CHEMICAL HYGIENE PLAN

for

JOHN CARROLL UNIVERSITY

Version 29 (effective JANUARY 1, 2024)

This document replaces the previous Chemical Hygiene Plan (version 28). It sets forth procedures, equipment, personal protective equipment and work practices that 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 JCU laboratories. Additionally, this is done to 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).

While the “Laboratory Standard” is a regulatory relief from the majority of OSHA industrial standards relating to employee protection from hazardous operations when performed at laboratory scale in a designated laboratory space, it doesn’t relieve the employer (JCU) from compliance with the General Duty Clause, Section 5(a)(1) of the 1970 Act, which states that:

> “Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.”

OSHA defines the work environment (i.e. place of employment) as

> "the establishment and other locations where one or more employees are working or are present as a condition of their employment. The work environment includes not only physical locations, but also the equipment or materials used by the employee during the course of his or her work." per 29 CFR 1904.5(b)(1).

Rev. 29.3; May 2, 2024

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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 employees who operate in laboratories where hazardous chemicals are in use may encounter particular health risks, 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 when dealing with chemicals, and to ensure the continuing protection of faculty 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 individuals themselves. Individuals always should be 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, Mr. Jeffrey Your, CSMM. He can provide assistance to employees in fulfilling their safety responsibilities.

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Sources:

This document has been adapted from the following sources:

Department of Labor; OSHA; 29 CFR Part 1910, rev.1974-May 14, 2019

Department of Transportation; 49 CFR Part 173, rev.1976-Sept 23, 2005

"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., Updated 2011

"Safety in Academic Chemistry Laboratories, 8th edition"; American Chemical Society, 2017

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

“Statement on the Wearing of Contact Lenses in the Laboratory Environment”, H.Ramsey, and W.H. Jack Breazeale, Jr of the Joint Board-Council Committee on Chemical Safety of the American Chemical Society, as reported in C&E News, June 1, 1998, 76(22) p6.

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PART 1. STANDARD OPERATING PROCEDURES

This part of the Plan includes standard operating procedures to be followed when working in labs or in other places at JCU such as in the Central Scientific Stores and Laboratory Support Services (CSSLSS) where hazardous chemicals may be encountered. The procedures apply to both teaching and research laboratories where hazardous chemicals can reasonably be expected to exist.

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

1.1 General laboratory 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, compliant with the ANSI/ISEA Z87.1-2020 standard. These are available for sale at Central Scientific Stores, room WG06.

This must take the form of chemical splash goggles that conform to the face, providing protection from the side as well as from the front, and are indirectly vented. Wearing of contact lenses in the laboratory is permitted as long as the appropriate chemical splash goggles are also worn. In the event that an employee normally, or occasionally wears contact lenses, it is the responsibility of the employee to inform co-workers of this so that in the case of an accident to the eyes, medical personnel can be notified of the presence of contact lenses. Employees conducting student labs, should obtain information about their students for the same reason. Employees may use their personal chemical splash goggles in the laboratory. If an employee does not have personal chemical splash goggles, they may obtain chemical splash goggles from CSSLSS, at no expense to them, for their use solely within the laboratory.

It is true that it may be possible to work in a laboratory containing a chemical hazardous to eyes without using that chemical, so there is no danger of that chemical contacting the eyes, without wearing eye protection. However, there is always the danger that someone else in that laboratory may be using that chemical. Since one should never work alone in the laboratory, it is always necessary to wear chemical splash goggles in the laboratory.

ii. Clothing

Clothing worn in the laboratory 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 must not be worn in the laboratory. If shorts or short skirts are worn, a lab coat should be worn to provide leg protection. Long hair and loose clothing (e.g., scarves, head coverings, neckties) 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

Choice of an appropriate glove should be chosen based on the glove material's resistance to the chemicals being handled; especially when handling corrosive, toxic or carcinogenic materials. Gloves are not an impenetrable barrier to chemicals, they simply slow the rate at which the chemical reaches the hand. Not all glove materials provide protection against all chemicals. The Chemical Hygiene Officer and the manager of CSSLSS are available to provide information about the resistance of most of the available glove materials to many common chemicals.

Check to ensure the absence of cracks or small holes in each glove before each use. This may be done quickly by filling the glove partially with air, closing the wrist opening and checking for air leaks.

Once 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. Gloves should be removed and discarded at frequent intervals, based upon the chemical and the glove material, and the hands promptly and thoroughly washed. When removing gloves, the preferred method is to start peeling the glove forward from the wrist, turning it inside out. After the glove is off the first hand, that glove should be held in the still gloved hand as the second glove is removed, again by peeling from the wrist. In this manner the surfaces of the gloves that had been in contact with potentially harmful chemicals remain away from the wearer's skin and possible exposure. Discard the gloves immediately after use in the appropriate container to prevent the spread of chemicals to telephones, doorknobs, lab notebooks etc. When handling chemicals in a hood, remove the gloves in the hood before leaving the hood area. When discarding gloves be aware that they may be contaminated with hazardous chemicals. Consider the unique hazards of the chemical reactions between used gloves and materials in the trash can. Will they react? If so, segregate glove waste.

iv. Personal Hygiene

Everyone working in any laboratory where chemicals are stored or used should be aware of the dangers of chemical exposure. The potential health effects that may result from exposure to chemicals depends on a number of

factors. These factors include the properties of the specific chemical (including toxicity), the dose and concentration of the chemical, the route of exposure, duration of exposure, individual susceptibility, and any other effects resulting from mixtures with other chemicals.

In order to understand how chemical hazards can affect you, it is important to first understand how chemicals can get into your body and do damage. The four main routes of entry are inhalation, ingestion, injection, and absorption through the skin, mucus membranes, and eyes. These precautions will minimize the possibility of such exposure:

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

While we all know that smoking is prohibited on campus, be aware that tobacco products in opened packages in the laboratory can absorb chemical vapors.

Avoid touching your face when wearing gloves. Do not apply cosmetics in the laboratory.

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

Never wear or bring lab coats or gloves into areas where food is consumed. Wash lab coats separately from other laundry.

Never place writing implements in your mouth.

Sitting or leaning on benchtops where chemicals or biologicals are used potentially exposes your clothing to contamination and absorption through the skin in contact with that clothing.

Be mindful of how you place your personal electronic devices on to countertops which may be contaminated. Even when there is no visible residue, puddles, or stains you should assume that a laboratory surface is not perfectly sterile. Put down a paper towel barrier first before placing devices on a benchtop.

v. Laboratory Protocol

The laboratory 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 laboratory protocol, both for the students' own safety and for the safety of the employees and all others in the laboratory.

vi. Housekeeping

In the laboratory and elsewhere, keeping things clean and neat generally leads to a safer environment. The following are some general guidelines to aid in keeping the laboratory neat.

Keep drawers and cabinets closed while working to avoid unnecessary hazards.

Never store materials, especially chemicals, on the floor, even temporarily.

Keep work spaces and storage areas clear of broken glassware, leftover chemicals and scraps of paper.

Remove packaging materials and empty boxes from the laboratory promptly after unpacking since they may constitute a fire hazard.

Keep aisles free of obstructions such as chairs, boxes, equipment, storage containers, and waste receptacles.

Keep the floor clear of ice, glass beads or rods, other small items, and spilled liquids to avoid slipping hazards.

Return objects and chemicals to their appropriate storage place as soon as they are no longer needed ***for the immediate activity*** to keep the workplace free from clutter and minimize the possibility of an accident involving those objects and chemicals.

vii. Cleaning Glassware

Cleaning glassware is a common laboratory process that has many often overlooked hazards. The following guidelines are applicable in most cases. Special cleaning needs, such as trace elemental or biological, will have special requirements and their own hazards.

Clean glassware at the laboratory sink.

Use plastic buckets or grey bus tubs to carry glassware to the sink area. These are available at Central Scientific Stores.

Use heavy rubber gloves when washing glassware.

Use hot water and detergent to avoid the use of organic solvents, if possible.

Use special non-chromium cleaning agents that are commercially available to avoid the use of strong oxidizing cleaning solutions such as chromic sulfuric acid mixtures. These strong oxidizing solutions present an explosion hazard under certain circumstances.

Broken glass becomes virtually invisible under water.

viii. Transporting Chemicals

Refer also to Section 1.5 "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 or corrosive materials is required. Prep carts should have a 2-3" deep pan if transporting bottles of hazardous materials. Large containers (more than one liter) should not be used for routine transfer of materials. 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 laboratory worker is responsible for ensuring that wastes are handled in a manner that minimizes personal hazard and recognizes the potential for environmental contamination. When disposing of chemicals one basic principle applies: Keep each different class of chemical in a separate clearly labeled disposal container. The following is the standard procedure to be followed in the laboratory on a routine basis:

Label a disposal container as soon as material is transferred to it. Empty disposal containers and blank chemical waste labels are available from CSSLSS. The label MUST contain the following information:

- Name of person responsible for the material
- Location where the material was generated
- Date when material was first transferred to the container
- Name of each material transferred to the container with their approximate percentage, concentration or amount. Abbreviations and chemical formula are NOT acceptable substitutes for complete chemical names.

Keep waste containers closed except when adding material. Vented caps are appropriate when waste materials might build up pressure, such as ethyl ether. This type of container should be kept under a fume hood at all times.

Dispose of waste materials promptly by taking the container to CSSLSS or by arranging CSSLSS to collect your container.

Do not put chemicals into a sink or down the drain unless they are deactivated or neutralized AND they are allowed by local regulation to be in the sanitary sewer system. If in doubt, use a waste container, not the sink. In considering disposal in a sink, be aware that a sink may contain a chemical which will adversely react with the chemical you are dumping (e.g. adding an acid to a sink with a sulfide will evolve deadly hydrogen sulfide gas).

Put ordinary waste paper in a wastepaper basket separate from the chemical wastes.

Put any contaminated paper, such as paper toweling used to clean up a spill, in a special disposal container that is marked for this use. It must be treated as a chemical waste. As such, the disposal container must be labeled with a description that identifies the chemical on the paper. Special containers are available from CSSLSS for spill cleanup and one or more of these kits should be kept available in each laboratory, along with appropriate cleaning tools/supplies.

Dispose of clean broken glass in waste containers separate from normal trash. Special containers are available from CSSLSS for glass waste.

Put any contaminated glass, such as a beaker that broke while holding a chemical, in a special disposal container that is marked for this use. It must be treated as a chemical waste. As such, the disposal container must be labeled with a description that identifies the chemical on the glass. This includes broken mercury thermometers or manometers.

x. Unattended Operation of Equipment

See also Part 5.5 below

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 inside a fume 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 its threshold limit value (TLV), Short Term Exposure Limit (STEL), or permissible exposure limit (PEL).

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, STEL, or PEL of less than 50 ppm.

xii. Refrigerators and Freezers

Refrigerators and freezers are notorious sources of leaks of hazardous or smelly chemicals. The refrigerator or freezer must be explosion-proof if it is to contain flammable or explosive materials. Chemicals stored in refrigerators or freezers 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 or freezer 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). Chemicals should not be stored in refrigerators or freezer solely due to their odor or toxicity (ventilated storage cabinets are better for these substances). Food should never be stored in a refrigerator or freezer used for chemical storage and vice-versa.

xiii. Working Alone

See also Part 5 below.

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

Employees must avoid working alone in any building. Employees must 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, may be treated using tepid potable water spigots in the sinks in all labs.

Chemicals in the eyes should be rinsed out using the eyewash stations near all labs. Eyes should be rinsed for at least 15 minutes. Bottles of eye-rinse, found in many of the first-aid kits, 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 through the skin and into the body, worsening 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 using the first-aid kits distributed around the building, 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 (campus extension 1234 or 9-1-1).

1.2 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 Safety Data Sheet (SDS) 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 SDS 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 SDSs in the individual laboratory or Central Scientific Stores should be consulted to ascertain if the relevant sheet is already on file.

ii. Consult the website of the chemical company from which the chemical was purchased to find an electronic version of the SDS.

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

iv. Consult the website of another chemical company (such as Fishersci.com or Millepore Sigma.com) to find an electronic version of their SDS for the chemical.

v. The Sigma-Aldrich catalog of safety data should be consulted. This two-volume book, kept in Mr. Your's office, W310, contains safety information on 14,500 chemicals supplied by Millepore Sigma. The information is less extensive than that covered by SDSs, but nevertheless includes the most pertinent hazard and safety procedure information.

vi. 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 (glass or plastic) containing the material. Any or all of these wrappings may contain hazard warnings. The final inner container will certainly contain a list of hazards.

vi. Appendix D explains select carcinogens. Appendix E explains reproductive toxins, teratogens and mutagens. Appendix F addresses acute toxicity.

1.3 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. Many labs and stockrooms throughout the world 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 Safety Data sheet (SDS) should be consulted to establish correct safety procedures. These sheets have been described above. Copies of the SDSs relating to each chemical in common use in each laboratory will be available in those labs. In addition, there are the files of SDSs in Central Scientific Stores as well as additional safety data sources from the Chemical Hygiene Officer. Care should be taken to establish the following hazards:

i. Flammability:

Flammable solids, liquids, and gases should not be used in any laboratory in which flames, sparks or other potential sources of ignition are present. Use of a fume hood is good general safety practice for the transfer of flammable materials from one container to another. However, be aware that a fume hood does not necessarily guarantee safety during the transfer. The blower motors, lights, and sensors in the fume hoods are potential sources of sparks that could ignite the material.

Flammable solids are either a Class 1 explosive that is wetted with water or alcohol, a solid that is self reactive and strongly (>300 J/g) exothermic (or self-accelerating decomposition temperature less than or equal to 75 °C), ignites by friction, has a burn rate of greater than 2.2 mm/sec, or is a metal powder that is completely consumed in less than 10 minutes of combustion.

Flammable liquids are any liquid having a flashpoint below 100 deg. F. (37.8 deg. C.), except any mixture having components with flashpoints of 100 deg. F. (37.8 deg. C.) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

Flammable gases are any material with a boiling point less than 20 °C and is either ignitable at less than or equal to 13% v/v in air at 20 °C or has an upper flammability limit greater than or equal to 12%v/v in air at 20 °C.

ii. Toxic or Corrosive Vapors:

Any material (solid, liquid or gas) which gives rise to toxic or corrosive vapors should be handled and disposed in a fume hood. Such material should be stored in the appropriate storage cabinet. The fume hood should be examined prior to opening the container of chemical to establish that: (a) it is operating; (b) it is operating properly (i.e. it is generating a draft of air in which air flows from the laboratory into the hood and upwards toward the hood's exhaust vents); and (c) it has been certified within the last two years and checked for face velocity. All fume hoods have a flowmeter that indicates the current linear flow rate through the sash of the fume hood. There is an audible alarm that sounds when the flow is less than 60 ft/min. Never perform an operation in a fume hood in which hazardous chemicals are involved if the flow is less than 60 ft/min. A quick way to check that the sensor is operating properly is to partially open the hood's sash and place a Kimwipe® in the opening. If it clearly is blown into the hood, the hood is likely to be operating safely.)

iii. Corrosive Liquids and Solids:

These should be handled with due caution. Gloves (nitrile or latex) and a lab coat should be worn. See Section 1.1.iii above for details on the proper use of gloves. Of course, chemical splash goggles, which should be worn at all times in the lab, are vitally important when handling such materials. See Section 1.1.i above for details on the proper use of chemical splash goggles.

iv. Toxic Liquids and Solids:

Measures should be taken to prevent contact with the skin, eyes, mouth and lungs. Eye protection must be worn. See Section 1.1.i above for details on the proper use of chemical splash goggles. If vapors or dust are involved the material should be handled in a fume hood. See Section 1.1.xi above for proper use of fume hoods.

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 located in Appendix A of this 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 particularly hazardous materials that are more likely to be encountered in our labs than other such particularly 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 SDSs and other safety data as described in Section 1.2 above. 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. See Section 1.1.xi above for proper use of fume hoods. 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.

vi. Cryogens: Dry Ice and Liquid Nitrogen/Helium

Cryogens such as dry ice, liquid nitrogen, and liquid helium (a.k.a. cryogenic materials) present a number of potential hazards due to their extreme cold. They may frostbite 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 less expensive, 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.

1.4 Storage of Hazardous Materials

Before opening any package, establish, by consulting the sources of information referred to in Section 1.2 above, the correct place to store the chemical before and after use.

Highly flammable liquids should be stored in flame-proof metal cabinets or in rooms specifically designed for their storage, such as WG09.

Liquids or solids which evolve **toxic or corrosive vapors** should be stored in vented cabinets or in rooms specifically for their storage, such as WG07.

Small cylinders of **toxic or corrosive gases** should be stored in fume hoods. Toxic or corrosive gases should not be present in large cylinders.

Heat sensitive and/or thermally unstable materials should be refrigerated in an explosion-proof refrigerator.

All **cryogens** (liquid nitrogen, liquid helium, and dry-ice) should be stored in the designated containers.

Large tanks of compressed gases should be stored in the room specifically designed room for their storage, WG12, *when not in use*. They should be chained in one of the gas stanchions *when in use*. When stanchions are not present, tanks of compressed gas may be secured by clamping it to a fixed support such as a bench. Clamps for this are available at Central Scientific Stores.

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.

1.5 Transportation of Hazardous Materials

Transport containers of **hazardous liquids or solids** 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.

Transport **large tanks of compressed gases** from the storage room, WG12, to the area of use in one of the wheeled gas carts which are kept in WG12. The protective cap must be secured over the main cylinder valve during transportation. These cylinders should be promptly secured as described in Section 1.4 once at their destination.

Transport **small tanks of compressed gases** secured on a normal

wheeled cart so that it cannot fall from the cart.

Transport small quantities of **cryogens** in a Dewar or other cryogenic container. Transport large quantities of cryogenic liquids in a special transportation Dewar. Avoid riding in elevators with cryogenic liquids or compressed gas cylinders. If this is necessary, consider using a buddy system to have one person send the properly secured Dewars or cylinders on the elevator, while the other person waits at the floor by the elevator doors where the Dewars or cylinders will arrive.

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:

1. Determine all the chemicals involved in the process

If Flammable Gases or Liquids Will…	Then…
Be involved	i. Remove active burners and other ignition sources from the vicinity {29 CFR 1910.106 (e)(2)(iv)(c)}. *Note: Electrical devices such as stirrer plates can be sources of ignition through electrical sparking.* ii. Install the apparatus in a fume hood. iii. Use appropriate traps,

	condensers or scrubbers to minimize release of material to the environment.
Not be involved	Continue assembling the apparatus

2. Determine if elevated temperatures are to be used

If Elevated Temperatures Will…	Then…
Be involved	i. Ensure that the heating source's temperature is less than the autoignition temperature of any chemicals likely to be released. *Note: Whenever possible, use controlled electrical heaters or steam in place of gas burners* ii. Ensure that the temperature control device does not spark. iii. Provide a vent as part of the apparatus to avoid the build-up or pressure as temperature rises.
Not be involved	Continue assembling the apparatus

3. Determine if hazardous gases or fumes are likely to be evolved

If Hazardous Gases or Fumes Will…	Then…
Be evolved	i. Install an appropriate gas trap on the apparatus. ii. Install the apparatus in a fume hood.
Not be evolved	Continue assembling the apparatus

4. Determine if a fume hood should be used for other reasons

If …	Then…
The reaction could cause an explosion	i. Install the apparatus in a fume hood. *Note: If a hood is not available, use a standing shield.* ii. Keep the sash closed except when preparing or disassembling the apparatus.
The apparatus involves a vacuum	1 Install the apparatus in a fume hood. *Note: If a hood is not available, use a standing shield.* 2 Keep the sash closed except when preparing or disassembling the apparatus.
Neither explosion or implosion are likely.	Continue assembling the apparatus

5. Examine glassware for flaws or strains

   Note: Polarized light can make flaws more visible.

If you see…	Then…
Star cracks or other flaws	Discard the glassware
No star cracks or other flaws	Continue assembling the apparatus

6. Place a pan under the reaction vessel or container to confine spilled liquids in the event of glass breakage.

7. Properly support condensers with securely positioned clamps

8. Secured attached water hoses with wire or clamps at each end of hose

9. Use proper eye and face protection when using the apparatus

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 fume hood is not an appropriate means for disposing of chemicals, nor is it a storage cabinet. Stored chemicals can interfere with efficient fume hood operation, and in the event of an accident or fire, every item in the fume hood may become involved.

The fume hoods are variable flow units that use control circuits to maintain at least 100 ft/min of air velocity through the front opening as the sash is raised or lowered.

Note: When the room is left unoccupied for a period of time, this velocity will reduce to 60 ft/min).

All fume hoods have a flowmeter that indicates the current linear flow rate through the sash of the fume hood. Additionally, there is an audible alarm that sounds when the flow is less than 60 ft/min.

Never perform an operation in a fume hood in which hazardous chemicals are involved if the flow is less than 60 ft/min. A quick way to check that the flow sensor is operating properly is to partially open the hood's sash and place a piece of Kimwipe® or light-duty wiper in the opening. If it clearly is blown into the hood and the flowmeter indicates more than 60 ft/min then the flow sensor is likely to be operating safely. Do not allow the wiper to be sucked up the fume hood stack.

If the sash is lowered to less than 3 inches, the flowmeter will display a “FLO” message indicate that the minimum volumetric air flow is moving through the hood. In this situation, the linear air flow will be greater than 100 ft/min (60 ft/min if the room is unoccupied) operation through the reduced openings.

1. Ensure that exhaust ports from the fume hood and supply air vents to the room are not be blocked.
   Note: Since the air pulled through the fume hood comes from the room, additional air must be supplied to the room.
2. Keep all doors closed to rooms with fume hoods as much as possible.
   Note: This maintains the proper air flow within the room.
3. Check that the hood is working properly before each use using one of the methods indicated above.
4. Equipment should be placed as far back into the hood area as practical and activities carried out at least six inches from the front edge of the hood.
   Note: This minimizes disruption of air flow into the hood and provides the greatest protection in the event of an explosion.
   Note: Adequate air flow and the absence of excessive turbulence are necessary for safe operation of the fume hood.
5. Keep sash openings to a minimum.
   Note: In no case should the sash be opened more than 18 inches if operations involving hazardous chemicals are occurring in the fume hood. There is a stop on the sashes to prevent the user from casually exceeding this height.
   Note: When not manipulating objects in the fume hood, the sash should be completely closed.

6. Keep the faces of all operators outside the plane of the hood sash
7. Remain alert to changes in air flow.

Note: When not manipulating objects in the fume hood, the sash should be completely closed.

iii-a. Floor-mounted Fume hood

There is one fume hood in Dolan Science Center W315 that is open to the floor. This fume hood has two movable sashes, but is otherwise identical to the other fume hoods.

Whenever a process is operating in the fume hood ...

a. Move one of the two sashes against the floor.
b. Move the second sash so that it covers the opening between the top of the bottom sash and the top of the fume hood.
c. If an adjustment must be made to the process during its operation, move whichever sash can be moved the minimum amount to allow the adjustment.

iii-b. Perchloric Acid Fume hood

There is one fume hood in Dolan Science Center W315 that has been specially designed for operations involving perchloric acid. Perchloric acid is dangerous because the salts formed from perchloric acid are often explosive when dry. This fume hood has a separate blower motor, and lacks much of the sound deadening material in the other fume hoods. To avoid unnecessary noise, this is only fume hood normally left without air moving through it.

1. Turn on the blower motor using the wall control unit immediately before perchloric acid operations are to commence.
2. Rinse the fume hood with water once the perchloric operations have stopped.

Note: This rinsing will safely wash away any perchloric acid salts that may have formed before they dry.

a. Remove all materials from the fume hood.
b. Turn off the blower motor using the wall control unit.
c. Wait for the blower motor to stop.
d. Start the exhaust water rinse using the wall control unit.
e. Start the hot water rinse by turning the white knob near the top of the hood.
f. Wait at least 15 minutes in order to completely remove any perchlorate salts from the fume hood
g. Stop the hot water rinse by turning the white knob near the top of the hood.
h. Stop the exhaust water rinse using the wall control unit.

Note: Detailed instructions for how to accomplish these tasks are mounted on the fume hood itself. Always follow these instructions when using this hood.

Since this fume hood normally does not have any air moving through it,

this fume hood absolutely **can never be used for storage of material**.

iv. Centrifuges

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

- Always close the centrifuge lid, if present, 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 and Fluorimeter in the Instrument Room (W317) both contain a visible laser. There is a free-standing He-Ne laser in the Instrument Room and in the Physics Dept. 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 that might deflect the beam out of the instrument.

vi. X-ray Generators

The powder diffractometer in the Instrument Room (W317) 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. UltraViolet Light Sources

The ICP instrument in the Instrument Room (W317) generate extremely high temperatures which produce large amounts of ultraviolet radiation. This radiation can burn eye tissue if exposed to it for a sufficient period of time. While sufficient protection is designed within the instrument, some adjustments must be made without them. **Do not attempt these adjustments without ultraviolet**

protection for your eyes.

Additionally, the ultraviolet and visible spectrometers (two in W317 and one in W338) and the ultraviolet and visible detectors on the two HPLC instruments in W317 generate ultraviolet light. **Do not attempt the view these ultraviolet light sources without adequate eye protection.**

viii. 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 potential explosives since their high pressure is a high-energy source.
- Lecture bottles of compressed gases should be avoided when at all possible. They cannot be refilled and present a storage problem.
- Restrain cylinders of all sizes, empty or full, by strapping them to a solid, firm support, or by using a suitable stand.
- Maintain the protective caps securely in place when storing or moving cylinders to protect the valve stems.
- Use one of the special carts kept in the gas cylinder storage room (WG12) when moving large cylinders.
- Never lubricate, modify, force, or tamper with cylinder valves.
- Use toxic, flammable, or reactive gases in fume hoods only.
- Store cylinders in the designated room within the Central Scientific Stores suite, WG12. Smoking and eating or drinking are forbidden in this 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 and return them to Central Scientific Stores.
- 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 a cylinder containing oxygen, chlorine, or other oxidizing agent. A fire or explosion can result.

- Corrosive gases should be stored for a maximum of 6 months before the cylinder should be returned. The corrosive gas may make the valve system non-functional through continued exposure.

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.

a. Wait until the solution is cooler than the boiling point of the extracting solvent
b. Add the extracting solvent through unstoppered end of a separatory funnel

<table>
<tr><th>If the Extracting Solvent Is…</th><th colspan="2">Then…</th></tr>
<tr><td rowspan="4">Volatile</td><td colspan="2">Perform the extraction away from flames, preferably in a fume hood</td></tr>
<tr><td>If the Funnel Volume is …</td><td>Then …</td></tr>
<tr><td>1 L or greater</td><td>a. Split the extraction into multiple batches.
Note: the force on the stopper may be too great and cause the stopper to be expelled.
b. Continue with Step c.</td></tr>
<tr><td>Less than 1 L</td><td>Continue with Step c.</td></tr>
</table>

Non-volatile	Continue with Step **c**.

c. Swirl the unstoppered separatory funnel to allow some solvent to vaporize and expel some air.
d. Stopper the funnel.
e. Invert the funnel with the stopper firmly held in place.
f. Open the stopcock immediately to release more air and vapor.
g. Close the stopcock
h. Shake the funnel with a swirl.
i. Open the stopcock immediately to release more air and vapor.
   *Note: Steps **e** through **i** should be done with the hand encompassing the barrel to keep the stopcock plug securely seated*
   *Note: Repeat steps **g** through **i** as needed to complete the extraction.*
j. Invert the funnel
k. Remove the stopper
l. Wait for the two immiscible layers to separate completely
m. Open the stopcock to drain the lower layer into an appropriate container.
n. Close the stopcock to prevent the upper layer from exiting
o. Open the stopcock to drain the upper layer into a separate container.
   *Note: An additional Close/Open sequence might be added between Steps **n** and **o** to ensure that none of one layer is included with the second.*

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.

- Perform the distillation in a fume hood whenever possible.
- Securely clamp the apparatus
- Ensure that there is an outlet for the excess pressure to escape the system **before applying any Heat**.
- Use one of the following methods to apply heat in order to maintain even heating
  - Heating mantle
  - Steam ring
  - Hot water, silicone, or mineral oil bath on a hot plate
  - Sand bath
  - Metal block with appropriately sized cavities Even heating is

important, especially under reduced pressure, to avoid local hot-spots. A flame should not be used. can all be used.

- Avoid Bumping

If the Distillation Will be Performed At …	Then…
Ambient Pressure	Use boiling stones or stir the mixture.
Reduced Pressure	a. Use a standing shield for protection in the event of an implosion. b. Evacuate the system gradually c. Stir the mixture magnetically or with an air or nitrogen bleed tube

- **Terminate any distillation before the mixture is completely dry**

Note: This is particularly important for organic solvents, 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.

iii. Temperature Control

1) 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 rapid boiling of the solvent. To avoid this:
   - Add one reagent in small amounts to the other.
   - Always add acid to water; never add water to concentrated acids
   - Have a cooling bath available to quickly cool down the mixture if necessary.
   - Set up the apparatus so that heating or cooling can be applied or withdrawn readily.
2) Test tubes should be held with a test tube holder, gently 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. This spreads the heat uniformly around the tube to avoid its contents being ejected.
3) When oil baths are used:

- Ensure that the oil is water free since the presence of water can cause violent bumping and splashing of the hot oil
- Use mineral oil or silicone oil
- Do not heat beyond the flash point of the oil
- Do not leave a hot oil bath unattended

4) When cooling is needed:
   - Use an ice water bath if possible
   - Use an ice/salt bath for lower temperatures
   - Use dry ice slush bath or liquid nitrogen for very low temperatures

   Note: For the appropriate procedures in using these materials [see Section 1.3 (vi) above].

iv. Reduced Pressure Operations

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

- Wrap vacuum desiccators and vacuum line bulbs in duct tape to prevent flying glass in the event of an implosion.
- Use only heavy walled flasks for vacuum filtration.
- Use a cold trap to protect vacuum pumps from vapors.
- Vent Exhaust from vacuum pumps to a fume hood whenever possible.
- Use a portable explosion guards for reactions or other operations carried out under reduced pressure. See the manager of Central Scientific Stores or the Chemical Hygiene Officer for availability.

PART 2. CRITERIA FOR EXPOSURE CONTROL MEASURES

2.1 Environmental Monitoring

Regular instrumental monitoring of airborne concentrations is not usually justified or practical in JCU laboratories but are 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 8, and if the particular chemical is in use more than three times in a week, the CHO and JCU's Risk Management 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 CHO and JCU's Risk Management 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 can be found in Appendix A. Reasons for believing that the action levels are exceeded could be

- Malfunction or possible inadequacy of a control device such as a hood.
- Excessive smell of a chemical which has a pronounced odor.
- 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.

2.2 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. Your working space on 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. Custodial personnel are not authorized to enter spaces where potentially hazardous chemicals are located unless they have received adequate training as described in Part 4 of this 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 shall be inspected monthly. Fume hoods should be inspected annually, 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 CHO, JCU's Risk Management Officer, and the JCU Facilities Department.

2.3 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.

2.4 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. 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 Manager of Central Scientific Stores and assistants, and shall be in accordance with ANSI Z358.1-2014 and manufacturer's specifications. Records shall be maintained. Location signs for safety and emergency equipment are posted.

PART 3. FUME HOODS AND OTHER PROTECTIVE EQUIPMENT

3.1 Fume hoods: Purpose

Fume hoods 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:

1) A physical barrier is placed between the worker and the chemical reaction. This can provide protection from splashes, sprays, fires, and minor explosions.
2) An effective containment device for accidental spills of chemicals.

3.2 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).

3.3 Hood Inspection and Maintenance

Facilities has the responsibility for the annual testing and inspection of fume hoods on campus. After each inspection, an inspection sticker is affixed to the fume hood. If a hood is found to be unacceptable, a warning sign indicating the hood did not pass inspection and should not be used is fixed to the sash. Hoods will be inspected using ANSI standard methods to ensure:

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

Additionally, the full ASHRAE test shall be conducted upon installation and whenever there is a modification of the duct system)

The documentation from these inspections are available from the CHO, JCU's Risk Management Officer and the JCU Facilities Department.

3.4 Hood Use

All fume hoods have a flowmeter that indicates the current linear flow rate through the sash of the fume hood. Additionally, there is an audible alarm that

sounds when the flow is less than 60 ft/min.

Never perform an operation in a fume hood in which hazardous chemicals are involved if the flow is less than 60 ft/min. A quick way to check that the flow sensor is operating properly is to partially open the hood's sash and place a piece of Kimwipe® or light-duty wiper in the opening. If it clearly is blown into the hood and the flowmeter indicates more than 60 ft/min then the flow sensor is likely to be operating safely. Do not allow the wiper to be sucked up the fume hood stack.

If the sash is lowered to less than 3 inches, the flowmeter will display a "FLO" message indicate that the minimum volumetric air flow is moving through the hood. In this situation, the linear air flow will be greater than 100 ft/min (60 ft/min if the room is unoccupied) operation through the reduced openings.

1. Ensure that exhaust ports from the fume hood and supply air vents to the room are not be blocked.
   Note: Since the air pulled through the fume hood comes from the room, additional air must be supplied to the room.
2. Keep all doors closed to rooms with fume hoods as much as possible.
   Note: This maintains the proper air flow within the room.
3. Check that the hood is working properly before each use using one of the methods indicated above.
4. Equipment should be placed as far back into the hood area as practical and activities carried out at least six inches from the front edge of the hood.
   Note: This minimizes disruption of air flow into the hood and provides the greatest protection in the event of an explosion.
   Note: Adequate air flow and the absence of excessive turbulence are necessary for safe operation of the fume hood.
5. Keep sash openings to a minimum.
   Note: In no case should the sash be opened more than 18 inches if operations involving hazardous chemicals are occurring in the fume hood. There is a stop on the sashes to prevent the user from casually exceeding this height.
   Note: When not manipulating objects in the fume hood, the sash should be completely closed.
6. Keep the faces of all operators outside the plane of the hood sash
7. Remain alert to changes in air flow.
   Note: When not manipulating objects in the fume hood, the sash should be completely closed.

Storage of chemicals and equipment inside the hood shall be kept to a minimum.

The hood shall not be used as a means of disposal for volatile chemicals.

3.5 Storage cabinets

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 Central Scientific Stores and under many of the fume hoods in the other laboratory spaces. The cabinets should be vented into the building exhaust system, and an adequate supply of air should pass so as to remove the vapors.

3.6 Special ventilation areas

Exhaust air from glove boxes, ovens, and certain instruments should be passed into the building exhaust system. If a particular 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 gauge.

3.7 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 4. INFORMATION AND TRAINING

4.1 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, when the nature of hazards change, and at a regular frequency as determined by the Chemical Hygiene Officer.

4.2 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 provisions of the OSHA laboratory standard, and its appendices.
ii. The location and availability of the Chemical Hygiene Plan.
iii. The permissible exposure limits (PEL) for OSHA regulated substances or recommended exposure values for other hazardous chemicals (TLV, REL) not regulated by OSHA which are present in the laboratory.
iv. Signs and symptoms of exposure to the chemicals present in the laboratory.
v. Location and availability of reference material on chemical hygiene.
vi. Procedures for the detection of presence or release of hazardous materials.
vii. Physical and health hazards of chemicals in the workplace.
viii. Protective measures including PPE, work practices, and emergency procedures.
ix. Interpretation of the information present of labels consistent with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

PART 5. REQUIREMENT OF PRIOR APROVAL FOR CERTAIN LABORATORY PROCEDURES

5.1 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.

5.2 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).

5.3 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).

5.4 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.

5.5 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 6. 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 of the employee's choice.

PART 7. CHEMICAL HYGIENE OFFICER DESIGNATION

Responsibility for implementation of this plan lies with all employees, but the effort will be coordinated by the Chemical Hygiene Officer, Mr. Jeffrey Your. He can provide assistance to employees in fulfilling their safety responsibilities.

The Chemical Hygiene Officer:

1. Establishes, maintains, and revises the chemical hygiene plan
2. Creates and revises safety rules and regulations in keeping with best practices
3. Monitors procurement, use, storage, and disposal of chemicals
4. Conducts regular inspections of the laboratories, preparation rooms, and chemical storage rooms, and submits detailed laboratory inspection reports to administrators.
5. Maintains inspection, personnel training, and inventory records
6. Assists laboratory supervisors in developing and maintaining adequate facilities
7. Seeks ways to improve the chemical hygiene plan.

Additional assistance may be obtained from the Dolan Science Safety Committee and the Director of the JCU Office of Safety and Risk Management, Mr. Garry Homany.

PART 8. PARTICULARLY HAZARDOUS SUBSTANCES

8.1 Carcinogens and Reproductive Toxins

Before any package from a chemical company is opened, or before any chemical is used, the SDSs and other safety information available in Central Scientific Stores 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), α-naphthylamine, β-naphthylamine, 4-Nitrobiphenyl, *N*-Nitrosodimethylamine, β-Propiolactone, vinyl chloride. Examples of embryotoxins are organomercurials, lead compounds, formamide. The package should not be opened or the chemical used until the CHO has been consulted. The CHO will determine whether the special precautions described below will need to be followed. See Appendices D, E, & F for further amplification.

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 laboratory 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 SDS). 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. See Appendix D.

8.2 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 SDS and other safety information available in Central Scientific Stores should be consulted, as described in Part 1.2. If the information in the " Hazard Identification" section of the SDS (Section 2) 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 SDS 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. See Appendix F below.

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 SDS).
- 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.

8.3 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 SDS and other safety information available in Central Scientific Stores should be consulted, as described in Part 1 (c). If the information in the "Health Hazard Data" section of the SDS 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-*alpha*-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 β-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.

APPENDIX A. HIGHLY TOXIC SUBSTANCES 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 Banner ID no.: _____ Supervisor: _____

Activity for which permit is requested:

Approval of Supervisor: _____

Approval of Chemical Hygiene Officer: _____

Approval of Departmental Chairperson: _____

APPENDIX C. DESCRIPTION OF THE JCU LABORATORY FACILITIES

The JCU chemistry department is located throughout the west wing of the Dolan Center for Science and Technology. It consists of: 2 General Chemistry Teaching Labs; 2 Organic Chemistry Teaching Labs; 1 Advanced Chemistry Teaching Lab; 1 Biochemistry Teaching Lab; 4 Preparation Rooms; 1 Instrumentation Lab; 9 Faculty Research Labs; 1 Molecular Modeling Lab; the John A. Carrabine Computer Lab; 3 storage rooms; and various departmental offices.

JCU Central Scientific Stores and Laboratory Support Services (CSSLSS) is located on the ground level of the west wing of the Dolan Science Center. It consists of: a biology stockroom; a main chemical stockroom; and separate storage rooms for chemical waste, corrosive materials, flammable materials, reactive materials, ethanol, and gas cylinders.

The JCU biology department is located on the first and second floors of the west wing of the Dolan Science Center. It consists of: 1 Development and Cell Biology Teaching Lab; 1 Comparative Anatomy and Human Biology Teaching Lab; 1 Ecology Teaching Lab; 2 General Biology Teaching Labs; 1 Microbiology and Molecular Biology teaching labs; 2 Environmental Temperature-controlled Rooms; 4 Prep Rooms; 15 Faculty Research Labs; 2 Aquatic and Insect Rearing Labs; 1 Greenhouse; 1 Vivarium; 1 storage room, and various departmental offices.

The JCU physics department is located on the first floor of the east wing of the Dolan Science Center. It consists of: 1 General Physics teaching lab, 1 Engineering Physics teaching lab, 1 Advanced Physics teaching lab, 1 Microscopy Lab, 4 faculty research labs, and 1 Dark Room, 3 storage rooms, and various departmental offices.

The JCU nursing department is located on the second floor of the atrium and east wing of the Dolan Science Center. It consists of: 2 Observation Labs and 1 Patient Care lab, storage rooms, and various departmental offices.

Additionally, there are numerous classrooms and other areas within the Dolan Science Center in which hazardous chemicals may be found due to various temporary activities, such as demonstrations.

The ventilation system of the building brings air from outside via ducts below grade both north and south of the building. This air is mixed with air drawn from inside the building with humidity and temperature adjusted as needed. 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, and pass it up to the roof and out through vents.

The laboratory facilities in the west wing of the Dolan Science Center, including Central Scientific Stores, are most likely to contain hazardous chemicals. These facilities generally contain the following features:

Bench areas where experiments and other manipulations are carried out. Many contain spigots for natural gas, nitrogen, vacuum, and compressed air in addition to electrical outlets and data ports.

Sinks for washing hands, rinsing glassware, other uses of flowing water (condensers, coolers, etc) and disposal of a limited number of non-hazardous materials. Many contain spigots for both hot and cold potable water and /or a separate spigot for deionized water

Combined safety shower and eye-wash stations. The safety showers are used for fire victims and for providing water rinse over large areas of the body. The eye-washes are used for rinsing chemical contamination from eyes.

Fume hoods for operations with hazardous gases, flammable liquids, materials that evolve hazardous vapors (toxic or flammable), and certain operations with very hazardous materials. Many contain sinks with separate spigots for cold potable water and deionized water, in addition to spigots for natural gas, nitrogen, vacuum, and compressed air in addition to electrical outlets.

Fire Extinguisher to extinguish small laboratory fires.

First-aid kit including various bandages, antiseptics and ointments for use by personnel in the area.

Chemical Storage Cabinets for corrosive materials such as acids, bases, and strong oxidizing agents or for flammable materials. Other chemicals may be stored on open shelves or non-specialty cabinets.

Safety data sheets (SDS).

Each laboratory has slightly different features that are specific to the particular function of the laboratory itself. It is the responsibility of the person supervising the activities in the particular laboratory to instruct everyone in the laboratory on the particular features of that lab.

By virtue of the large volume of chemical supplies that are stored therein, the various storage rooms of CSSLSS 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 them.

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

The remaining storage rooms of CSSLSS contain bulk storage containers of flammable solvents, highly corrosive and reactive materials, as well as some other toxic, smelly, or otherwise controlled chemicals and hazardous waste. They are ventilated and separated from the rest of CSSLSS by lockable doors. Access is restricted to the manager and staff of CSSLSS and chemistry faculty.

The following rooms, each referred to as “the laboratory” in this Plan, in the Dolan Science Center were known to have potentially hazardous chemicals within them. A copy of this Chemical Hygiene Plan should exist, and the procedures contained herein followed, in all of these rooms as well as any other spaces where potentially hazardous chemicals are located.

WG02 Hazardous Materials Storage
WG06 Central Scientific Stores
WG07 Acid Storage Vault
WG08 Reactive Chemistry Storage Vault
WG09 Flammable/Bulk Storage Vault
WG10 Ethanol Storage Vault
WG12 Compressed Gas Storage
WL06-WL14 Vivarium Labs
W134 General Chemistry Lab
W135 General Chemistry Prep Room
W136 General Chemistry Lab
W218 Mascotti Research Lab
W219A Temperature-controlled Room
W219B Temperature-controlled Room
W221 Biochemistry Lab
W222 Biochemistry Prep Room
W232 Chai Research Lab
W314 Advanced Chemistry Prep Room
W315 Advanced Chemistry Lab
W317 Instrument Room
W318 Organic Chemistry Lab
W319 Organic Chemistry Lab
W320 Organic Chemistry Instrument Room
W328 Unassigned Research Lab
W331 Waner Research Lab

W332 Kwan Research Lab
W333 Nichols Research Lab
W336 Unassigned Research Lab
W337 Macnaughtan Research Lab
W338 Unassigned Research Lab
W108 Saporito Research Lab
W109 Martin Research Lab
W110 Saporito Research Lab
W113 Tissue and Culture Lab
W114 Johnson Research Lab
W115 Developmental and Cellular Biology Prep Room
W116 Human Biology Lab
W117 Johansen Research Lab
W118 Johansen Research Lab
W119 Johansen Research Lab
W121 Anatomy & Physiology Prep Room
W128 Ecology Research Lab
W138 Vanderzalm Research Lab
W213 General Biology Lab*
W216 General Biology Prep Room
W217 General Biology Lab*
W228 Microbiology and Molecular Biology Prep Room
W229 Microbiology and Molecular Biology Lab
W234 Watling Research Lab
W230 Anthony Research Lab
W231 Lissemore Research Lab
W239 Drenovsky Research Lab
W240 Drenovsky Research Lab
E111 Grossman-Ponemon Research Lab
E122 General Physics Lab
E124 Dyck Research Lab
E126 Piracha Research Lab
E132 Microscopy Lab
E133 Engineering Physics Lab
E135 Advanced Physics Lab
E141 Gloeckner Research Lab
E241 Nursing Skills Lab

* Chemicals present during teaching use only.

APPENDIX D. SELECT CARCINOGENS

What are carcinogens?

Carcinogens (pronounced “kahr-sin-o-jens”) are substances that may increase your risk of developing cancer. Experts have identified more than 100 carcinogens. Carcinogens may be physical, such as ultraviolet rays from the sun; chemical, like asbestos; or biological, such as infections caused by certain viruses. Simply having contact with a carcinogen doesn’t mean you’ll develop cancer. While you may not be able to avoid some carcinogens, there are steps you can take to reduce your risk of developing cancer from carcinogen exposure.

https://my.clevelandclinic.org/health/articles/25081-carcinogens

A carcinogen is any substance which meets one of the following criteria:
(1) It is regulated by Cal/OSHA as a carcinogen; or
(2) It Is listed under the category, "known to be carcinogens," In the *Annual Report on Carcinogens* published by the National Toxicology Program **(NTP) (1985** edition); or
(3) It Is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer *Monographs* **(IARC)** (Volumes 1-48 and Supplements 1-8); or
(4) It Is listed in either Group 2A or 28 by IARC or under the category, "reasonably anticipated to be carcinogens" by **NTP,** and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;
b. After repeated skin application of less than 300 mg/kg of body weight per week; or
c. After oral dosages of less than 50 mg/kg of body weight per day.

Signal Word		Danger		Warning
Pictogram				
Hazard Statement		May cause		Suspected of causing
Preface		*Known Human Carcinogen*	*Presumed Human Carcinogen*	*Suspected human carcinogen*
Category		Category 1A	Category 1B	Category 2
Definition		Based on human evidence	Based on demonstrated animal carcinogenicity	Limited evidence of human or animal carcinogenicity
Approximate Equivalency[1]	IARC	Group 1	Group 2A	Group 2B
	NTP *RoC*	Known	Reasonably Anticipated	Note 1
GHS H Code		H350		H351

APPENDIX E. REPRODUCTIVE TOXINS, TERATOGENS, AND MUTAGENS

Chemicals which affect the reproductive capabilities including chromosomal damage (mutations), and have effects on fetuses (teratogens), adverse effects on sexual function and fertility in males and females, as well as adverse effects on the development of offspring. Chemicals classified as reproductive toxins in accordance with the Hazard Communication Standard are to be considered reproductive toxins under this Plan.

Signal Word	Danger		Warning	
Pictogram				
Hazard Statement	May damage		Suspected of damaging	May cause harm to breast-fed children
Preface	*Known*	*Presumed*	*Suspected*	
Category	**Category 1A**	**Category 1B**	**Category 2**	**Additional Category**
Definition	Based on human evidence	Based on experimental animals	Human or animal evidence possibly with other information	Effects on or via lavation
GHS H Code	H360		H361	H362

APPENDIX F. ACUTE TOXICITY

	Signal Word	Danger			Warning		
	Pictogram					*Note: Only used in International GHS. Not adopted by OSHA.*	
	Hazard Statement	Fatal		Toxic	Harmful	May be Harmful	
	Preface	*Extremely*	*Highly*				
Route	**Acute Toxicity**	**Category 1**	**Category 2**	**Category 3**	**Category 4**	**Category 5**	
Oral	**Oral** (mg/kg)	≤ 5	> 5 ≤ 50	> 50 ≤ 300	> 300 ≤ 2000		Criteria: • Anticipated oral LD_{50} between 2000 and 5000 mg/kg; • Indication of significant effect in humans;* • Any mortality at class 4;* • Significant clinical signs at class 4;* • Indications from other studies.* *If assignment to a more hazardous class is not warranted.
	H Code	H300		H301	H302	H303	
Dermal	**Dermal** (mg/kg)	≤ 50	> 50 ≤ 200	> 200 ≤ 1000	> 1000 ≤ 2000		
	H Code	H310		H311	H312	H313	
Inhalation	**Gases** (ppm)	≤ 100	> 100 ≤ 500	> 500 ≤ 2500	> 2500 ≤ 5000		
	Vapors (mg/l)	≤ 0.5	> 0.5 ≤ 2.0	> 2.0 ≤ 10	> 10 ≤ 20		
	Dusts & Mists (ng/l)	≤ 0.05	> 0.05 ≤ 0.5	> 0.5 ≤ 1.0	> 1.0 ≤ 5		
	H Code	H330		H331	H332	H333	

APPENDIX G. ANATOMY OF SAFETY DATA SHEETS

The 16 Sections of Safety Data Sheets [SDS] Explained

Safety data sheets (SDS) are generally physical papers providing safety information relating to hazardous chemicals in the workplace. This includes pure, mixed and branded chemical substances.

This information on safety data sheets includes the physical, health and environmental hazards of each chemical as well as how to safely store, handle and transport them.

How many sections in SDS?

Following GHS guidelines, SDS must include 16 specific sections which are grouped into four categories: 1) general information about the chemical, 2) technical and scientific information, 3) information governed by other agencies and 4) other.

In this article we'll explain each category and what is required in each specific section of a safety data sheet.

SDS Sections 1-8: General Information

The first eight sections of an SDS contain information most needed for quick access. Examples of information found in Sections 1-8 include, identifying the chemical and its composition, how it should be handled and stored, exposure limits, etc.

Section 1: Identification

Section 1 of an SDS is designed to tell you what the chemical is, how it should and should not be used, and how to contact the supplier.

Required information includes product identifier, common names/synonyms, recommended use, restrictions on use and the name, address, phone number and emergency phone number of the manufacturer or distributor.

Section 2: Hazard(s) Identification.

SDS section 2 warns you of risks associated with the chemical on that particular SDS. Required information includes hazard classification, signal word, hazard statements, pictograms, precautionary statements and descriptions of unclassified hazard.

In the case of mixtures, the percentage that consists of an ingredient with unknown acute toxicity should also be disclosed.

Section 3: Composition/Information on Ingredients.

The third section on an SDS tells you exactly what the product is made of, including impurities and stabilizing additives. This is important because impurities and stabilizing additives have their own classifications and contribute to the overall classification of the chemical substance.

For all substances, SDS Section 3 requires: chemical name, common name/synonyms, Chemical Abstracts Service (CAS) number and other unique attributes. If the following criteria is met, then the chemical name and exact percentage (concentration) are required:

- The chemical includes additional ingredients classified as health hazards
- The additional ingredients are present in an amount greater than the concentration limits or exhibit a health risk below the concentration limits

Percentage ranges can be used on safety data sheets for mixtures with batch-to-batch variation, a group of substantially similar mixtures or if there is a trade secret claim. If exact percentages are withheld due to a trade secret claim, a statement to that effect is required in Section 3.

Section 4: First Aid Measures

Information required for SDS Section 4 includes a description of symptoms and effects (both acute and delayed). First aid instructions must be included for exposure via inhalation, skin and eye contact and ingestion as well as recommendations for immediate medical care or special treatment when needed.

Section 5: Firefighting Measures

This part of an SDS tells you what to do in case of fire caused by the chemical. Required information includes, appropriate/not appropriate extinguishing equipment, special equipment/precautions for firefighters and advice on specific hazards that develop from the chemical during the fire.

Section 6: Accidental Release Measures

SDS Section 6 tells you what to do should the chemical be spilled, leaked or otherwise released. Required information includes emergency procedures, protective equipment and appropriate cleanup and containment methods.

Section 7: Handling and Storage

Section 7 on your SDS provides a guideline for safely handling and storing chemicals. Requirements include information for safely handling the chemical to minimize release into the environment, general hygiene, as well as conditions for safe storage, specific storage needs and storage incompatibilities.

Section 8: Exposure Controls/Personal Protection

SDS Section 8 is designed to help you avoid personal exposure to chemicals in quantities or time periods longer than can be done so safely. It lists the maximum amount of personal exposure that is considered safe and the protective measures that should be used to safely handle the chemical.

Information required for protection includes appropriate engineering controls, personal protective equipment (PPE) and any special material and/or resistance requirements for PPE.

Information required for exposure includes:

- OSHA Permissible Exposure Limits (PELs)
- American Conference of Governmental Industrial Hygienists (ACGIH)
- Threshold Limit Values (TLVs)
- Any other limits recommended for safety

Sections 9-11: Technical & Scientific Information

Safety data sheets organize technical and scientific information into Sections 9 through 11 (and sometimes Section 16).

The information required in these particular sections of the safety data sheet is very specific and detailed and they cannot be left blank.

If there is no relevant information for a required element in any of these sections, it must be stated on the SDS in the appropriate field.

Section 9: Physical and Chemical Properties

This section is where the chemical's characteristics are listed on the SDS. The minimum required fields include:

- Appearance (physical state, color, etc.)
- Auto-ignition temperature
- Decomposition temperature
- Evaporation rate
- Flammability (solid, gas)
- Flash point
- Initial boiling point and boiling range
- Melting point/freezing point
- Odor
- Odor threshold
- Partition coefficient: n-octanol/water
- pH
- Relative density
- Solubility(ies)
- Upper/lower flammability or explosive limits
- Vapor density
- Vapor pressure
- Viscosity

Section 10: Stability and Reactivity

SDS Section 10 tells you how stable the chemical is and the likelihood of hazardous reactions. Required information is divided into three clear sections:

- Specific test data for the chemical, class or family.
- **Chemical stability.** Whether the chemical is stable or unstable (at regular room temperature) while in storage and being handled, any stabilizers that may be needed and any changes in physical appearance that indicate safety issues.
- Possibility of hazardous reactions, conditions to be avoided, incompatible materials and any known or anticipated hazardous decomposition products that could be produced because of use, storage or heating.

Section 11: Toxicological Information

This section of an SDS provides you with health risks associated with poisoning from the chemical. Information required includes routes of exposure, related symptoms, acute and chronic health effects, numerical measures of toxicity and whether or not the chemical is considered carcinogenic.

Sections 12-15: Information Governed by Other Agencies

It's important to note that OSHA requires safety data sheets to contain Sections 12-15 to uphold GHS guidelines, but does not enforce the content included in those sections.

While not mandated by OSHA, content in SDS Sections 12-15 is enforced and governed by other agencies such as the Environmental Protection Agency (EPA).

Section 12: Ecological Information (non-mandatory)

SDS Section 12 includes information helpful for evaluating the environmental impact if the chemical(s) were released into the environment. Examples of this type of information include bioaccumulation potential, ozone layer depletion and groundwater absorption studies.

Section 13: Disposal Considerations (non-mandatory).

This SDS section tells you how to safely dispose of, recycle or reclaim the chemical and/or its container. Examples include appropriate disposal containers, disposal methods, physical and chemical properties that may affect disposal, language discouraging sewage disposal and any special precautions for landfills or incineration.

Section 14: Transport Information (non-mandatory)

SDS Section 14 provides information for shipping and transporting hazardous chemicals by road, air, rail or sea. This type of information can include UN number and shipping name, transport hazard classes, packing group number, environmental hazard, bulk transport guidance and special precautions associated with transport.

Section 15: Regulatory Information (non-mandatory)

Section 15 includes any additional safety, health, and environmental regulations not indicated anywhere else on the SDS sheet. Regional regulatory information is a common example of this type of information.

Section 16: Other Information

Section 16 is for communicating when the most recent update was made, and any other useful information not included anywhere else in the SDS. Information to record here includes when the SDS was prepared, the last known revision date, and where changes were made in the most recent revision.

Source: https://www.avery.com/articles/the-16-sections-of-safety-data-sheets-sds-explained
Accessed 2-6-24.

APPENDIX H: History of Updates to this Document

4/16/2024	Updated Appendix C