CHEMICAL HYGIENE PLAN

JOHN CARROLL UNIVERSITY

Version 7 (effective 29th Aug. 1996)

This document replaces the previous Chemical Hygiene Plan (version 6) and sets forth procedures, equipment, personal protective equipment and work practices that
(i) are designed to protect employees of John Carroll University (JCU) who work in JCU laboratories from the health hazards presented by hazardous chemicals used in the JCU laboratories and,
(ii) meet the requirements of paragraph (e) Part 1910 of title 29 of the Code of Federal Regulation (CFR), "Occupational Exposures to Hazardous Chemicals in Laboratories", published by the Department of Labor, Occupational Safety and Health Administration (OSHA).

Statement of Policy.

John Carroll University is committed to protecting the health and safety of its employees in their work within the university. Recognizing that particular health risks may be encountered by employees who operate in laboratories where hazardous chemicals are in use, the administration endorses the implementation of the Chemical Hygiene Plan herein. The goal of this plan is to make JCU laboratories as safe as possible, and to ensure the continuing protection of faculty, student assistants and all other employees who work within the labs, as well as the students who are trained in them.

The ultimate responsibility for excellent safety and health performance lies with the employees themselves. Employees should be always vigilant and dedicated to safety practices as a first priority. There can be no room for carelessness or for casual attitudes.

Responsibility for implementation of this plan lies with all employees, but the effort will be coordinated by the Chemical Hygiene Officer, Dr. P. R. Challen, of the Chemistry Department. He is available to provide assistance to employees in fulfilling their safety responsibilities.

Sources.
This document has been adapted from the following sources:

Department of Labor; OSHA; 29 CFR Part 1910

"Prudent Practices for Handling Hazardous Chemicals in Laboratories"; Committee on Hazardous Substances in the Laboratory, Assembly of Mathematical and Physical Sciences, National Research Council; National Academy Press; Washington, D.C. 1981.

"Safety in Academic Chemistry Laboratories"; American Chemical Society.

"OSHA Laboratory Standard Implementation Guide"; Leo C. Hearn, Jr., CIH, Steven L. Goode, CSP, CIH, David F. Coble, CSP; Lewis Publishers

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PART 1. STANDARD OPERATING PROCEDURES

This section describes general equipment in use in JCU labs, and general operating procedures to be followed when working in those labs or in other places in the JCU chemistry department (such as the stockroom) where hazardous chemicals may be encountered. The procedures apply to both teaching and research laboratories.

Safety is an ongoing and active concern in a laboratory. All employees are responsible to their peers for ensuring that specific standard safety procedures are followed by everyone involved. Safety in the laboratory depends on critical judgements and how each team member applies the information that is made available and observes the procedures. The approval of the Department Head and/or the Safety Officer is required before any deviations from these procedures are permitted.

1.1 Description of the JCU Chemistry Laboratory Facility

The JCU chemistry department, located on the 2nd floor of the Bohannon Science Building, consists of two(2) General Chemistry Teaching Labs, two(2) Organic Chemistry Teaching Labs, one(1) Physical Chemistry Teaching Lab, one(1) Analytical Chemistry Teaching Lab, one(1) Biochemistry Teaching Lab, one(1) Instrumentation Lab, ten(10) Research Labs, a Stockroom, a solvent and waste storage room (adjacent to the loading dock), an acid storage room (adjacent to the "Radiochemistry" lab.), several lecture rooms, and departmental offices.

The ventilation system of the building brings air from outside via ducts in the walls of the 3rd floor. This air is mixed with air drawn from inside the building and either heated or cooled, depending on the season. The air is forced under positive pressure into the labs, offices and other rooms. Other vents allow air out of the rooms and return it to be mixed with outside air. The fume hoods draw air from the labs, mix it with air drawn from outside and pass it up to the roof and out through vents.

Each teaching lab contains the following general features:

Bench areas where most experiments and other manipulations are carried out.

Sinks on each bench for washing hands, rinsing glassware, other uses of flowing water (condensers, aspirators etc) and disposal of a limited number of non-hazardous materials.

Outlets for water, gas and air on each bench.

Safety shower attachments on each bench for a fire victim and for providing water rinse.

Eye-wash attachments on most sinks at the ends of the benches.

Fume hoods for operations with hazardous gases, flammable liquids, materials that evolve hazardous vapors (toxic or flammable), and certain operations with very hazardous materials.

Fire blankets for use on a fire-victim.

Fire Extinguisher.

Eye wash bottles.

First-aid kit.

The organic labs and general labs contain in addition:

Safety showers.

The stockroom contains:

Supplies of chemicals, glassware and apparatus.

Oxygen supply for medical emergencies.

Eye-wash bottles

First-aid kit.

Respirators and gas-masks.

Material safety data sheets (MSD sheets) and other safety data.

The stockroom is off-limits to non-authorized personnel. Authorized personnel include the stockroom manager, chemistry department faculty and administrators, stockroom assistants, and certain graduate and undergraduate assistants. Students who do not fall into one of the above categories are not allowed in the stockroom.

By virtue of the large volume of chemical supplies that are stored therein, the stockroom should be regarded as a potentially hazardous place, and the same precautions and safety procedures that apply to labs also apply in equal or greater force to the stockroom.

The solvent storage room contains bulk storage containers of flammable solvents as well as some other toxic or smelly chemicals and containers of waste chemicals. It is ventilated and insulated from the rest of the building by brick walls. Access is restricted to the stockroom manager and chemistry faculty.

1.2 General lab safety policies

The following is adapted from the American Chemical Society document

"Safety in Academic Chemistry Laboratories". It is applicable to students under the direction of employees as well as to the employees themselves.

i. Eye protection

All people in the laboratory including visitors must wear eye protection at all times. This should take the form of safety goggles, which provide protection from the side as well as from the front. Wearing of contact lenses in the lab is forbidden because contact lenses can hold foreign materials against the cornea. Furthermore they may be difficult to remove in the event of a splash. Soft contact lenses present a particular hazard because they can absorb and retain chemical vapors.

ii. Clothing

Clothing worn in the lab should offer protection from splashes and spills, should be easily removable in case of an accident, and should be at least fire resistant. High-heeled or open-toed shoes, sandals, or shoes made of woven material should not be worn in the lab. If shorts or short skirts are worn, a lab coat should be worn to provide leg protection. Long hair and loose clothing should be constrained. Jewelry such as rings, bracelets, and watches should not be worn in order to prevent chemical seepage under the jewelry, contact with electrical sources, catching on equipment, and damage to the jewelry itself.

iii. Gloves

Plastic or rubber gloves should be worn when handling corrosive, toxic or carcinogenic materials. Check to ensure the absence of cracks or small holes in the gloves before each use. The gloves should be discarded immediately after use to prevent the spread of chemicals to telephones, doorknobs, lab notebooks and the like. When handling chemicals in a hood, the gloves should be removed in the hood before leaving the hood area, and they should not be removed from the hood until they are free of hazardous chemicals. Be aware that if a chemical diffuses through a glove, that chemical is held against the hand and the exposure is worse than if the glove had not been worn. For this reason gloves should be removed and discarded at frequent intervals, and the hands promptly and thoroughly washed. Not all glove materials provide protection against all chemicals. Choice of an appropriate glove based on knowledge of the resistant properties of the glove material to the chemicals being handled should be made with due care.

iv. Personal hygiene

Everyone working in a chemical lab should be aware of the dangers of ingesting chemicals. These common sense precautions will minimize the possibility of such exposure:

Do not prepare, store (even temporarily), or consume food or beverages in any laboratory.

Do not smoke in any laboratory. Additionally, be aware that tobacco products in opened packages can absorb chemical vapors.

Do not apply cosmetics in a lab

Wash hands and arms thoroughly before leaving the lab, even if gloves have been worn

Wash lab coats separately from other laundry

Never wear or bring lab jackets or gloves into areas where food is consumed

Never pipette by mouth. Always use a pipette aid or suction bulb

v. Laboratory protocol

The lab is a place for serious learning and working. Horseplay cannot be tolerated. Variations in procedures including changes in quantities or reagents may be dangerous. It is the responsibility of employees to insist that students under their direction follow proper lab protocol, both for the students' own safety and for the safety of the employees and all others in the lab.

vi. Housekeeping

In the lab and elsewhere, keeping things clean and neat generally leads to a safer environment. Avoid unnecessary hazards by keeping drawers

and cabinets closed while working. Never store materials, especially chemicals, on the floor, even temporarily. Work spaces and storage areas should be kept clear of broken glassware, leftover chemicals and scraps of paper. Packaging materials and empty boxes may constitute a fire hazard and should be removed from the lab promptly after unpacking. Keep aisles free of obstructions such as chairs, boxes and waste receptacles. Avoid slipping hazards by keeping the floor clear of ice, glass beads or rods, other small items, and spilled liquids.

vii. Cleaning glassware

Clean glassware at the laboratory sink. Use plastic buckets to carry glassware to the sink area and heavy rubber gloves when washing glassware. Use hot water and detergent and avoid the use of organic solvents if possible. Avoid the use of strong oxidizing cleaning solutions such as chromic sulfuric acid mixtures since these present an explosion hazard under certain circumstances. Special non-chromium cleaning agents are commercially available. Take care of broken glass hidden in turbid water. To minimize breakage of glassware, sink bottoms should have rubber or plastic mats which do not block the drains.

viii. Transporting chemicals

Refer also to 1.5 "Storage and Transportation of Hazardous Materials" below. Transport all chemicals using the container-within-a-container concept. This will shield them from shock during any sudden change of movement. Use of plastic buckets to carry bottles of flammable solvents or corrosive materials is strongly recommended. Large containers (more than one liter) should not be used for routine transfer of materials. Rather the material should be transferred first to a smaller container. When a flammable liquid is withdrawn from a drum, or when a drum is filled, both the drum and the other equipment should be electrically wired to each other and to the ground in order to avoid the possible buildup of a static charge.

ix. Disposal

The handling of reaction byproducts, surplus and waste chemicals, and contaminated materials is an important part of laboratory safety procedures. Each lab worker is responsible for ensuring that wastes are handled in a manner that minimizes personal hazard and recognizes the potential for environmental contamination. The following is the standard procedure to be followed in the lab on a routine basis.

Dispose of waste materials promptly. When disposing of chemicals one basic principle applies: Keep each different class of chemical in a separate clearly labeled disposal container. Disposal containers are available from the stockroom.

Never put chemicals into a sink or down the drain unless they are deactivated or neutralized and they are allowed by local regulation in the sanitary sewer system. If in doubt, use a waste container not the sink. Be aware that a sink may contain a chemical which will adversely react with the chemical you are dumping (e.g. an acid sink with a sulfide will evolve deadly hydrogen sulfide gas).

Put ordinary waste paper in a wastepaper basket separate from the chemical wastes. If a piece of paper is contaminated, such as paper toweling used to clean up a spill, put the contaminated paper in a special container that is marked for this use. It must be treated as a chemical waste. The container should be labeled with a description that identifies the chemical on the paper.

Broken glass belongs in its own marked waste container. If the glass is contaminated with chemical, the name of the chemical should be added to the label of the container. Broken mercury thermometers belong in a separate "broken mercury thermometer" container, since they may contain mercury in the fragments.

x. Unattended operation of equipment

See also 6.5

Reactions that are left to run unattended overnight or at other times are prime sources for fires, floods and explosions. One should always consider a "worst case scenario" before leaving a reaction unattended. Do not let equipment such as power stirrers, hot plates, heating mantles, and water condensers run overnight without fail-safe provisions. Check unattended reactions periodically. Always leave a note plainly posted with a phone number where you can be reached in case of emergency. Remember that in the middle of the night emergency personnel are entirely dependent on accurate instructions and information.

xi. Fume hoods and ventilation

A large number of common substances present acute respiratory hazards and should not be used in a confined area in large amounts. They should be dispensed and handled only where there is adequate ventilation, such as in a hood. This applies also to flammable liquids and gases (see General Procedures for handling chemicals in the labs). Adequate ventilation is defined as ventilation that is sufficient to keep the concentration of a chemical below the threshold limit value (TLV) or permissible exposure limit. If you smell a chemical, it is obvious that you are inhaling it. However, odor does not necessarily indicate that a dangerous concentration has been reached. By contrast, many chemicals can be present at hazardous concentrations without any noticeable odor. As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm.

xii. Refrigerators

Refrigerators are notorious sources of leaks of hazardous or smelly chemicals. The refrigerator should be explosion-proof. Chemicals stored in refrigerators should be sealed, double packaged if possible, and labeled with the name of the material, the date placed in the refrigerator, and the name of the person who stored the material. Freezer bags are useful in this regard. Chemicals should be stored in a refrigerator only with good reason (e.g. they deteriorate at room temperature, they develop too high a pressure at room temperature, they evaporate too fast at room temperature) and not because they are smelly or toxic (fume hoods, or a ventilated storage cabinet are better for these substances). Food should never be stored in a refrigerator used for chemical storage and vice-versa.

xiii. Working alone

See also Part 6.

A Chemical Hygiene Permit (Appendix B) is required for any employee working in a laboratory with hazardous chemicals when no-one else is in the building.

Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are very hazardous.

xiv. Dealing with chemical exposure

In the event of exposure of a large area of the body or clothing to a hazardous chemical, the safety showers should be used. These provide continuous drenching for an unlimited period.

A smaller area of exposure, such as a hand or part of an arm, can be treated using the shower attachments located next to the sinks in all labs.

Chemicals in the eyes should be rinsed out using the eyewash attachments located in the sinks in all labs. Eyes should be rinsed for several minutes. Bottles of eye-rinse can be used for further rinsing.

Do not use organic solvents such as alcohol or acetone to rinse hazardous chemicals from the skin. These solvents may carry the hazardous chemical into the skin and worsen the situation. Always rinse with water as a first action, then later wash the area thoroughly with soap and water.

Further first-aid treatment can be carried out in the stock-room where bandages, anti-septic creams and other items are available.

If additional medical treatment is needed, the victim should be taken to a local emergency facility, or an ambulance called.

1.3 Procedure for handling materials received from chemical suppliers

DO NOT UNDERESTIMATE THE POTENTIAL HAZARDS ASSOCIATED WITH ANY CHEMICAL. New information is constantly being accumulated, and chemicals once considered harmless are often found to have harmful properties. Do not rely exclusively on your chemical training, however extensive that may be. Always consult safety data as described below.

Upon receiving any chemical from a supplier, the Material Safety Data (MSD) sheet accompanying the material should be read carefully with a view to establishing the particular hazards associated with the chemical, and the correct procedures for opening, handling, using, storing, and disposing of the chemical. The law requires all chemical suppliers to provide such information. If the MSD sheet has not yet been received from the company and it is deemed necessary to open and use the chemical, the following procedure should be adopted:

i. The file of MSD sheets in the stockroom should be consulted to ascertain if the relevant sheet is already on file.

ii. The Aldrich-Sigma catalog of safety data should be consulted. This two-volume book, kept in the stockroom next to the MSD sheets, contains safety information on 14,500 chemicals supplied by Aldrich-Sigma. The information is less extensive than that covered by MSD sheets, but nevertheless includes the most pertinent hazard and safety procedure information.

iii. Consult the catalog of the chemical company from which the chemical was purchased to find more (usually brief) information on potential hazards.

iv. Read the warnings on the outer and inner packaging of the chemical. Most chemicals come in boxes containing layers of metal cans, other boxes, plastic wrapping etc. and a final container (usually glass) containing the material. Any or all of these wrappings may contain hazard warnings. The final inner container will certainly contain a list of hazards. Consult the sheet with explanations of codes and technical terms which is contained in the Aldrich-Sigma volumes (see ii. above). This will explain less familiar terms such as carcinogen, teratogen etc.

1.4 General procedures for handling chemicals in the labs

As a general principle when ordering chemicals which are known to be hazardous one should order no more than is to be used in a short period of time (weeks rather than months). This will alleviate the problem of storage of hazardous materials. Most labs and stockrooms are replete with containers of chemicals which have been sitting for years and which have deteriorated and now present a disposal problem. Such problems can be avoided with a little forethought.

Before using any chemical in the lab, and before allowing any student to handle the chemical, the Material Safety Data (MSD) sheet should be consulted to establish correct safety procedures. These sheets have been described above. Copies of the MSD sheets relating to each chemical in common use in each lab will be posted in those labs. In addition there are the files of MSD sheets in the stockroom as well as additional safety data sources in the stockroom. Care should be taken to establish the following hazards:

i. Flammability:

Highly flammable liquids or gases should not be used in any lab in which flames, sparks or other potential sources of ignition are present. Use of a fume-hood is good safety practice for the transfer of flammable materials from one container to another.

ii. Toxic or corrosive vapors:

Any material (solid, liquid or gas) which gives rise to toxic or corrosive vapors should be stored, handled and disposed in a fume-hood. The fume-hood should be examined prior to opening the container of chemical to establish that (a) it is turned on (b) it is operating properly (i.e. it is generating a draft of air in which air flows from the lab into the hood and upwards toward the hood's exhaust vents. A quick way to check this is to partially close the hood's front screens and place a piece of Kimwipe or tissue paper in the opening to see if it is blown into the hood and upwards toward the vents). (c) it has been serviced and checked for face velocity.
If an appropriate respirator or gas-mask is indicated by the safety information it may be obtained from the stock-room.

iii. Corrosive liquids and solids:
These should be handled with due caution. Gloves (plastic or rubber) and a lab coat should be worn. Of course, safety goggles, which should be worn at all times in the lab, are vitally important when handling such materials.

iv. Toxic liquids and solids:
Measures should be taken to prevent contact with the skin, eyes, mouth and lungs. Eye protection must be worn. If vapors or dust are involved the material should be handled in a fume hood. An appropriate respirator or gas-mask may be indicated by the safety information and may be obtained from the stock-room.

v. Highly toxic substances, carcinogens and other substances warranting special procedures:
Acute toxins, certain carcinogens, and other substances with particularly severe harmful properties require special procedures in their handling and disposal. A list of some of these substances which may be encountered in our laboratories is appendix A of the CHP. By no means is this list to be considered complete in the sense that a substance not appearing on the list is not a special hazard or is never to be encountered in our laboratories. Rather the list should be regarded as an attempt to focus on well-known highly toxic or specially hazardous materials that are more likely to be encountered in our labs than other such specially hazardous materials. The list draws attention to this class of severely hazardous substances. It should not, however, take the place of a thorough review of the MSD sheets and other safety data as described in 1.3. If there is doubt concerning the special hazards of a substance, its use should be avoided or postponed until the properties have been investigated and the necessary safe procedures understood.

Highly toxic gases must be used and disposed within a fume-hood whose efficient operation has been previously established. The gas should be used in a system which is closed except for an outlet through which unused gas is allowed to vent via a trap which removes, chemically or otherwise, the highly toxic gas. The highly toxic gas must not be allowed to pass into the hood in an uncontrolled fashion; every effort should be made to contain it within the system and to render it less harmful at the place where it eventually vents into the hood. This procedure will minimize the possibility of exposure to the gas of both the operator and the environment. Respirators are available in the stockroom which can handle certain highly toxic gases up to certain concentrations. These respirators should be regarded as a final line of defense against the toxic gas and not as a substitute for the safe procedures outlined above. Their use would be called for, for example, if the above controls were found not to be capable of adequately limiting the escape of the gas into the lab, and temporary protection were required for the operator while the generation or flow of toxic gas was cut off.

vi. Dry ice and liquid nitrogen:
These extremely cold (cryogenic) materials present a number of potential hazards. They may burn the skin on contact and should be handled using

insulating gloves designed for the purpose. Before pouring liquid nitrogen into a Dewar flask, the flask should be "tempered" with a small quantity of the cold material to prevent it cracking and imploding from thermal shock. The possibility of the condensation of liquid oxygen should be considered when using liquid nitrogen. Liquid oxygen is potentially explosive, especially when in contact with oxidizable materials such as grease. Thus a system connected to a liquid nitrogen trap should not be opened to the atmosphere until the trap has been removed. Also, if the system is closed after even a brief exposure to the atmosphere, some oxygen (or argon) may have already condensed. Then, when the liquid nitrogen bath is removed or when it evaporates, the condensed gases will vaporize with attendant pressure buildup and potential blowup. When adding dry ice to a solvent to prepare a "slush bath" the rapid bubbling and foaming of the mixture should be anticipated. Such an operation should be carried out in a fume hood. Isopropanol or ethanol should be used in preference to acetone since they are cheaper, less toxic, less flammable, and less prone to foaming. A less flammable mixture of ethylene glycol or propylene glycol in a 3:2 mixture with water and thinned with Isopropanol may also be used. Add the dry ice to the liquid in small amounts, waiting for the foaming to subside before proceeding with the addition. Dry ice and liquid nitrogen baths should never be closed systems since they can develop uncontrolled and dangerously high pressures.

1.5 Storage and Transportation of Hazardous Materials

Before opening any package, establish, by consulting the sources of information referred to in 1.3 i - iv above, the correct place to store the chemical before and after use. Highly flammable liquids should be stored in flame-proof metal cabinets; liquids or solids which evolve toxic or corrosive vapors should be stored in vented cabinets or fume-hoods; heat sensitive and/or thermally unstable materials should be refrigerated in an explosion-proof refrigerator; cylinders of toxic or corrosive gases should be stored in fume-hoods; large tanks of gases should be stored in the room next to the stockroom, and when in use in labs should be well secured by clamping to a fixed support (such as a bench; clamps are available in the stockroom); liquid nitrogen and dry-ice (solid carbon dioxide) should be stored in the designated containers. If a material has a combination of the above properties such that it is unclear as to the correct storage procedure, consult the Chemical Hygiene Officer before opening the package.

Containers of hazardous chemicals should be transported in plastic buckets to reduce the possibility of breakage through impact, and to contain the materials in the event of breakage of the primary container. Large containers of flammable or corrosive liquids should never be carried without using a secondary container such as a plastic bucket. Gas tanks should be transported from the storage room to the lab in the wheeled cart which is kept in the stockroom. These containers should be promptly clamped to a bench or other fixed support as described above. Dry ice should be transported in a Dewar or other cryogenic container. Liquid nitrogen should be transported in a special carrying Dewar.

1.6 Equipment use

The following is adapted from the American Chemical Society document "Safety in Academic Chemistry Laboratories". It is applicable to students under the direction of employees as well as to the employees themselves.

i. Glassware

Borosilicate glassware is recommended for all laboratory glassware except for special experiments that use UV or other light sources. Any glass equipment to be evacuated, such as suction flasks, should be specially designed with heavy walls. Dewar flasks and large vacuum

vessels should be taped or contained in a metal jacket to prevent flying glass in the case of an implosion.

ii. Assembling apparatus

Following these recommendations will help make apparatus assembly easier and equipment use safer:

Use only equipment that is free from flaws. Glassware can be examined in polarized light for strains. Do not use flasks that contain star-cracks, especially in vacuum work.

A properly placed pan under a reaction vessel or container will confine spilled liquids in the event of glass breakage.

When working with flammable gases or liquids, do not allow burners or other ignition sources in the vicinity. Note that electrical devices such as stirrer plates can be sources of ignition through electrical sparking. Use a fume hood. Use appropriate traps, condensers or scrubbers to minimize release of material to the environment. If a hot plate is used, ensure that its temperature is less than the autoignition temperature of the chemicals likely to be released and that the temperature control device does not spark.

Whenever possible, use controlled electrical heaters or steam in place of gas burners.

Condensers should be properly supported with securely positioned clamps and the attached water hoses secured with wire or clamps.

A vent should be provided as part of the apparatus for chemicals that are to be heated.

Whenever hazardous gases or fumes are likely to be evolved, an appropriate gas trap should be used and the operation confined to a fume hood.

Use a hood when conducting a reaction that could result in an explosion or when using a vacuum system (which may implode). Close the sash to provide a shield. If a hood is not available, use a standing shield. Proper eye and face protection must be worn even when using the shields or hood.

iii. Fume Hoods

Fume hoods serve to control exposure to toxic, offensive or flammable vapors. Apparatus used in hoods should be fitted with condensers, traps or scrubbers to contain or collect waste solvents or toxic vapors. The hood is not an appropriate means for disposing of chemicals, nor is it a storage cabinet. Stored chemicals can interfere with efficient hood operation, and in the event of an accident or fire, every item in the hood may become involved.

Before each use, check that the hood is working properly. Although not a substitute for velometer measurement, a continuous monitoring device such as a narrow strip of tissue paper can be used to ensure that the hood is operating. Adequate air flow and the absence of excessive turbulence are necessary for safe operation. Exhaust ports from the hood and supply air vents to the room should not be blocked. Sash openings should be kept to a minimum. Horizontal sashes or combined horizontal and vertical sashes make this easier to do. Users should keep their faces outside the plane of the hood sash and should remain alert to changes in air flow. Equipment should be placed as far back in the hood as practical and activities carried out at least six inches from the front edge of the hood.

iv. Centrifuges

If a tabletop centrifuge is used, make certain that it is securely anchored in a location where its vibration will not cause bottles or equipment to fall. The following rules apply to the safe operation of centrifuges:
Always close the centrifuge lid during operation.

Do not leave the centrifuge until full operating speed is attained.

Stop the centrifuge immediately and check the load balances if vibration occurs. Check swing-out buckets for clearance and support.

Regularly clean rotors and buckets with non-corrosive cleaning solutions.

v. Lasers
The FTIR instrument in the instrumentation lab contains a visible laser, and the FT Raman instrument in the Analytical Research lab contains a near infra-red laser. Normal operation of these instruments should not involve any health risk. Do not look directly into the beam source, or allow any object into the sample compartment which might deflect the beam.

vi. X-ray generators
The powder diffractometer in the Physics Department generates X-rays. Potential hazards arise from the radiation generated and the high voltage used. Warning signs must be displayed on or near the main power switch of the instrument. Do not use this instrument without first acquiring detailed instructions and safety information. Do not tamper with the beam-stop mechanism. Check that the cooling-water supply to the X-ray tube is connected and operating properly.

vii. Compressed gases
Gases are often supplied in cylinders under high pressure. These present some hazards beyond the chemical hazards associated with the gases themselves. The procedures for the proper use of compressed gases include:
Handle cylinders of compressed gases as high-energy sources and therefore as potential explosives.

Restrain cylinders of all sizes, empty or full, by strapping them to a solid, firm support, and by using a suitable stand.

When storing or moving cylinders, have the protective caps securely in place to protect the valve stems.

When moving large cylinders use the special cart kept in the stockroom.

Never lubricate, modify, force, or tamper with cylinder valves.

Use toxic, flammable, or reactive gases in fume hoods only. Cylinders should be stored in the ventilated room adjacent to the stockroom. Smoking and eating or drinking are forbidden in that room.

Do not extinguish a flame involving a highly combustible gas until the source of gas has been shut off; otherwise it can re-ignite causing an explosion.

Close the main cylinder valve tightly when not in use.
Promptly remove the regulators from empty cylinders and replace the protective caps at once. Mark the empty cylinder.

Never bleed cylinders completely empty. Leave a slight pressure to keep contaminants out.

Use the appropriate regulator on each gas cylinder. The threads on the regulators are designed to avoid improper use. Adaptors or homemade modifications can be dangerous.

Do not put oil or grease on the high pressure side of an oxygen, chlorine, or other oxidizing agent cylinder. A fire or explosion can result.

1.7 Operations

The following is adapted from the American Chemical Society document "Safety in Academic Chemistry Laboratories". It is applicable to students under the direction of employees as well as to the employees themselves.

i. Extractions

Extracting a solute from an aqueous phase by means of a volatile organic solvent (such as ether or chloroform) can present a hazard because of the possible buildup of pressure. Glass separatory funnels are commonly used for this operation. A buildup of pressure could result in the ejection of the stopper or stopcock and the spilling of the liquid. The following procedure is designed to minimize this risk.

Do not attempt to extract a solution until it is cooler than the boiling point of the extracting solvent. When a volatile solvent is used, the unstoppered separatory funnel should first be swirled to allow some solvent to vaporize and expel some air. Close the funnel and invert it with the stopper held in place and immediately open the stopcock to release more air plus vapor. This should be done with the hand encompassing the barrel to keep the stopcock plug securely seated. The operation should be carried out away from flames and preferably in a fume hood. Close the stopcock, shake with a swirl, and immediately open the stopcock to again vent the vapors. The procedure can be repeated to complete the extraction, each time venting the vapors through the stopcock with the funnel in the inverted position. If it is necessary to use a separatory funnel larger than 1 liter for an extraction with a volatile solvent, the force on the stopper may be too great and cause the stopper to be expelled. Consider performing the extraction in several smaller batches.

ii. Distillations

Distillations may be carried out at atmospheric pressure, under inert atmosphere, at reduced pressure (vacuum distillations), and using steam (steam distillation). Dangers arise from the pressures that may buildup, the flammability of the materials, and the use of heat. Each type of distillation involves a particular design of apparatus, and experimental descriptions and diagrams should be consulted.

The distillation should be carried out in a fume hood whenever possible.

Heat should never be applied to a system in which there is no outlet for the excess pressure to escape.

Bumping should be avoided by stirring the distillation mixture, or by using boiling stones (only effective for distillations at atmospheric pressure).

Even heating is important, especially under reduced pressure, to avoid local hot-spots. A flame should not be used. Heating mantles, steam rings or hot water baths, silicone or mineral oil baths on a hot plate, sand baths, and metal blocks with appropriately sized cavities can all be used.

Never evaporate organic solvents to dryness, especially ethers or other organics which may form peroxides. These peroxides can be highly explosive and have led to many documented cases of serious injuries.

Bumping is particularly common with vacuum distillations. A standing shield should be used for protection in the event of implosion. Heating should be even, and evacuation should be carried out gradually. The apparatus should be securely clamped. The mixture should be magnetically stirred, or an air or nitrogen bleed tube should be used.

iii. Temperature control

Care should be taken when reagents are first mixed. An exothermic reaction may have an induction period during which time little reaction or heating occurs, followed by a rapid reaction with the release of heat and too rapid boiling of the solvent. To avoid this, one reagent should be added in small amounts to the other, with a cooling bath available to quickly cool down the mixture if necessary. The apparatus should be set up so that heating or cooling can be applied or withdrawn readily.

Test tubes should be held with a test tube holder, shaken while cautiously heated, and pointed away from people. A hot water bath, steam bath, or oil bath are preferable to a flame. If a Bunsen burner is used it should be a small flame without a blue cone, and the test tube should be alternately heated and removed from the flame, with shaking, and spreading the heat uniformly around the tube to avoid the contents being ejected.

If oil baths are used, care should be taken to ensure that the oil is water free, since the presence of water can cause violent bumping and splashing of the hot oil. Mineral oil or silicone oil may be used. Do not heat beyond the flash point of the oil. Do not leave a hot oil bath unattended.

For cooling baths use ice water, or ice/salt if lower temperatures are required. For very low temperatures use a dry ice slush bath or liquid nitrogen. For appropriate procedures in using these materials see 1.4 (vi) above.

iv. Reduced Pressure Operations

Special care should be taken with glassware under reduced pressure ("vacuum").

Vacuum desiccators and vacuum line bulbs should be wrapped in duct tape to prevent flying glass in the event of an implosion.

Only heavy walled flasks should be used for vacuum filtration.

Vacuum pumps should be protected from vapors by means of a cold trap.

Exhausts from vacuum pumps should be vented to the hoods whenever possible.

Portable explosion guards are available for reactions or other operations carried out under reduced pressure. See the stockroom manager or safety officer.

PART 2. EXTRA PROTECTIVE MEASURES FOR PARTICULARLY HAZARDOUS SUBSTANCES

2.1 Carcinogens and Reproductive Toxins.

Before any package from a chemical company is opened, or before any chemical is used, the MSDS and other safety information available in the stockroom should be consulted, as described in 1.3. If the information refers to the chemical as being a carcinogen (cancer causing agent), teratogen (causes fetal mutation), embryotoxin or reproductive toxin, special precautions may need to be taken.

Examples of OSHA-regulated carcinogens are 2-Acetylaminofluorene, acrylonitrile, 4-aminobiphenyl, asbestos, benzidine, bis(chloromethyl)ether, 3,3'-Dichlorobenzidine (and its salts), 4-Dimethylaminoazobenzene, ethyleneimine, inorganic arsenic,

methyl chloromethyl ether, 4,4'-methylene-bis(2-chloroaniline), a-naphthylamine, §-naphthylamine, 4-Nitrobiphenyl, N-Nitrosodimethylamine, §-Propiolactone, vinyl chloride. Examples of embryotoxins are organomercurials, lead compounds, formamide. The package should not be opened or the chemical used until the safety officer has been consulted. The safety officer will determine whether the special precautions described below will need to be followed.

Special precautions:

Embryotoxins: These are substances that act during pregnancy to cause adverse effects on the fetus. These effects include embryolethality (death of the fertilized egg, the embryo, or the fetus), malformations (teratologic effects), retarded growth, and postnatal functional deficits. If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact. Store these substances, properly labeled (e.g. EMBRYOTOXIN: READ SPECIFIC PROCEDURES FOR USE), in an adequately ventilated area in an unbreakable secondary container. Notify supervisors of all incidents of exposures or spills; consult a qualified physician when appropriate (e.g. skin contact or any inhalation by a woman of child-bearing age).

Select Carcinogens: Use and store these substances only in areas of restricted access with special warning signs. Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance. Do not dispose of these materials by evaporation into the hood. If practical, waste materials and waste solvents containing select carcinogens should be decontaminated chemically by some procedure that can reasonably be expected to convert essentially all of the material to non-carcinogenic substances. If chemical decontamination is not feasible, the waste carcinogens should be stored in closed impervious containers so that personnel handling the containers will not be exposed to their contents. In general, liquid residues should be contained in glass or polyethylene bottles half-filled with vermiculite. The containers should carry the warning: CANCER-CAUSING AGENT. Contaminated clothing or shoes should be thoroughly decontaminated or incinerated. The lab worker should be prepared for possible accidents or spills. If a carcinogen contacts the skin, the area should be washed well with water. If there is a major spill outside the hood, the room or appropriate area should be evacuated and cleanup personnel should wear suitable protective apparel and equipment (refer to the MSDS). If the material is volatile, or produces dust, the cleanup personnel should wear a supplied-air full-face respirator. Records should be kept that include amounts of material on hand, amounts used and names of workers involved. These records will normally be a part of the laboratory notebook record of the experiment.

2.2 Substances which have a high degree of acute toxicity, or a moderate degree of chronic toxicity.

Before any package from a chemical company is opened, or before any chemical is used, the MSDS and other safety information available in the stockroom should be consulted, as described in Part 1 (c). If the information in the "Health Hazard Data" section of the MSDS or other information describes the substance as being "highly toxic", "acutely toxic", "severe health hazard" or contains other indications of extreme toxicity, special precautions may need to be taken. Examples of acute

toxins are hydrogen cyanide, hydrogen sulfide, hydrofluoric acid, arsine, nitrogen dioxide, di-isopropyl fluorophosphate. Substances of moderate chronic toxicity are those for which infrequent exposure to small quantities does not constitute a significant health risk, but which can be dangerous to those exposed to high concentrations or repeated small doses. Substances which are not known to cause cancer in humans, but have shown statistically significant, but low, carcinogenic potency in animals fall into this category. Examples are very numerous, and the MSDS should be used as the appropriate indicator. The package should not be opened or the chemical used until the safety officer has been consulted. The safety officer will determine whether the special precautions described below will need to be followed.

Special precautions:

At least two people should be present at all times if the compound is highly toxic. Areas where highly toxic substances are being used and stored should have restricted access, and special warning signs should be posted. Protect the hands and forearms by wearing gloves and a laboratory coat to prevent contact of toxic material with the skin. Always wash hands and arms immediately after working with these materials. Use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute). Store breakable containers of these substances in pans or trays of polyethylene or other chemically resistant material; also mount apparatus above such trays, or line the hood with a chemically resistant liner to contain spills. If a major spill occurs outside the hood, evacuate the area, and ensure that cleanup personnel wear suitable protective apparel and equipment (refer to the MSDS). Do not dispose of these materials by evaporation into the hood. If practical, waste materials and waste solvents containing these materials should be decontaminated chemically by some procedure that can reasonably be expected to convert essentially all of the material to non-toxic substances. If chemical decontamination is not feasible, the waste toxins should be stored in closed impervious containers so that personnel handling the containers will not be exposed to their contents. In general, liquid residues should be contained in glass or polyethylene bottles half-filled with vermiculite. The containers should carry the warning: ACUTE TOXICITY. Contaminated clothing or shoes should be thoroughly decontaminated or incinerated. Records should be kept that include amounts of material on hand, amounts used and names of workers involved. These records will normally be a part of the laboratory notebook record of the experiment.

2.3 Substances with a high degree of chronic toxicity (including known carcinogens).

Before any package from a chemical company is opened, or before any chemical is used, the MSDS and other safety information available in the stockroom should be consulted, as described in Part 1 (c). If the information in the "Health Hazard Data" section of the MSDS or other information describes the substance as having a "high degree of chronic toxicity", or "causes cancer in humans", or "shows high carcinogenic potency in test animals", special precautions may need to be taken. Examples include certain heavy metal compounds (e.g. dimethyl mercury and nickel carbonyl), benzo-a-pyrene (3,4-benzpyrene), N-nitrosodiethylamine (diethylnitrosamine), and strong carcinogens. These substances may be cumulative toxins whose harmful effects are subtle and not immediately apparent but are often irreversible. They may be harmful in very small quantities. If they are to be used in quantities in excess of a few milligrams to a few grams (depending on the hazard posed by the particular substance), the additional

precautions described below should be used. The package should not be opened or the chemical used until the safety officer has been consulted.

Special precautions:

In addition to the procedures described above for substances of high acute or moderate chronic toxicity, the following extra precautions should be taken for substances of high chronic toxicity:

Prepare a plan for use and disposal of the materials, and obtain the approval of the laboratory supervisor or safety officer. Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab., for which all people with access are aware of the substances being used and necessary precautions. Any area being used for storage of substances of high chronic toxicity should be maintained under negative pressure with respect to surrounding areas. Controlled areas should be clearly marked with a conspicuous sign such as WARNING:TOXIC SUBSTANCE IN USE or CANCER-SUSPECT AGENT: AUTHORIZED PERSONNEL ONLY. If a positive pressure glove box is used with highly toxic compounds, the box should be checked for leaks before each use, and the exit gases should be passed through a suitable trap or filter. Lab vacuum pumps should be protected by high-efficiency scrubbers or HEPA filters, and vented into an exhaust hood. Vacuum pumps and other contaminated equipment, including glassware, should be decontaminated in a hood before removal from the controlled area. On leaving a controlled area, remove any protective apparel (placing it in an appropriate container with a label such as CAUTION: CONTENTS CONTAMINATED WITH SUBSTANCES OF HIGH CHRONIC TOXICITY and a list of the contaminants) and thoroughly wash hands, forearms, face and neck. Waste chemicals (including washings from contaminated flasks) should be collected and either decontaminated chemically, or placed in closed, suitably labeled containers for incineration away from the controlled area. An example of decontamination would be the treatment of b-propiolactone, bis(chloromethyl)-ether or methyl chloromethyl ether with concentrated aqueous ammonia for 10 min. An appropriate label for waste would be CAUTION: COMPOUNDS OF HIGH CHRONIC TOXICITY or CAUTION: CANCER-SUSPECT AGENT followed by a list of the waste chemicals. Normal work in the controlled area should resume only after adequate decontamination has been achieved. In the event of repeated use of a substance of high chronic toxicity a qualified physician should be consulted to ascertain whether regular medical surveillance is advisable.

PART 3. CRITERIA FOR IMPLEMENTATION OF CONTROL MEASURES

3.1 Environmental monitoring

Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices, or when a highly toxic substance is stored or used regularly.

If a chemical falls under the category of "particularly hazardous substance" as described in Part 2, and if the particular chemical is in use more than three times in a week, the safety officer should be consulted about setting up air sampling.

If there is reason to believe that exposure levels for a hazardous chemical exceed the OSHA "action level" or, in the absence of an action level, the OSHA "Permissible Exposure Limit" (PEL), the safety officer should be consulted about setting up air sampling. The action levels and PELs are listed in the OSHA publication 29 CFR part 1910, the relevant section of which will be appended to the CHP. Reasons for believing that the action levels are exceeded could be

(a) Malfunction or possible inadequacy of a control device such as a hood.

(b) Excessive smell of a chemical which has a pronounced odor.
(c) Indications of toxic effects on persons in the vicinity.
The results of air sampling studies will be recorded in a form which will be appended to the CHP.

3.2 Housekeeping, Maintenance and Inspections.

i. Cleaning.

Floors should be cleaned regularly. All spills on lab benches or floors should be immediately cleaned and properly disposed of. The lab benches should be kept clear of equipment and chemicals except those necessary for the work currently being performed. All floors, aisles, exits, fire extinguishing equipment, eyewashes, showers, electrical disconnects and other emergency equipment should remain unobstructed. Chemical containers should be clean, properly labeled and returned to storage upon completion of usage. All chemical wastes should be disposed of in accordance with the directions described in other parts of the CHP.

ii. Inspections.

Formal housekeeping and chemical hygiene inspections should be held biannually; informal inspections should be continual.

iii. Maintenance.

Safety showers and eye wash equipment should be inspected quarterly. Fume hoods should be inspected biannually, and the hood face velocity (at half-height) maintained at between 75 and 150 linear feet per minute. A record of inspections should be maintained by the Chemical Hygiene Officer.

3.3 Medical Program

i. Compliance with regulations.

Regular medical surveillance should be established to the extent required by regulations.

ii. Routine surveillance.

Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable.

3.4 Safety and Emergency Equipment

Telephone numbers of emergency personnel, supervisors and other workers as deemed appropriate will be posted. All laboratory personnel will be trained in the proper use of fire extinguishers when hired and annually thereafter. All employees who might be exposed to chemical splashes shall be instructed in the location and proper usage of emergency showers and eyewashes. The eyewash and emergency shower shall be inspected monthly. These inspections shall be performed by the safety officer and helpers, and shall be in accordance with ANSI Z358.1 and manufacturer's specifications. Records shall be maintained. Location signs for safety and emergency equipment will be posted.

PART 4. FUME HOODS AND OTHER ENGINEERING CONTROLS

4.1 Fume hoods: Purpose

As well as their function as local ventilation devices used to prevent toxic, offensive or flammable vapors from entering the general laboratory atmosphere, hoods offer two other significant types of protection. With the hood sash closed, a physical barrier is placed between the worker and the chemical reaction. This can provide protection from splashes, sprays, fires, and minor explosions. Furthermore, the hood can provide an effective containment device for accidental spills of chemicals.

4.2 Hood availability.

In a laboratory where workers spend most of their time working with chemicals, there should be at least one hood for each two workers, with at least 2.5 linear feet of hood space at the face. In teaching

labs where hoods are used intermittently, experiments should be designed so that students have access to hood space whenever they conduct an operation which requires such ventilation (see Part 1.4).

4.3 Hood Inspection and Maintenance

Hoods will be inspected biannually for the following features:

i. Adequate face velocity (60-150 linear feet per minute).
ii. Uniformity of air delivery (lack of turbulence) across the face area at various sash positions.

iii. Appropriate baffle position to give uniform air flow across the hood and into the vent ducts.

The latest inspection was completed during July '97. The documentation from this inspection is available from the stockroom manager or from the Safety Officer.

4.4 Hood use

i. Confirm adequate hood ventilation performance prior to opening chemical containers inside the hood. An inward flow of air can be confirmed by holding a piece of paper at the face of the hood and observing the movement of the paper.
ii. Keep the sash of the hood closed at all times except when adjustments within the hood are being made. At these times, maintain the sash height as low as possible.
iii. Storage of chemicals and equipment inside the hood shall be kept to a minimum.
iv. Minimize interference with the inward flow of air into the hood.
v. Leave the hood operating when it is not in active use if hazardous chemicals are contained inside the hood or if it is uncertain whether adequate general laboratory ventilation will be maintained when the hood is non-operational.
vi. The hood shall not be used as a means of disposal for volatile chemicals.

4.5 Storage cabinets

i. Flammable solvents and substances which yield corrosive or toxic vapors should be stored in ventilated cabinets designed for the purpose. Such cabinets can be found in the stockroom, the organic lab, and some research labs. The cabinets should be vented into a fume hood, and an adequate supply of air should pass so as to remove the vapors.

4.6 Special ventilation areas.

i. Exhaust air from glove boxes should be passed into a hood. If the glove box is of the negative pressure type, and a particularly toxic material is being handled inside, the exhaust air will require special treatment before release into the regular exhaust system. Glove boxes of the positive pressure type, such as are used to handle air-sensitive materials under inert atmosphere, should be checked for leaks if highly toxic materials are inside. There should be a method of monitoring the integrity of the system, such as a pressure gage.

4.7 General laboratory ventilation.

i. This system should provide a source of air for breathing and for input to local ventilation devices.
ii. It should not be relied upon for protection from toxic substances released into the lab.
iii. It should continually replace the laboratory air, preventing increase of air concentrations of toxic substances during the working day. A rate of 4-12 room air changes/hour is adequate, provided fume hoods are in operation as the primary method of toxic vapor control.
iv. Air flow should be directed into the laboratory from non-

laboratory areas and out to the exterior of the building.

v. General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas.

PART 5. EMPLOYEE INFORMATION AND TRAINING

5.1 Hazard Information

All employees will be apprised of the hazards presented by the chemicals in use in the laboratory. Each employee shall receive training at the time of initial assignment to the laboratory, prior to assignments involving new exposure situations, and at a regular frequency as determined by the Chemical Hygiene Officer.

5.2 Training

This training shall include methods of detecting the presence of a hazardous chemical, physical and health hazards of chemicals in the lab, and measures employees can take to protect themselves from these hazards. The training shall present the details of the Chemical Hygiene Plan, and shall include;

i. The contents of the OSHA laboratory standard, and its appendices.

ii. The location and availability of the Chemical Hygiene Plan.

iii. The permissible exposure limits for OSHA regulated substances or recommended exposure values for other hazardous chemicals not regulated by OSHA which are present in the laboratory.

iv. Signs and symptoms associated with exposure to the chemicals present in the laboratory.

v. Location and availability of reference material on chemical hygiene.

PART 6. PRIOR APPROVAL OF LABORATORY ACTIVITIES

6.1 Permit System

A permit system shall be used for laboratory activities which present specific, foreseeable hazards to the employees. These activities include off-hours work, sole occupancy of building, extremely hazardous operations and unattended operations. The permit entitled "Chemical Hygiene Permit" will be included as an appendix to this plan and shall be executed prior to the performance of these activities.

6.2 Off-Hours Work Procedures

Work in labs outside of normal working hours is permitted with the approval of the appropriate faculty member. A Chemical Hygiene Permit should be filled out (Appendix B).

6.3 Sole Occupancy

At no time shall hazardous work be performed in the laboratory when the only person in the building is the laboratory person performing the work. Under unusual conditions, cross-checks, periodic security guard checks, or other measures may be taken when permitted. A Chemical Hygiene Permit should be filled out (Appendix B).

6.4 Hazardous Work

All hazardous operations are to be performed during a time when at least two personnel are present at the laboratory. At no time shall a laboratory person, while working alone in the laboratory, perform work which is considered hazardous. The determination of hazardous operations shall be made by the appropriate faculty member.

6.5 Unattended Operations

When laboratory operations are performed which will be unattended by laboratory personnel (continuous operations, overnight reactions, etc.), the following procedures will be employed:

i. The faculty member will review work procedures to ensure for the safe completion of the operation.
ii. An appropriate sign will be posted at all entrances to the laboratory.
iii. Precautions shall be made for the interruption of utility service during the unattended operation (loss of water pressure, electricity, etc.).
iv. The person responsible for the operation will return to the laboratory at the conclusion of the operation to assist in the dismantling of the apparatus.

PART 7. MEDICAL CONSULTATIONS AND EXAMINATIONS

An opportunity to receive medical attention is available to all employees who work with hazardous chemicals in the laboratory. The opportunity for medical attention will be made available to employees under the following circumstances:

i. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory,
ii. Where exposure monitoring reveals an exposure level above the action level for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, and/or,
iii. Whenever an event takes place in the laboratory such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure the employee will be provided an opportunity for medical consultation for the purpose of determining the need for medical examination.

These medical consultations and examinations shall be provided without cost to the employees, without loss of pay and at a reasonable time and place.
These medical consultations and examinations shall be administered by or under the direct supervision of a licensed physician.

Appendix A
List of some highly toxic substances and/or carcinogens, which may be encountered in JCU labs.

Substance	TLV-TWA* (ppm) or ceiling*(C)
Hydrofluoric acid	3 (C)
Sodium azide	0.11 (C)
1,1,2,2-Tetrachloroethane (skin)	1
Thionyl chloride	1 (C)
o-Toluidine (skin)	2, A2*

p-Toluidine (skin)
2, A2

Vinyl bromide
5, A2

Strychnine sulfate
0.02

Uranium(natural)
0.02

Vanadium pentoxide (dust)
0.05

Zirconium compounds
1

Antimony (and compounds)
0.1

Arsenic (and compounds)
0.1

Barium (and compounds)
0.1

Cadmium (dusts and salts)
0.01

Chromium (VI) compounds
0.02

Hydrazine (skin)
0.1,A2

Lead (dusts)
0.02

Mercury (vapor)
0.005

Phosphorus
0.1

Cyanides (skin)
5

Selenium (and compounds)
0.1

Anisidine(o-,p-isomers)(skin)
0.1

Benzidine (skin)
A1

Benzoquinone
0.1

Biphenyl

0.2

Boron trifluoride
C1

Bromine
0.1

1,1,-Dichloro-1-nitroethane
2

Dicyclopentadiene
5

Dimethyl sulfate (skin)
0.1,A2

Dinitrobenzene(all isomers)(skin)
0.15

Ethylene chlorohydrin (skin)
C1

Ethylene oxide
1, A2

Hexamethylphosphoramide (skin)
A2

Hydrazine (skin)
0.1, A2

Hydrogen sulfide
10

Iodine
C 0.1

Iron pentacarbonyl
0.1

Maleic anhydride
0.25

N-Methylaniline (skin)
0.5

2-Naphthylamine
A1

Nitric oxide
25

Nitrogen dioxide
3

2-Nitropropane
10, A2

Pentachlorophenol (skin)
0.1

Phenylhydrazine (skin)
5, A2

Platinum (soluble salts)
0.001

Rhodium (soluble salts)
0.005

*TLV-TWA: Threshold Limit Value-Time-Weighted Average
*C: Ceiling
*A1: Confirmed Human Carcinogen
*A2: Suspected Human Carcinogen

Appendix B
Chemical Hygiene Permit
Execution of the activity for which this permit is requested shall be carried out in full compliance with the procedures described in the Chemical Hygiene Plan. The permit is issued on the understanding that safety will be the first consideration in setting up and conducting said activity.

Name: Department:

Employee ID no.: Supervisor:

Activity for which permit is requested:

Approval of supervisor:

Approval of Chemical Hygiene Officer:

Approval of Departmental Chairperson:


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