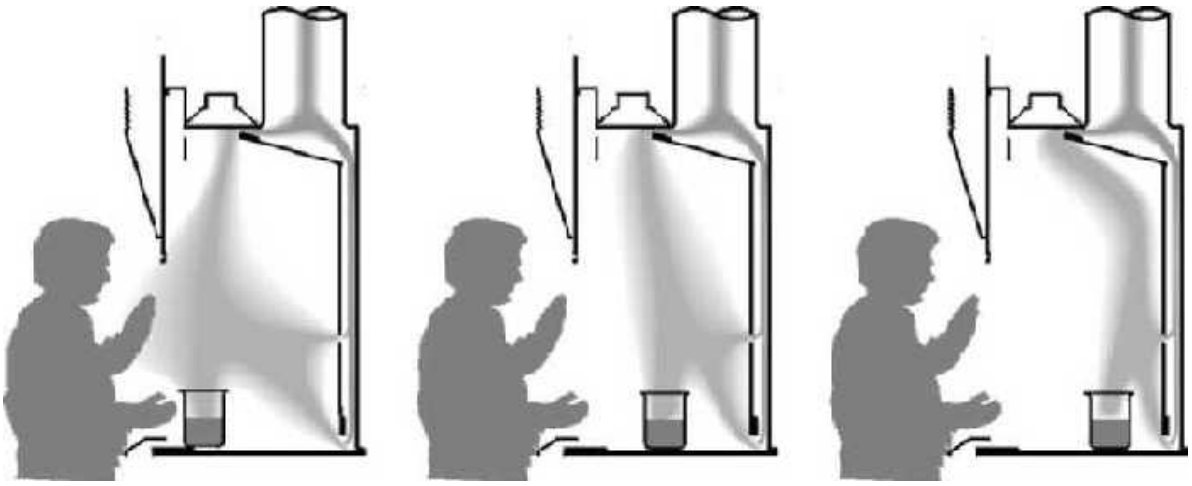
There are two types of fume hoods which are commonly used: Constant Air Volume (CAV) and Variable Air Volume (VAV) fume hoods. A CAV fume hood exhausts air at a constant rate. As the sash is lowered, the face velocity increases. Most CAV hoods have bypasses, which allow more air to pass through them as the sash is lowered. Having a bypass also means that air can be exhausted when the sash is closed.

For a VAV fume hood, the exhaust rate or quantity of air pulled through the hood varies as the sash is adjusted, in order to maintain a constant face velocity. As the sash is lowered, less air is exhausted through the hood, creating a more constant velocity that can be maintained across different sash heights.

Recirculating (self-contained) fume hoods are not permitted for protection from chemical hazards at the University of Toronto. Existing hoods of this type may continue to be used for low risk activities; however serious consideration should be given to replacing the unit. Under no circumstances should recirculating hoods be used where materials of high or unknown toxicity have the potential to become airborne.

When using a fume hood, one must remember that the hood does not provide absolute containment or absolute protection from the materials being used in the hood. Adequate protection can be provided if the following practices are observed:

- All work involving hazardous chemicals should be performed in a fume hood.
- **Never** conduct work in a malfunctioning fume hood. Always ensure the hood is operational **before** starting an experiment.
- Keep head away from the inside of hood when contaminants are being generated.
- The sash should be used to minimize the size of the working aperture and to act as a safety screen. While performing work in the hood, the sash should be kept as low as possible and never above the sash stop.
- If the sash needs to be raised above the maximum safe working height and the sash stop overridden to facilitate the movement of materials or equipment into or out of the fume hood, the sash must be returned to a safe working height before work with hazardous materials commences.
- **Close** the sash when the fume hood is **not in use**.
- All equipment and materials should be placed at **least 6 inches** back from the face of the hood; these items should not obstruct the movement of air into the hood. Work should be performed as deeply within the fume hood as practical. It is recommended that the 6 inch distance be marked with tape as a visual reminder.



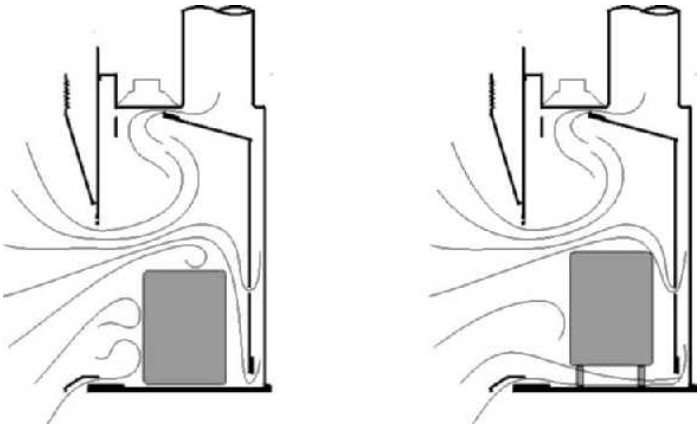
Bad placement of materials *Better placement of materials* *Best placement of materials*

(Image source: http://web.princeton.edu/sites/ehs/labsafetymanual/sec6b.htm)

- Keep the inside of the fume hood **clean** and **tidy**.
- The hood should **not be used as a storage area** or be overloaded with unnecessary equipment and materials. The presence of these materials can seriously affect the air flow in the hood and cause contaminants to escape into the laboratory.
- The hood should not be used for long-term storage of hazardous chemical waste.
- Cross drafts created by foot traffic, air supply inlets, or the opening and closing of doors and windows can disrupt the air flow and reduce the effectiveness of the hood to capture and

contain contaminants. Therefore, laboratory activity and foot traffic should be minimized while the hood is in use.

- **Do not** use infectious material in a chemical fume hood.
- Radioactive materials may not be used in a fume hood without prior approval from Radiation Protection Services.
- **DO NOT** use a hood for any function for which it was not intended (e.g. perchloric acid).
- The emergency procedure should be followed in the event of a ventilation failure. See *SECTION 8: Emergency Preparedness Procedures and Equipment.*
- Electrical receptacles or other potential spark sources should not be placed inside the hood when flammable liquids or gases are present. All electrical connections should be made outside the hood and no permanent electrical receptacles should be permitted within the hood.
- When instrumentation is used for a process inside a hood, all instruments should be elevated a minimum of 2 inches from the hood base to facilitate proper air movement.



Poor placement of large equipment *Good placement of large equipment*

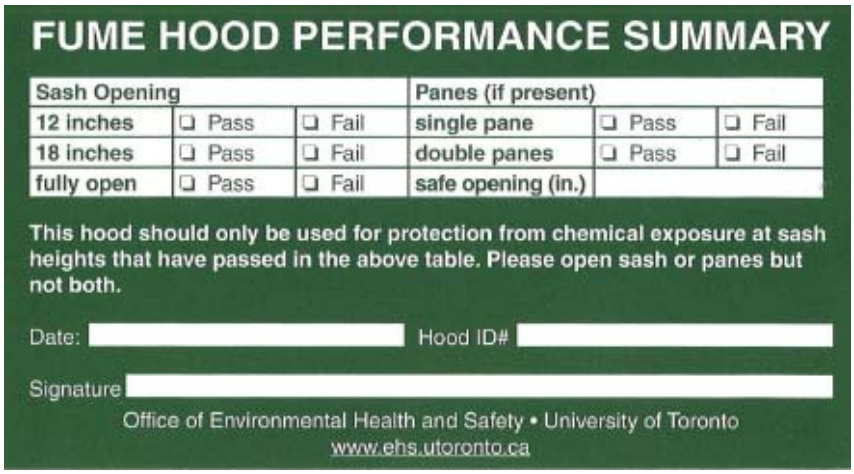
(Image source: http://web.princeton.edu/sites/ehs/labsafetymanual/sec6b.htm)

User Maintenance Checks

Users must ensure proper operation of fume hoods by performing the following "Maintenance Checks" **prior** to using the fume hood:

- Inspect the physical condition of the hood interior, sash and visible duct work
- Check sash for ease of operation
- Test air-flow monitoring device if present (e.g. Ventalert alarm system)
- Check mechanical services inside the hood (e.g. water, steam, compressed gas, vacuum)
- In case of fume hood malfunction:
    - Discontinue use of fume hood. Seal containers and close sash.
    - Label as "Out-of-Service"
    - Inform your supervisor
    - Call Facilities Management (416-287-7579)
    - Report your name, phone number, exact location and reason for call
    - Once fume hood has been repaired, remove "Out-of-Service" sign

The Office of Environmental Health and Safety is responsible for performing the annual certification of fume hoods on campus. Each fume hood must have a green "FUME HOOD PERFORMANCE SUMMARY" sticker. If a fume hood does not have a certification sticker, please contact the Office of Environmental Health and Safety at 416-978-4467 to arrange for certification.



FUME HOOD PERFORMANCE SUMMARY

Sash Opening			Panes (if present)		
12 inches	❑ Pass	❑ Fail	single pane	❑ Pass	❑ Fail
18 inches	❑ Pass	❑ Fail	double panes	❑ Pass	❑ Fail
fully open	❑ Pass	❑ Fail	safe opening (in.)		

This hood should only be used for protection from chemical exposure at sash heights that have passed in the above table. Please open sash or panes but not both.

Date: Hood ID#

Signature

Office of Environmental Health and Safety • University of Toronto
www.ehs.utoronto.ca

Laboratory Ventilation

A net negative pressure (vacuum) is created in a laboratory because more air is exhausted from the space than is supplied to it. Negative pressure draws air into the laboratory from surrounding areas and prevents hazardous airborne contaminants from spreading outside the laboratory in the event of an accidental release. Balancing laboratory ventilation must take into consideration the amount of air exhausted by local ventilation devices such as fume hoods. **Leaving doors and windows open in the laboratory should not be permitted** because it can pressurize the room, pushing air from the laboratory into adjacent non-laboratory areas.

ADMINISTRATIVE CONTROLS

General Laboratory Safety Procedures

Although there is a wide variety of hazards that may be present in any laboratory, the likelihood of injuries or accidents in the laboratory can be reduced by following general laboratory safety procedures.

Good Work Practices

- **Before** starting any work in a laboratory, individuals should familiarize themselves with the following:
  - Hazards of the materials in the laboratory, safe handling and storage of chemicals, and emergency procedures.
  - Read labels and material safety data sheets (MSDSs) before moving, handling or opening chemicals. Never use a product from an unlabelled container and report missing labels to the supervisor.
  - Agents, processes and equipment in the laboratory. Consult the laboratory supervisor before proceeding with any experiment that you are unsure of (e.g. safe handling of material, operation of equipment, experimental technique, etc).
  - Any hazardous reactions that may occur.
  - Location and operation of safety and emergency equipment such as fire extinguishers, eyewash stations, safety showers, first aid and spill response kits, fire alarms, telephone and emergency exits.
  - Emergency spill response procedures for the materials handled.

  - Designated and alternate escape routes.
- **Report** all unsafe conditions, accidents and injuries **immediately** to the supervisor.
- Laboratory personnel shall not perform experiments that have not been authorized by the laboratory supervisor.
- Be aware of other workers in the laboratory and the work they are doing.
- **All** equipment should be inspected and maintained on a **regular** basis.
- Laboratory access should be restricted to authorized personnel only.
- Any operation that may release chemical gases, vapours, and/or dust in the air should be performed in a fume hood.
- Keep the fume hood free of clutter.
- **Walk.** Do not run in the lab.
- Horseplay and practical jokes are **prohibited**.
- **Keep** exits and passageways **clear at all times**.
- Ensure access to emergency equipment is not blocked.
- **Never** pipette by mouth.
- When diluting solutions, **always add acid to water**; never water to acid.
- Observe all precautions listed on the chemical label and MSDS.
- Spills must be cleaned up **immediately**.
- Laboratory workers should perform a safety check at the end of each experiment and at the end of each day before leaving the lab to ensure that gas, water, electricity and other services have been turned off if not required.
- Laboratory workers shall not leave an experiment unattended if it presents a potentially hazardous situation. If it is necessary to leave any experiment unattended, proper procedures must be followed.

Personal Hygiene Practices

- Wash hands and arms carefully after handling chemicals and before leaving the lab. Take care not to contaminate surfaces or equipment.
- Tie back long hair and avoid wearing loose clothing, as these can easily catch fire, inadvertently come in contact with chemicals or become entangled in equipment.
- Insertion or removal of contact lenses, application of cosmetics or any other practice that could transfer hazardous materials to the eyes or mouth is **not permitted** in the laboratory.

Food and Drink

- **Consumption of food or drink** (including water) in any lab is **strictly prohibited**.
- Food or drinks are not to be stored in refrigerators used for chemical storage.
- The use of laboratory equipment (e.g. glassware, refrigerators, freezers, ovens, etc.) to store or prepare food is **strictly prohibited**.
- Ice from laboratory ice makers is not to be consumed.

Housekeeping

Laboratory safety requires that good housekeeping practices be followed. Each laboratory worker is responsible for maintaining the cleanliness of his/her work area. All laboratory workers share a responsibility to maintain the cleanliness of common areas.

- All work areas, walkways and aisles must be kept **clean and free of obstructions**.
- Clean up all spills **immediately**. All spills must be reported to the supervisor.
- Bench tops, fume hoods, stairways and halls shall **not** be used as storage areas.
- Any articles stored near aisles shall be restrained to prevent them from falling.
- Exits and access to emergency equipment (e.g. fire extinguishers, safety showers, eyewash stations, etc.) shall not be obstructed.
- Chemicals and equipment should be returned to their proper storage location immediately after use. Laboratory samples being processed should be returned to their storage locations as soon as possible.
- Items should be **kept away** from the edge of bench tops, counters or shelves so they cannot be easily knocked off.
- Contaminated or dirty glassware should be placed in designated containers and not be allowed to accumulate in sinks, on bench tops or in surrounding areas.
- Equipment and materials no longer being used must be disposed of following proper waste removal procedures and **not allowed to accumulate** in the laboratory.
- Experiments should be cleaned up upon completion or at the end of the day.

Working Alone

It is not advisable to conduct laboratory work alone. If an individual is working in a laboratory out of visual and verbal contact with another person and assistance is not immediately available in the event of an injury, illness or emergency, working alone procedures **must** be followed.

- PIs/lab supervisors that supervise laboratory workers who may have to work alone must assess the hazards of the work to be done and the hazards of the laboratory itself prior to allowing specific projects or tasks to be performed while the individual works alone.
- The supervisor must be informed of dates, times and locations of all working alone situations.
- All supervisors should develop a written hazard assessment and protocol detailing procedures for working alone in their laboratories.
- When working alone, laboratory personnel are encouraged to make arrangements to have someone check-in with them regularly either in person or by phone.

- In laboratory situations where chemical, physical or biohazardous agents are being used, the supervisor should implement a "buddy system" to ensure that no worker is ever out of visual and verbal contact with another worker while in the laboratory.
- UTSC Campus Police Services have developed a Working Alone Program for individuals who may have work alone. For more information, please visit: http://www.utsc.utoronto.ca/~police/lone_worker

The following circumstances are examples of situations where **working alone should be prohibited**:

- Work involving acutely toxic substances (e.g. sodium cyanide);
- Work involving explosive substances (e.g. peroxides);
- Hot work (i.e. work involving an open flame where flammable substances are present);
- Work involving the use of highly corrosive substances (e.g. hydrofluoric acid).

Unattended Procedures

In general, laboratory activities should only be conducted while the experimenter or a knowledgeable co-worker is present in the laboratory or in an adjacent office where he or she can respond immediately in the event of an accident or emergency. However, there are circumstances where laboratory procedures may need to run when there is no one in the lab. If a procedure is left unattended, prior review of the hazards (e.g. materials and procedures) should be completed. This must be done in consultation with the laboratory supervisor and must consider consequences of interruptions such as loss of power, water leaks, and failure of equipment. Only procedures that are deemed to be safe if left unattended are allowed to continue without personnel being present in the laboratory. The following are requirements for unattended laboratory procedures:

- Unattended procedures are to be visited periodically.
- A notice must be posted outside the laboratory door indicating that an unattended experiment is in progress. This notice should describe the nature of the experiment, equipment involved and the names and telephone number of people to be contacted in case of an emergency. The notice should also indicate the start date and time along with the expected completion date and time of the work. See template.
- Unattended experiments should only be conducted if a laboratory worker can be readily contacted in case of an emergency.
- Laboratory supervisors are responsible for ensuring that unattended experiments are only conducted when they cannot be avoided and that they are conducted in a way that minimizes the consequences of an equipment or service failure.
- Unattended procedures using water are to have hoses securely attached and the water adjusted to the minimum flow necessary. Ensure plumbing drains are clear before leaving the procedure.
- Unattended heating is only to be done using heating equipment that reliably maintains stable temperatures.
- If heating is being performed, flammable materials are to be removed from the area including hazardous waste.
- The sash is to be closed on all fume hoods.

Visitors in the Laboratory
Due to the potential hazards present in the laboratory, to protect the integrity of the procedures/experiments being performed and for the security of equipment and supplies, visitors **must** be escorted.

- No visitor may enter a laboratory without the knowledge and approval of the laboratory supervisor.
- Visitors are subject to the same requirements with respect to personal protective equipment and adherence to laboratory safety procedures outlined for laboratory personnel.

Laboratory Security
Principle investigators, laboratory supervisors and all laboratory workers shall cooperate to prevent the unauthorized entry of individuals into the laboratory and the removal of hazardous materials. No hazardous material shall be removed from any laboratory except with the knowledge and permission of the laboratory supervisor. Hazardous materials may not be left unattended or unsecured at any time. **When vacant, laboratories shall be locked to prevent unauthorized entry**. Freezers, refrigerators, cold rooms and storage cabinets where hazardous materials are stored or used should be locked at all times, except when they are under the direct observation of the laboratory supervisor or a laboratory worker.

The laboratory supervisor is responsible for ensuring the security of all hazardous materials stored or used by laboratory staff or students. The laboratory supervisor shall immediately report any unaccountable loss of hazardous material(s) to UTSC Campus Police Services, the Office of Environmental Health and Safety and the Department Chair. Individuals should report anyone or anything that looks unusual or out of place to UTSC Campus Police Services at 416 287-7333.

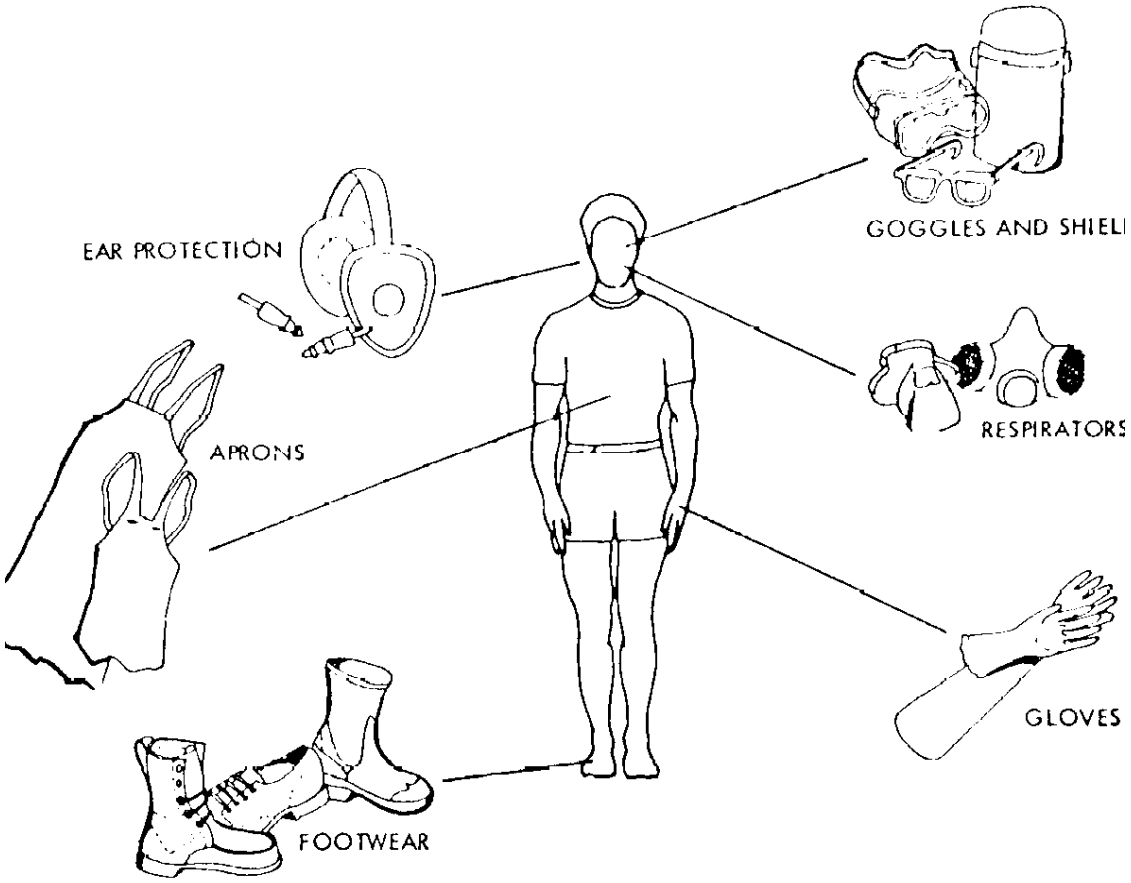
Pregnant Workers in the Laboratory
Laboratory conditions can present unique risks to pregnant workers. Exposures to *certain* chemical, biological, physical or ergonomic risk factors may be hazardous to the pregnant worker and fetus. The University's Workplace Screening Tool for Pregnant Workers must be used by the laboratory supervisor and pregnant worker to assess what reproductive hazards may be present in the laboratory. If such hazards exist, the Office of Environmental Health and Safety should be contacted to conduct a more detailed assessment.

PERSONAL PROTECTIVE EQUIPMENT
Personal protective equipment (PPE) is used to protect the wearer from specific hazards of a substance. It is a last resort with respect to protection in the laboratory and should be used in addition to other forms of control measures (e.g. fume hoods). PPE does not reduce or eliminate the hazard, but only provides a degree of protection to the user. The need for PPE depends on the type of chemical hazard (nature and quantity) and operation being performed. The individual may need to use safety glasses or goggles, face shields, gloves or protective clothing. See University Standards for Personal Protective Equipment provided in this manual.

Two essential elements of PPE use are:

(A) Match the type of PPE to the specific hazard.

(B) Implement a maintenance program for the PPE which involves regular inspection and repair, cleaning and proper storage.



Laboratory areas should be clearly labelled as to the PPE required, to ensure communication to any individual entering the area. Personal protective equipment is not to be used in place of engineering controls such as fume hoods, but is to provide supplemental protection. Individuals must be properly trained on any PPE (e.g. function, proper use, and limitations) they are required to use.

Eye and face protection

Eye protection should always be worn in the lab. Safety glasses with side shields are adequate wherever there is the possibility of objects striking the eye, such as particles, glass or metal shards. Safety glasses do not provide adequate protection from chemical splashes because they do not form a seal to the face, resulting in gaps at the top, bottom and sides, where chemicals may enter. Safety glasses are also not appropriate for dusts and powders, which can also enter through the gaps. *Chemical splash goggles* should be worn when there is the potential for hazardous materials to splash (e.g. exposure to corrosive materials such as strong acids or bases).

Face shields should be worn where there is the potential for explosions, implosions or splashing, or when working at reduced pressure as it protects the face, neck and ears. Face shields must be used in conjunction with safety glasses or goggles.

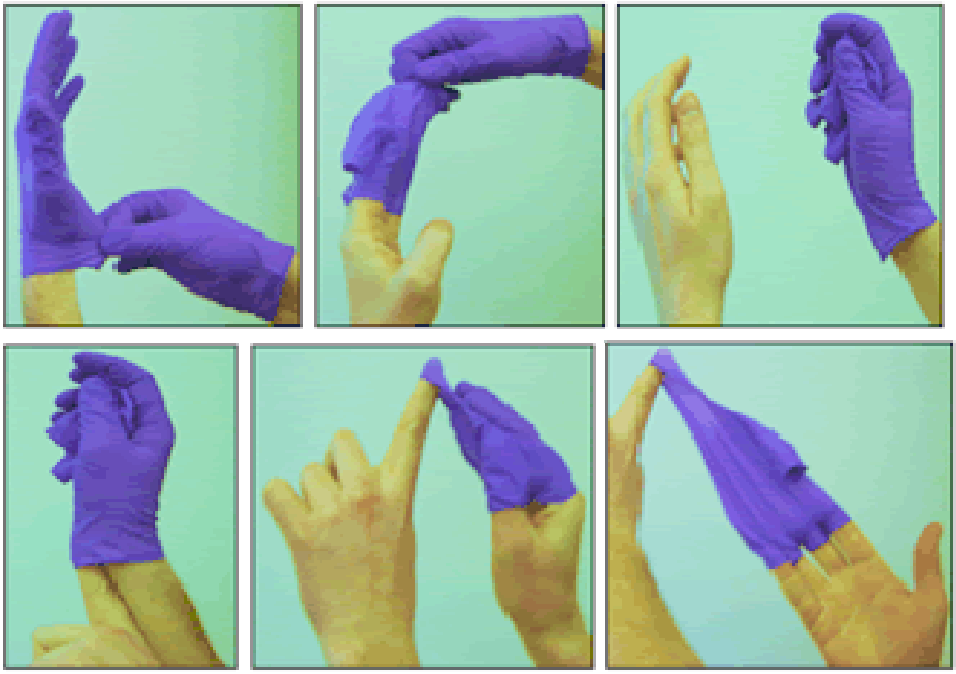
Contact lenses may be worn in the laboratory, but do not offer any protection from chemical contact. If a contact lens becomes contaminated with a hazardous chemical, immediately remove the lens and rinse the eye(s) using an eyewash station. Contact lenses that have been contaminated with a chemical must be discarded.

Gloves

Gloves should be worn whenever there is a risk of skin damage and/or absorption such as when handling hazardous materials, chemicals of unknown toxicity, corrosive materials, rough or sharp-edged objects, and very hot or very cold materials. Gloves must be selected on the basis of the material being handled, the particular hazard involved and their suitability for the operation being conducted.

When handling chemicals in the laboratory, disposable latex, vinyl or nitrile gloves are usually appropriate for most circumstances. These gloves will offer protection from incidental splashes or contact. When working with chemicals with high acute toxicity, working with corrosives in high concentrations, handling chemicals for extended periods of time or immersing all or part of a hand into a chemical, the appropriate glove material should be selected, based on chemical compatibility.

Inspect the gloves before using them to ensure there are no cracks or small holes. Avoid contaminating clean surfaces with used gloves. Remove gloves prior to leaving the lab.



Gloves should be removed properly to avoid skin contact with the exterior of the glove and possible contamination.

1) Grasp the exterior of one glove with your other gloved hand. Carefully pull the glove off your hand turning it inside-out. The contamination is now on the inside.

2) Ball the glove up and hold in your other gloved hand. Slide your ungloved finger into the opening of the other glove. Avoid touching the exterior.

3) Carefully pull the glove off your hand, turning it inside out again. All contamination is contained. Discard in appropriate container.

Foot Protection

Appropriate footwear must be worn in the laboratory. Closed-toed shoes should be worn at all times where chemicals are stored or used. Any footwear that exposes toes or any portion of the foot (e.g. sandals, slippers) must not be worn in the laboratory as they provide no barrier between the laboratory worker and chemicals or broken glass. Safety shoes with toe guards should be worn by individuals likely to be exposed to a foot injury, such as those required to work around heavy or rotating equipment, or those handling heavy materials.

Protective Clothing

Laboratory coats must be worn where there is the potential for chemical splashes or spills. Plastic or rubber aprons should be worn at all times when handling acids, caustics and strong oxidizing solutions. Disposable outer garments (e.g. Tyvek suits) may be useful when cleaning and decontaminating reusable clothing is difficult. Any protective clothing should be easily removable in case of an accident. **Laboratory coats should be removed when leaving the lab**. Laboratory coats should not be laundered with regular clothing.

Respiratory Protection

Respirators provide personal protection either by removing contaminants from the air before they are inhaled (e.g. air-purifying respirator), or by supplying breathable air (atmosphere-supplying respirators). Respirators are required for work which involves exposure to potentially hazardous environments. The use of respirators may be required when engineering control measures are inadequate, during shutdown for maintenance or repair, or during emergency situations. Consult with the Office of Environmental Health and Safety if respiratory protection is needed, as training and fit-testing is required prior to respirator use.

Hearing Protection

Appropriate hearing protection should be worn by individuals who work in areas with noise hazards or have the potential to develop noise-induced hearing loss as a result of their occupation, and where it is not practical or feasible to reduce or eliminate excessive noise exposure in the laboratory by means of engineering controls or work practices.