CBE Safety Handbook

Contents

Laboratory Safety Rules

1. ***Eye Protection**:* All students must wear safety goggles or industrial quality safety spectacles in laboratories where chemical work is done. Contact lenses should not be worn in labs – even behind safety goggles.
2. ***Warning Signs**:* "No smoking," "Caution – Radiation Area" or other warning signs must be strictly obeyed.
3. ***Horseplay**:* Horseplay and practical joking of any kind is strictly forbidden.
4. ***Labeling Containers**:* All containers of chemicals must be clearly labelled, showing the name of the chemical, date, owner's name, and safety precaution if hazardous.
5. ***Securing Compressed Gas Cylinders**:* Compressed gas cylinders must be secured with a strap or chain at all times.
6. ***Working Alone**:* No one is to perform experimental work in a chemical laboratory unless a second person is present or located within calling distance or they have an approved Working Alone/After Hours application.
7. ***Work Authorization**:* Unauthorized experiments are forbidden. Before any experiment is performed in an instructional laboratory, the instructor in charge must give approval. Experimental work in research laboratories must be a part of the program approved by the research supervisor.
8. ***Radiation Hazards**:* Experimental work with radioactive materials or equipment generating ionizing radiation is strictly forbidden without official approval from the University Radiation Committee. Approval for such work may be requested by the researcher who will contact the University Radiation Safety Officer (telephone 8494).
9. ***Reporting Accidents and Fires**:* All accidents resulting in injury, property damage, or fire must be reported promptly to the appropriate supervisor and to the Department Safety Chair. (See section on General Safe Practices, SP-1, for instruction on reporting).
10. ***Waste Chemical Disposal**:* Dumping of chemicals or chemical containers into wastepaper baskets or other trash receptacles and the dumping of chemicals down sinks is forbidden. (See section on Chemical Waste Disposal, SP-4). Individuals must fill out a Hazardous Waste Disposal Form online if waste containers need to be emptied, or unusable empty containers need to be collected.
11. ***The Chemical Engineering Undergraduate Laboratory**:* Situated in Room 1D25 Engineering is to be designated as a "hard hat" area with the exception of the walkways, which will be specified by yellow lines on the floor, leading to the doorways. All persons within the hard hat area will be required to wear hard hats which are to be provided by the department and located near the main entrance/exit doorway.

Safe Practices

SP-1 General Work Practices

Laboratory Layout Facilities

The instructional and research laboratories in the Chemical Engineering Department are housed in the Engineering Building. It is important that graduate students, postdoctoral fellows and faculty assigned to a given laboratory make a thorough safety assessment of the facility before starting work. The scope of such a safety check of the laboratory layout should include:

- Locating the exits from the laboratory and from the building. Are the aisles, stairwells, and corridors clear? Fire Prevention codes forbid blocking of all passages to exits. Locating the fire exit doors. Fire Prevention codes require that fire doors be kept closed (See section on Fire Prevention, SP-8). Locating the nearest telephone for use in case of an emergency. Call 9-911 (or 911 from a cell phone) to report a fire or request an ambulance, giving building and room number. Locating and checking the condition of fire extinguishers. Locating and checking the operability of the safety showers and eye fountain. Checking to make sure the exhaust hood system is operating properly. Locating and checking the operating condition of utility lines, such as hot and cold water, distilled water, steam, gas, electrical power, and sewer drains. Location of the main cut-off valves and switches to the laboratory should be known. Requests for repairs should be submitted to technicians or lab managers. Make an inventory of chemicals and apparatus using the spreadsheet available from the Fire Warden. Arrange for discarding waste chemicals and obsolete apparatus. Arrange for the return of apparatus and equipment not needed to storage or storerooms. Inspect and clean all cabinets and benches. Check to see that the proper trash, chemical and solvent waste disposal containers are available.
- Make sure gas cylinder supports (chains or straps are available. If needed place request for such).

Teaching Assistants assigned to an instructional laboratory for the first time are expected to make a like assessment in order or be prepared for emergencies. The teaching assistant should know:

- Location of emergency exits from the laboratory and building. Location of the fire alarm. Location of the first aid kit. Location and condition of fire extinguishers. Location and operability of safety showers and eye fountain. Location and operability of the self-contained breathing apparatus. Location of power line and utility line cut-offs.
- Operating condition of exhaust hoods.

Working Alone During Regular Hours

Faculty, postdoctoral fellows, and graduate researchers may work alone in areas other than offices provided the following minimum safety criteria are met:

- That the researcher's presence is known to a second researcher located on the same floor within calling distance. That there is little potential for a serious injury-producing accident which would render the researcher helpless to call for assistance by voice, telephone, etc. That the researcher shall call the second person on the floor hourly and that the second person shall contact the lone worker immediately in the event he fails to call at the agreed time. When the experiment is such that there is potential for a serious accident or one which may reach a condition by becoming progressively worse, then a second researcher shall be immediately available for assistance.
- To perform experimental work in a laboratory, an undergraduate student must have authorization from her/his instructor. Under no circumstances is an undergraduate permitted to work alone.

Working Outside Regular Hours

The only students who are authorized to be in the building during hours when the building is locked are those to whom keys have been issued. The key is assigned to a given individual strictly for her/his own personal use for purposes related directly to her/his academic work. He/she must, under no circumstances, use it to allow access by any unauthorized individual to the building or any room within the building, except by special permission, in writing, from the Head of the Department. All students in the building after hours must have suitable identification. No one is to perform experimental work in a chemical laboratory after hours unless a second person is present or located within calling distance or they have an approved Working Alone/After Hours application.

No student is allowed in the building between midnight and 7:00 a.m. Exceptions to this rule may be made in a few special cases, such as when a long research experiment is in progress. On each separate occasion when this may be necessary, the student must have an approved Working Alone / After Hours application.

Utility or Power Failures

To perform laboratory work safely it is essential that the worker include in her/his experimental design provision for a possible utility failure which could cause an accident situation or an unsafe condition to develop. For example, in distillation operations loss of cooling water flowing through the condenser would develop an unsafe condition and result in a possible fire unless provision is made to cut off the source of heat to the still pot. Loss of power to vacuum pumps can cause serious damage to vacuum systems and expensive instruments unless the equipment design and operating procedures are carefully planned to meet such an eventuality. Those requesting night permits must provide and keep in their assigned laboratory a flashlight for use in the event of a power failure. In the event of loss of power or a critical utility, the worker should quickly terminate her/his experiment, close down and evacuate the laboratory. He/she should then inform her/his supervisor and report the situation to Protective Services using a cell phone (306-966-5555).

Unattended Operations

Operations or experiments are not to be left unattended except for certain routine operations. If possible automatic safety shut offs should be installed, in the event of loss in power and other utilities. Special precautions should be used to ensure that tubes carrying cooling water are fastened securely, for example condensers, etc. The research supervisor must approve such unattended operations. On operations where permission has been given for unattended operation, a conspicuous notice shall be placed on the equipment, giving the name and phone number of the person operating the equipment, and the professor in charge, so that one or the other may be reached by the night watchman in case of difficulty.

Eating

The preparation of food in laboratories or shops is strictly forbidden. Lunches should be eaten outside these areas. Before handling food or drink or any other item which may be placed in the mouth, researchers should thoroughly wash their hands with soap and water to prevent ingestion of harmful materials. If the hazardous chemical is not readily soluble in soap and water, another effective safe solvent should be used, followed by washing with soap and water. Refrigerators used for chemicals are not to be used for food or drink.

Sleeping

Sleeping is not permitted in the labs.

Smoking

Smoking is not permitted anywhere in the building.

Reporting Unsafe Practices and Conditions

Unsafe practices and conditions cause virtually all accidents. Immediate correction of potential accident causes is a basic accident-prevention technique. A person observing an unsafe act, practice, or situation should call it to the attention of the researcher involved or his/her supervisor. Should no responsible person be present, then inform any member of the Departmental Safety Committee.

Reporting Accidents

All accidents resulting in an injury, in property damage, or in a fire must be reported promptly to the instructor in charge or to the appropriate supervisor and to the Department Safety Chair. In the event of an accident, the following steps should be taken:

- 1. In case of injury render prompt first aid doing only the minimum necessary to prevent more serious injury to the patient.

- 2. If the accident occurs during regular hours, have someone summon help from a supervisor. The supervisor will call an ambulance if necessary.
- 3. All requests for assistance in an emergency, such as for fires, accidents, medical assistance, or for an ambulance are to be made to 9-911 (or 911 from a cell phone).
- 4. Report the accident promptly to your supervisor; also to the Department Safety Chair.
- 5. Information concerning an incident resulting in injury, property damage, or a fire, should be submitted promptly to the Department Safety Chair so that an Accident Report can be prepared.
- 6. In case of fire:

o If small and easily extinguished select and use the appropriate laboratory extinguisher or cover appropriately.

o If fire is big or difficult to extinguish have someone call the fire department 9-911 (or 911 from a pay phone) giving room number and building name and at the same time have someone sound the building fire alarm. Then proceed with an orderly evacuation. (See Section of Fire Prevention, SP-8).

Visitors

Visitors shall comply with all safety regulations in force in the place visited. Appropriate Personal Protective Equipment (PPE) shall be worn by visitors to any laboratory.

SP-2 Housekeeping – (Removal of the Hazard)

The continuous practice of good housekeeping is essential to the prevention of accidents, fires, and personal injuries. Students working in laboratories are expected to keep their benches neat and orderly. A cluttered workplace is a dangerous place in which to work; by cleaning up after each operation a general housecleaning is necessary only occasionally. Each laboratory worker is responsible for:

- Keeping benches, tables, hoods, floors, aisles, and desks clear of all materials not being used. Keeping clear an adequate passageway to exits. Keeping clear space around safety showers, fire extinguishers, fire blankets, and electrical controls. Keeping floors free of spilled ice, dropped stirring rods, stoppers, pencils, and other tripping hazards. Cleaning up spills and disposing of the materials used to absorb the spills. Assuring all rotating belts and shafts have protective guards. Assuring all dewars and vacuum desiccators are taped to prevent scatter of sharp fragments in the event they implode. Keeping pressurized cylinders clamped tightly in place at all times. Removing and disposing broken glass. Using proper waste-disposal receptacles for solvents, glass, rags, paper, etc. Keeping chemical containers clean and properly labeled. Retaining only the quantities of chemicals needed for current work. Unused chemicals should not be allowed to accumulate in the laboratory. Inspecting all reagents periodically, and removing those that are not needed. Checking dates on labels of materials that may form hazardous substances on prolonged storage. Keeping the total amount of volatile, flammable solvents stored in a laboratory to less than ten US gallons or a maximum of 50 US gallons if stored in an approved metal cabinet. Keeping all 95% and absolute alcohol in a locked cupboard. Disassembling and returning to storage surplus equipment. Keeping protective equipment on hand. Hanging clothing in its proper place; do not drape over equipment and work benches.
- Containers should be collected in each lab. Once there are sufficient containers collected, individuals can fill out a hazardous waste removal form online if waste containers need to be emptied, or unusable empty containers need to be collected.

SP-3 Handling Chemicals

Chemicals can be hazardous unless properly handled. Serious skin and eye irritations and damage to clothing can result from needless spills and sprays. Toxic materials can cause severe illness, even death; all chemicals, especially new compounds, the toxicity of which has not yet been determined, should be assumed to be highly toxic. Flammable gases, liquids, and solids can cause fires and develop into explosive mixtures. Before working with any chemical, it is essential to **KNOW** its properties. The properties of known reaction products, intermediates or even possible reaction products should be ascertained before work begins. In exploratory research work only very small quantities of chemicals should be employed. Larger amounts may be used after the initial work has been successfully completed and the reaction rates and the properties of the reaction products have been established. Hazardous chemicals include, in addition to flammable materials, those substances which are toxic, corrosive and/or reactive. It must be recognized that a material, which by itself is comparatively harmless, can become very hazardous under conditions to which it may be subjected accidentally – as in the event of a fire. A partial list of a number of hazardous substances frequently encountered in chemical laboratories is compiled in Table I. Here an attempt has been made to classify the substance according to the degree of hazard under various conditions. Chemicals which are hazardous when mixed with other common chemicals include some of those incompatible materials listed in Table II. Good references for additional information on chemicals and their hazardous properties are available in Table III.

A most important safety practice in the handling of chemicals is to keep reagent containers properly **LABELLED**. Containers of all substances in your laboratory shall be labeled showing:

- The chemical or generic name. The date of purchase, preparation, or transfer to its present containers. The owner's name. A brief notation of any applicable hazard, eg. Toxic, Corrosive, Flammable, Explosive, Poison, Radioactive.

Listed below are a few simple, but important reminders of precautions that should be considered in the routine handling of reagents.

- Before undertaking any chemical reaction, always try to assess the hazards that may arise. Know the locations of safety showers and eye washes and know how to use them. Keep reagent containers clean on the outside to protect your hands; use rubber or plastic gloves when appropriate. Be sure rubber gloves are clean on the inside before using; cleanse or decontaminate gloves regularly. Lab coats and closed-toed shoes should be worn to minimize hazards from splashes and spills. Avoid prolonged contact of chemicals with skin; wash hands and face frequently; be sure laboratory clothing is cleaned regularly. If water in not the appropriate washing agent, or antidote, procure proper first aid supplies

before starting work. Avoid inadvertent contamination by not returning unused portions of reagents to stock bottles; stoppers should be held while pouring. Experiments involving toxic and corrosive vapours should be carried out in fume hoods. In general when working with small quantities of such materials the hood exhaust volume is sufficient to prevent an atmospheric pollution problem above and outside the building. When large scale operations are carried out in the fume hoods which involve large amounts of either flammable, corrosive, or toxic vapours these vapours should not be simply vented to the outside but should be treated to destroy the harmful effects and thereby prevent atmospheric pollution outside the building. Condense flammable vapours and then dispose of the condensate. Other materials can be absorbed in an appropriate chemical solution. Never test chemicals by taste or smell. Use a safety pipet filler, (pipetting by mouth is dangerous). Cool sealed vials of chemicals below the boiling point of the substance contained therein before breaking seal. Cool gradually, first in ice water, then CO2 etc., to avoid temperature shock to the glass vial and a possible explosion. Add concentrated chemicals to water (never vice versa). Low flash point liquids should be stored in safety cans. Limit quantities of solvents in glass bottles to one gallon. Keep flammable solvents such as benzene, ether, etc., away from hot plates and flames. Use care in transporting chemicals. The transporting of acids, liquids and hazardous solids to and from labs is to be done using a pail or other carrier to retain the material if breakage occurs. This is to be strictly enforced by the safety personnel. Use caution in working with mercury. The equilibrium concentration of Hg vapour over liquid mercury at room temperature is approximately 20 times the threshold toxic limit.

- Clean up spills of mercury and other chemicals promptly. (See SP-4 for cleanup procedure for mercury spills; see *The Handbook on Laboratory Safety* (available through the U of S library) for the method of cleanup of other chemicals).

PEROXIDES

- Are a frequent cause of laboratory explosions. Common solvents that peroxidize easily include:

o Ethers – dioxane, tetrahydrofuran, ethylene glycol dimethyl ether (glyme), diethylene glycol dimethyl ether (diglyme), diethyl ether, diisopropyl ether; Alcohols – some secondary alcohols, for example, isoprophyl alcohol;

o Hydrocarbons – cyclohexene, also other olefins; tetralin, decalin, branched-chained saturated hydrocarbons, alkyl substituted cycloaliphatics.

Since peroxide explosions occur most frequently during distillation they should be carried out behind shields. Such materials should not be stored over long periods of time because peroxides form readily in poorly closed containers or even in well closed containers if there is air space above the solvent. Solvents should always be tested for peroxide content before using.

- Text methods and procedures for removing peroxides are described in *The Handbook on Laboratory Safety* (available through the U of S library).

PERCHLORIC ACID

- Do not use perchloric acid on wooden benches or tables. Keep the perchloric acid bottles on glass or ceramic trays with enough volume to hold all the acid in case the bottle breaks. Discoloured acid (contaminated) should be disposed of immediately. Acids should be diluted prior to disposal. To dispose of acids, fill out the Hazardous Waste Disposal Form.
- Operations in which the acid is heated to fuming are forbidden in ordinary hoods.

SP-4 Chemical Waste Disposal – (Removal of the Hazard)

Responsibility

In the instructional laboratories, the disposal of unused waste chemicals is incorporated as an integral part of the course and specific instructions are given on methods of handling and disposing of waste products. In the research laboratory, where many unusual and specific chemicals are used, the responsibility for disposal of unused reagents and waste reaction products is vested directly with the researcher and her/his project supervisor, because, in most cases, it is only the researcher who knows how to handle the materials safely.

Laboratory Waste Disposal Procedures

Procedures for the safe disposal of waste chemicals produced in laboratories are listed in:

- 1. MSDS Catalogue (http://safetyresources.usask.ca/) 2. Handbook on Laboratory Safety by Steere (located in the Library). 3. Toxic and Hazardous Industrial Chemicals Safety Manual (located on shelf across from Chemistry Stores). 4. Guide for Safety in the Chemical Laboratory (located in the General Office).
- 5. Aldrich Chem. Catalogue (1D24).

The information and recommendations contained in these manuals makes it possible for a researcher to convert most waste chemicals into harmless water soluble materials that can be disposed of using the Hazardous Waste Disposal Form. Waste materials that cannot be so converted will require special attention such as return to manufacturer, etc. At no time should chemicals be flushed down the sink or sewer.

Solvent wastes are not to be stored in fume hoods. They should be stored in appropriate stoppered waste disposal containers. The solvent wastes should be disposed of using the Hazardous Waste Disposal Form. An inventory of the amount and type of disposed chemical should be kept in each laboratory. Sheets for this inventory are available through Safety Resources http://safetyresources.usask.ca/. Safety Resources will also recycle waste solvent containers. They should be contacted for details (4675).

Useful Unused Chemicals

Unused chemicals remaining in sufficient quantity to have value, which will not develop hazards on prolonged storage in their individual containers, should be traded in using the Safety Resources Program for Valuable Unused Chemicals.

Water Soluble Wastes

In general, small quantities (100 ml. or less) of water soluble chemicals which do not hydrolyze to form volatile, toxic, or odoriferous materials, and materials in minor quantities such as acids and alkalis, should be placed in a waste container containing other similar chemicals, then disposed of by Safety Resources . Large quantities of waste acids, bases, and chemicals, which hydrolyze to form corrosive and hazardous products, should be treated to render them harmless before being placed in disposable containers.

Shock-sensitive, Explosive, Pyrophoric Wastes

Waste chemicals that are known to be shock-sensitive, explosive, or pyrophoric should be handled with extreme caution. Such materials should be retained in its original separate container. Before moving such a material, its container should be carefully packaged, using an inert packing material such as Vermiculite. Safety Resources should be consulted before storage or disposal of such materials is attempted.

Flammable Liquid Wastes

Low flash point flammable wastes and solvents should be placed in safety cans. Waste solvents containing materials in solution apt to form toxic or corrosive substances on hydrolysis, oxidation, etc.

should first be treated to render them harmless and then placed in a waste container containing other similar chemicals, then disposed of using the Hazardous Waste Disposal Form.

Radioactive Wastes

The Campus Radiation Safety Officer (phone 8494) should be consulted before disposal of radioactive materials is attempted.

Cleanup procedure for Mercury Spills

When a mercury spill is experienced, the immediate area should be blocked off to prevent any accidental tracking of the metal. The bulk of the mercury is removed mechanically using a vacuum probe. The proposed cleanup procedure for spilled mercury utilizes a 1:1 mixture by weight of zinc dust and sawdust to remove both the liquid and the mercury vapour in the area of the spill by amalgamation. The thoroughness with which the mercury and its vapour art trapped and the relatively innocuous compositions of the decontamination mixture are attractive features of the procedure. The sawdust used provides a suitable vehicle for transporting the zinc and collecting the mercury droplets from pits and cracks in surfaces. Its porosity allows the mercury vapour to penetrate and deposit on the zinc powder that is dispersed throughout the sawdust mass. Estimate the weight of the remaining spill and apply 20 parts of the zinc-sawdust mixture for each part of the mercury spill (by weight). It is recommended that the zinc dust and sawdust be stored separately and mixed just before applying it to the spilled area. The mixture is then poured on the spill and on adjacent areas. The zinc-sawdust is mixed with the mercury using a brush or broom. The entire mixture should be allowed to stand 30-60 minutes. The mixture is removed from the spill area by sweeping until no zinc-sawdust remains. The contents are place in a plastic bag, sealed, properly labelled, encased in another container and disposed of appropriately. Utensils used in the sweeping should be placed in a plastic bag, sealed and stored for future use. The affected area should then be treated with a wash composed of equal parts of slaked lime and flowers of sulphur mixed with sufficient water to form a thin paste. This yellow wash should be liberally applied and allowed to dry on the floors, the lower parts of the walls, workbenches and any other contaminated surfaces. Twenty-four hours later the wash should be removed with clean water and the surfaces again allowed to dry.

Materials to be used in mercury cleanup may be ordered. Person spilling material is responsible for cleanup.

Emptied Chemical Containers

Before discarding, all empty chemical containers must be rinsed. Rinse containers for organic reagents first with acetone and then with water. This practice prevents subsequent injury to those handling the discarded containers.

SP-5 Handling Compressed Gas Cylinders - (Safe Technique)

Compressed gases impose potential hazards on the laboratory worker if not properly handled. Such gases can be used in the laboratory with safety if the following precautions are complied with completely during cylinder receiving operations, storage, transportation, usage, and empty cylinder disposal.

- *Know the cylinder contents:* Do not accept, keep, or use a cylinder unless its contents can be quickly and completely determined by the wording on the cylinder or on a tag securely attached to the cylinder (not its cap). If tag is defaced or becomes detached, mark the cylinder "unidentified" and return to supplier. Do not rely on colour: different companies use different colours: some people are colourblind. Never remove or deface a label. *Know the properties of cylinder contents:* This includes physical properties, flammability, corrosiveness, and physiological properties such as toxicity, anesthetic, and irritating qualities. *Handle cylinders carefully:* Cylinders are built as light weight as possible consistent with safety and durability for use as shipping containers. Abuse and hard knocks can seriously weaken a container. *Transport of cylinders:* Never move a cylinder with an attached regulator or without having its cap properly screwed down. Transport large cylinders only with a wheeled cart. *Keep cylinders away from heat:* Most cylinders are equipped with fusible metal safety plugs; it may release if a cylinder is heated above 70oC. *Securing Cylinders:* Always securely fasten a cylinder with a strap or chain before removing cap and while using. A falling cylinder can break legs or crush feet. Should the valve break off it can become a rocket. *Warming Cylinders:* If it is necessary to warm a cylinder to facilitate discharge of a compressed liquid, immerse not more than the lower 20% in warm water. Never use steam directly on a cylinder; remember the fusible plug will melt at about 70^{o}C. Never warm a cylinder in any way unless the valve is at least partly open. *Regulation Valves:* Never use a cylinder without a regulator. Select only the proper regulator for a given gas. Be sure the threads on the regulator are the same as the cylinder outlet. Never force the connection; if they don't fit you have selected the wrong one. *Opening Valves:* Wear goggles or safety glasses and point the valve opening to direct the flow of gas away from you and others. Open the valve slowly. *Traps:* A trap should be used between a cylinder and equipment. If there is a possibility of building up pressure in the line down stream have the line equipped with a pressure indicator and a safety vent. *Never completely empty cylinder:* Avoid suck-back contamination which might result in an explosion. *Keep cylinder valve closed on inactive cylinders:* The valves used on most cylinders, particularly those used with corrosive gases, are designed so that the valve stem and packing are protected from contact with the gas when the valve is completely open or closed. Hence the cylinder valve should always be either of these two positions. Always close the cylinder valve when gas in not in use.
- *Close valves on empty cylinders and replace cap.*

- *Mark empty cylinders with "MT" and date. Return empty cylinders to the gas cage. Never attempt to refill a cylinder.*
- *Never attempt to tighten nuts or bolts on fitting of high pressure apparatus while pressure is applied.* Release the pressure first, then make adjustments.

SP-6 Handling Equipment and Apparatus - (Safe Technique, Judgement)

Any material, be it a chemical, apparatus, an item of furniture, a fixture, can present a hazard, start a fire, or cause injury if not properly handled. You can remove or minimize the hazard with proper handling. Some of the precautions in handling laboratory equipment are listed below.

- Locate equipment set-ups as far back from the bench edge as possible. All hoses carrying cooling water to an apparatus should be properly clamped. Apparatus may tip unless the center of gravity is within the base area. Use ring stands properly. Use round-bottom glass flasks for low pressure reactions. All pressure equipment should be carefully inspected before using. Know the limitation of the equipment with respect to temperature and pressure; provide for safety pressure relief. Never open a pressure vessel until internal pressure has been reduced to atmospheric pressure via a relief valve. Never examine a pressure gauge without shielding between you and the gauge. Turn compressed gas (or vacuum) lines on or off slowly and with caution. Always place a capillary relief valve in the system when carrying out a low pressure (vacuum) distillation. Use appropriate traps in vacuum systems; avoid corroding the pumps by corrosive gases such as halogens, SO2 HCl, etc. Protect or cover pump shafts, moving belts, etc., to avoid entangling towels, clothing such as shirt sleeves and avoid personal injury. Avoid makeshift wiring assemblies. Don't use worn extension cords – immediately replace when there is any sign of thinning insulation. Don't handle any electrical connections with damp hands or when standing in or near water. Don't continue to run a motor after liquid has been spilled on it; turn it off immediately and allow to dry thoroughly inside and out. Use only explosion proof motors and switches on operations in areas exposed to flammable vapours. Ground all apparatus, using either three-prong plugs or pigtail adapters.
- Check periodically for static accumulation, especially in high voltage situations.

SP-7 Handling Laboratory Glassware - (Safe Technique)

If not properly handled, glass apparatus can be a serious hazard to the chemist. These hazards can be minimized by exercising certain precautions:

- Always carry glass tubing or rod in a vertical position. Protect your hands with a cloth towel or gloves when cutting and breaking tubing. Keep all sharp edges of glass tubing and glassware fire polished. Lubricate the surface of glass tubing before inserting into rubber tubing or stoppers. Use water or glycerine for lubrication. When making such connections, protect your hands with a towel or gloves and keep your hands close together. When removing glass tubing from rubber tubing or stoppers protect your hands with a towel or gloves and never use great force. Work a lubricant in between the rubber and the glass with the neck of a file. Do not force stoppers and stopcocks; gentle tapping or heating is preferred. Vacuum desiccators and Dewar flasks should be shielded or wrapped with tape to prevent flying glass in the event of an implosion. Test glass apparatus for strains and when necessary remove strains by annealing. Employ shields when working with glass apparatus under pressure or vacuum to protect from flying glass in the event of an explosion or implosion. Remove the cover of a glass desiccator with caution. Slide cover to one side; do not lift. Sometimes the lubricant on the ground-glass surface hardens and sticks. The lubricant can be softened by gentle warming with hot water. Glassware should always be washed before storing or discarding. Discard all broken or fractured glass into proper disposal can.
- Remove broken glass fragments from desk tops and floors with a brush; do not use your towel. Dispose of glass in Cardboard Glass Disposal Bin.

SP-8 Fire Prevention - (Judgement, Safe Technique)

To start a fire three components must be present; you must supply a fuel, an oxidizing agent, and a source of heat for ignition. Many fires can be avoided if the worker simply keeps the fuel and oxidant away from the hot ignition source. The major sources of heat in the laboratory are:

- matches
- the Bunsen burner
- electric hot plates
- electric sparks
- steam baths

The major source of oxidant is, of course, air, (oxygen); however, other oxidizing agents can supply the oxidant. Sources of fuel are:

- wood
- painted surfaces
- towels, oily rags
- paper and books
- hair and clothing
- gases (methane, hydrogen)
- flammable solvents
- many other chemicals or dusts thereof.

The storage and handling of volatile flammable liquids requires that certain precautions be taken to minimize the fire hazard. The inherent fire and explosion hazard depends not only on the flash point of the fuel but also on its ignition temperature, explosive range, and vapour density.

- The flash point of a fuel is the lowest temperature at which it volatilizes fast enough to form an ignitable mixture with the air surrounding the flash apparatus. The ignition temperature of a material, whether solid, liquid, or gaseous, is the temperature required to cause sufficiently rapid oxidation to be self-sustained when the hot ignition source is removed. The explosive range of a fuel refers to the definite limitations of combustibility and rate of burning of the flammable vapour or dust mixture in air. The mixture is "too lean to burn" when the particles are so widely separated that those set afire by the hot ignition source will not set fire to others that are nearest. The mixture is "too rich to burn" when the particles are so close together that they exclude the oxygen necessary for combustion. The concentrations between the "leanest" and "richest" mixtures that will burn is called the explosive range.

- *flash fire* results from very rapid oxidation and occurs only when:
  - The fuel is mixed with sufficient oxygen for complete combustion. The particles of fuel vapour or dust are suspended in a diffused state in air, close enough to each other to propagate the flame through the vapour or dust and still sufficiently separated to make room for the required amount of oxygen for combustion.
  - A source of heat equal to the ignition temperature is present.
  - To avoid a flash fire keep the fuel at a temperature below its flash point, and keep it away from hot surfaces that are above the ignition temperature. Remember that vapours having a density greater than air will flow downward to the hot plate whereas those less dense than air will flow upward. The properties of a few common hazardous flammable chemicals are listed in Lange's Handbook of Chemistry (available through the U of S Library) and other handbooks. A fire is extinguished by applying the same principles followed in trying to avoid it.
- Reduce the air supply by smothering - cover the vessel or apply CO2. Shut off or reduce the fuel supply.
- Cool the fuel below its ignition temperature.

Types of Fires

- Class A: burning wood, paper, cloth etc.: extinguished with water, dry chemical or CO2Class B: burning oils, greases, paints, etc.: extinguished with CO2 or dry chemical. Class C: live electrical equipment: extinguished with CO2 or dry chemical.
- Class D: active metals such as sodium, potassium, aluminum, magnesium, lithium, also diborane, etc.: extinguish by smothering with dry chemical, dry sodium chloride, sand (**never** use water or CO2).

Fire Regulations

General

- There is a fire alarm system in the Engineering Building. When the fire alarm is activated the Fire Department and Campus Security are alerted and will respond to the alarm.
- Unless otherwise informed, such as during repairs to the system or during monthly testing (which usually occurs on the first Monday of each month around 11:00 a.m.), anyone hearing a fire alarm should react immediately and be prepared to evacuate the building.
- Persons working in the building after hours or during weekends or holidays, on hearing a fire alarm should evacuate by the nearest safe exit.

Discovery of Fire (during regular hours). The person discovering a fire will:

1. Assess the situation and determine whether the fire can be extinguished by local control and if so use the appropriate method of extinguishing.
2. If the fire is beyond immediate control he/she should sound the fire alarm by pulling the handle on one of the fire alarm boxes located in the hallways of the building.
3. Undertake to evacuate personnel in the immediate area.
4. When the Fire Warden or Assistant arrives, indicate the fire location to them and if requested to do so, offer whatever assistance possible.

Discovery of Fire (after hours or during weekends or holidays). The person discovering a fire will:

1. Assess the situation and determine whether the fire can be extinguished by local control and if so use the appropriate method of extinguishing.
2. If it is a fire that has been burning undetected in another area of the building and is obviously beyond control, sound the building alarm and proceed directly to step 3
3. Undertake to evacuate personnel in the immediate area.
4. Proceed to the nearest exit and await arrival of the Fire Department and Campus Security. Direct them to the location of the fire. If you have any knowledge of the source of the fire and the potential hazards in the area, advise the firemen of the materials they are dealing with.
5. If you have extinguished a fire, but have not summoned the Fire Department for assistance, you MUST phone Campus Security (5555) and advise them about the incident and its location and ask them to maintain extra surveillance overnight on the location.

Fire Warden Program

A list of names of the Building Chief Warden, Assistant Chief Warden, Wardens, Assistant Wardens and Door Guards will be updated yearly for attachment to this Safety Booklet.

Duties of Chief Warden, Assistant Chief Warden, Wardens, Assistant Wardens and Door Guards

Chief Warden

- will immediately go to the annunciator panel to determine the location of emergency will go to area, assess situation, assist in first aid if required, and notify firemen of special hazards in area
- after emergency is over notify wardens and assistant wardens that it is safe to re-enter the building

Assistant Chief Warden

- will immediately go to the annunciator panel to determine the location of the emergency remain at the main North Exit, meet firemen and direct them to location of emergency
- will act a Chief Warden in her/his absence

Wardens

- see to the complete and immediate withdrawal of all personnel in her/his area through a pre-determined route if the emergency has occurred in the warden's area, then he should assess the situation and take appropriate action to insure the safety of personnel (redirect flow away from the emergency area, etc.) and notify the Chief Warden of special hazards in the immediate area
- replace the Warden if he/she is absent at the time of the alarm and ask another person to replace him as Assistant Warden

Door Guards

- guard exit door to prevent premature re-entry during an emergency
- ensure that personnel stay a safe distance away from the building during the emergency

Evacuation Procedures

When the fire alarm sounds:

1. The fire Wardens will evacuate the persons from their respective areas as quickly as possible in a safe and controlled manner.
2. The normal evacuation routes from the building are indicated in the map on the back cover.
3. In the event that one of the stairwells is smoke-filled, Wardens will move their personnel to the nearest clear stairwell, and filter them into the stream of evacuees allotted those stairs.
4. Elevators are not to be used during evacuation of the building.
5. The Wardens will search their respective areas, including lecture rooms, washrooms and elevators, to ensure that all personnel are out and that all doors are closed. They will then proceed to their allocated exit and stand by for any further instructions from the Chief Warden or the Assistant Chief Warden.
6. Every Lecturer and Laboratory Demonstrator is responsible for her/his class. When the alarm sounds he/she must see to the immediate evacuation of the students through the pre-determined fire exit route.
7. No person is to re-enter the building following an emergency or fire drill until the Chief Warden or the Assistant Chief Warden indicates that it is permissible.

The following is a summary of important points to observe to prevent or handle a fire:

- See that corridors and doorways are kept clear; avoid placing chemicals, equipment, and furniture therein.
- Know the location of fire-blankets, safety showers, sans buckets, and fire extinguishers.
- If a fire occurs, assess the situation, extinguish the fire, render assistance, or get additional help.
- Never return an empty or partially used extinguisher to its rack. Tag it empty and deliver it to the Stores and have it recharged.
- All fires for which an extinguisher is used or which cause damage or injury must be reported to the Department Safety Chair.
- If your clothing should catch fire, try to stay calm, don’t run, but quickly get under a shower and keep the water running. Or wrap yourself in a fire blanket. Yell for help.

Table 1 - Hazardous

Hazardous

1. Highly dangerous- Will explode owing to heat, flame, shock.

Acetylides	Mercury azide
Acetyl peroxide	Methyl isocyanide
Aluminum alkyls	Nitrocellulose, dry
Ammonium chlorate	Ozonides (dry)
Diazoethane	Parathion
Diazomethane	Perchloric acid (less than 10% water)
Dichloroacetylene	Phenyl diazosulfide
N1N1 diethyl carbanilide	Picric acid and Cu, Pb and Zn salts, (dry)
Ethylene oxide	Radioisotopes, gamma emitters
Formyl peroxide	Silver azide
Fulminates	Tetracene
Glycerol trinitrate	Tetracetylene dicarbonic acid
Hexane hexanitrate	Tetranitromethane
Hydrogen (high press.)	Trinitroaniline
Hydrogen peroxide (< 35% water)	Trinitroanisole
Iodine azide	Trinitrobenzene
Lead azide	Trinitrochlorbenzene 2, 4, 6-trinitro-m-cresol
Manganese heploxide	Trinitrotoluene 2, 4, 6-trinitroxylene
Mannitol hexanitrate	Zinc peroxide
Mercury acetylide	

2. Highly dangerous – Gives off highly toxic fumes on heat, flame, shock.

Carbon disulfide	Mercuris perchlorate
Carbon monoxide	Methyl nitrite
Carbonoxysulfide	Methyl phosphine
Dibromoacetylene	Phosgene
Diethyl ether	Thionyl chloride-fluoride

Dimethyl ether	Thiophosgene
Ethyl nitrite	Vinyl Chloride
Hyponitrous acid	Vinyl ether
Mercury	Vinylidene chloride

Special

3. Dangerous – When exposed to heat or flame may explode or is spontaneously flammable in air.

Acetyl benzoyl peroxide	Magnesium peroxide
Acetylene	Mercurous azide
Acetylene chloride	Methyl acetylene
Alkyl ethers <C4	Methyl lactate
Allylene	Nickel hypophosphite
Aluminum chlorate	Nitriles ethyl
Ammonium chromate	Nitrogen bromide
Benzoyl peroxide, dry	Inorganic salts of alkyl nitrates
Butadiene – 1, 3	Nitrosognanidum
Chlorates	Nitrosomethyul urca (dry)
Dialkyl phosphines	Ozone
Diazoacetic ester	Ozonides (solution)
Diazoamidobenzol	Pentaborane
Diazobenzene chloride	Perbenzoic acid
Diethyl carbonate	Perchlorates
Dilsopropyl & higher alkyl ethers	Perchloric acid (10% or more water)
Ferrous perchlorate	Performic acid
Furan	Peroxides (organic)
Hydrazine, anhydrous	Phosphorus (white)
Hydrazoic acid	Phenylazoimide
Hydrides, volatile	Silicon hydride
Hydrogen cyanide (unstabilized)	Silver oxalate
Hydrogen (low press.)	Sodium chlorite
Hydrogen peroxide (>35% water)	Trinitrobenzaldchyde

4. Dangerous – Will react with water or steam to produce hydrogen or toxic fumes or highly flammable gases.

Acetone	Diphosgene
Alkali cyanides, hydrides, sodium & other metals	Fuming nitric acid
Aluminum borohydride, carbide, chloride, hydride and nitride	Grignard reagents
	Hydrides (nonvolatile)
Benzoyl chloride	Hydrogen cyanide (stabilized)
Boron compounds	Hydrogen fluoride
Carbonyls	Lithium aluminum hydride
Chlorine	Magnesium metal
Cyanogen	Nitric acid
Cyanogen bromide	Oleum
Cyanogen chloride	Phosphenyl chloride
Dialkyl carbamyl chlorides	Phosphides
Dialkyl cyanamide	Phosphorus nitride, oxyhalides, pentahalides & tri-halides
Dialkyl aluminum hydrides	
Diborane	Radioisotopes, beta emitters
Dibromoketone	Sodium azide
Dichloromethyl chloroformate	

Conventional

5. When heated to decomposition gives off highly toxic fumes and/or products, which may be explosion hazards when, exposed to flame.

Acetic acid	Chlorobutanol
Acetic anhydride	Chloroform
Acetoacetanilide	2-chloropyridine
Acetone cyanohydrin	Cresols
Acetyl chloride	Cyanates
Acrolein	N, N-dialkyl amino ethylamine
Acrylonitrite	Dibutylphosphite
Alcohols	Dicyandiamide
Alkaloids	Diethylamino ethanol
Alkyl aryl acids, alcohols, amines, esters,	Diethyl phosphite

ethers >C3	Diethyl sulfate
halides, hydrocabons, ketones,	Diketene
mercaptans & sulfides	Epichlorohydrin
Alkyl dihalides	Esters
Alkyl nitrates	Ethylene imine
Allyl amine	Hydrazine hydrate
Allyl cyanide	Hydrogen sulfide
Allyl ether	Hydroxylamine salts
Allyl halide	Inorganic Hg compds.
Amines	Iodates
Aminoacetophenone	Iodides
p-aminoazobenzene	Ketones >C3Methyl acrylate
p-aminophenol	Methylene chloride
2-ammino pyridine	Nitriles
Amino pyrine	Nitrosomethyl urea (wet)
2-aminothiazole	Petroleum ether
Ammonia	Piperidine
Ammonium nitrate	Propargyl bromide
Amyl nitrite	Pyridine
Aniline	Sodium alkozide
Benzene sulfonyl chloride	Sodium azide
Benzoyl peroxide (wet)	Sodium borohydride
Bromine & iodine	Tetrabromoethane
N-bromoacetamide	Tetrachloroethane

6. Moderately stable when heated gives off acid fumes.

Alcohol	Dimethyl formamide
Alkyl acids >C2	Formic acid
Alumina	Hydrocarbons
Ammonia	Inorganic acids
Amyl alcohol	Methyl diacetoacetate
Benzoic anhydride	Phenyl cellosolve
Benzophenone	Silica gel
Charcoal	Tetradecane
Chlorophenyl carbamate	

Diethylene glycol	Tetrahydrophthalic anhydride

Table II - Incompatible Chemicals

Substances in the right hand column should be stored and handled so they cannot possibly accidentally contact corresponding substances in the left hand column.

Alkaline and alkaline earth metals, such as sodium, potassium, cesium, lithium, magnesium, calcium, aluminum	Carbon diozide, carbon tetachloride, and other chlorinated hydrocarbons, any free acid or halogen. Do not use water, foam, or dry chemical on fires involving these metals.
Acetic acid	Chromic acid, nitric acid, hydroxyl containing compounds, ethylene glycol, perchloric acid, peroxides, and permanganates.
Acetone	Concentrated nitric and sulfuric acid mixtures and chloroform.
Acetylene	Chlorine, bromine, copper, silver, fluorine, and mercury.
Ammonia (anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine and hydrogen fluoride.
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organics or combustibles..
Aniline	Nitric acid, hydrogen peroxide.

Bromine	Ammonia, acetylene, butadiene, butane and other petroleum gases, sodium carbide, turpentine, benzene, and finely divided metals.
Calcium carbide	Water (see also acetylene).
Calcium oxide	Water..
Carbon, Activated	Calcium hypochlorite.
Copper	Acetylene, hydrogen peroxide.
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organics or combustibles.
Chloroform	Acetone.
Chromic acid	Acetic acid, naphthalene, camphor, glycerine, turpentine, alcohol, and other flammable liquids, paper or cellulose.
Chlorine	Ammonia, acetylene, butadine, butane and other petroleum gases, hydrogen, sodium carbide, turpentine, benzene, and finely divided metals.
Chlorine dioxide	Ammonia, methane, phosphine, and hydrogen

	sulfide.
Fluorine	Isolate from everything.
Hydrocyanic acid	Nitric acid, alkalis.
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, any flammable liquid, combustible materials, aniline, nitromethane.
Hydrofluric acid, anhydrous (hydrogen fluoride)	Ammonia, aqueous or anhydrous.
Hydrogen sulfide	Fuming nitric acid, oxidizing gases.
Hydrocarbons (benzene, butane, propane, gasoline, turpentine, etc.)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide.
Iodine	Acetylene, ammonia (anhyd or aqueous).
Mercury	Acetylene, fulminic acid, ammonia.
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, and nitritable substances.
Nitroparaffins	Inorganic bases.

Oxygen	Oils, grease, hydrogen, flammable liquids, solids, or gases.
Oxalic acid	Silver, mercury.
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils, organic amines or anti-oxidants.
Peroxides, Organic	Acids (organic or mineral); avoid friction.
Phosphorous (white)	Air, oxygen.
Potassium chlorate	Acids (see also chlorate).
Potassium perchlorates	Acids (see also perchloric acid).
Potassium permanganate	Glycerine, ethylene glycol, benzaldehyde, any free acid.
Silver	Acetylene, oxalic acid, tartaric acid, fulminic acid, ammonium compounds.
Sodium	See alkaline metals (above)

Sodium nitrate	Ammonium mitrate and other ammonium salts.
Sodium oxide	Water, any free acid.
Sodium peroxide	Any oxidizable substance, such as ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerine, ethylene glycol, ethyl acetate, methyl acetate, and furfural.
Sulfuric acid	Chlorates, perchlorates, permanganates.
Zirconium	Prohibit water, carbon tetrachloride, foam, and dry chemical on zirconium fires.

Table III - Reference Materials

1. WHMIS MSDS Collection http://ccinfoweb.ccohs.ca/msds/search.html
2. MSDS web site located at http://safetyresources.usask.ca/.
3. CRC Handbook on Laboratory Safety by Steere (available through the U of S library).
4. Toxic and Hazardous Industrial Chemicals Safety Manual (located on shelf across from Stores).
5. Guide for Safety in the Chemical Laboratory. For a listing of hazardous reactions refer to page 296 of book 3.
6. Hazards in the Chemical Laboratory (available through the U of S library).
7. Safety in the Chemical Laboratory (available through the U of S library).
8. Handbook of Chemistry by N. Lange (available through the U of S library).
9. Controversial Chemicals, Kruus and Valeriote, eds.
10. Carcinogenic Materials - A listing of proven and suspected carcinogens, as supplied by the Occupational Health and Safety Division, Province of Saskatchewan, is available for perusal.
11. Aldrich Chem. Catalogue.
12. Various additional safety manuals are located in the Library.

Emergency Phone Numbers

Fire: Pull Alarm and Call 9-911 (or on a cell phone) 911

Security: 5555

Ambulance: 9-911 (or on a cell phone) 911

Student Health Centre: 5768 (daytime)

Maintenance Services:

(daytime) 4496

(after hours) 5555

Spills: 8497 (daytime)

Other useful numbers:

Waste Management Facilities: 8497

Chemical/Environment Safety Manager: 8512

Occupational Hygienist/General Safety Manager: 8495

Radiation Safety Manager: 8494

after hours: 5555

Links

Safety Resources (formerly WSEP)

http://safetyresources.usask.ca/

Appendix

1. **Compressed Gas Cylinder Summary**
2. **Nanoparticles/Nanomaterials Use- College Protocol and Training Acknowledgement**
3. **Working Alone/After Hours Policy and Procedure**
4. **Research Standard Operating Procedure & Emergency Response Plan**

COMPRESSED GAS CYLINDERS

Hazards

- Compressed gas cylinders must be properly stored, transported and handled to prevent health or safety hazards from becoming injuries, illnesses or worse. Potential hazards relating to compressed gas cylinders include exposure to flammable, combustible, explosive, corrosives, poisonous environments, asphyxiation due to oxygen displacement, cold burns or frost bite, projectile objects resulting from dropped, damaged or unsecured cylinder, incorrectly fitting or type of regulator and MSI (musculoskeletal) injuries (strains, sprains and bruises) from handling or moving compressed gas cylinders.

General Safety Guidelines

- Single cylinders must be secured in place or on a cylinder cart so they can't be readily knocked over.
- A single cylinder must be secured in an upright position by a cylinder stand, clamp, chain or cable.
- Reference the MSDS/SDS prior to beginning tasks associated with compressed gas cylinders and that control measures and precautions are in place
- Ensure that the proper regulator and fittings are used for the particular gas in the cylinder
- Each time a compressed gas cylinder is used, the cylinder, regulator and connections should be visually inspected for disrepair or damage
- When working with toxic gases the installation of permanent gas detectors or carrying personal detectors for leak detection is required. Gas detectors and monitors must be calibrated and maintained as per the manufacturer's operating instructions. Records of this maintenance must be maintained
- Only move cylinders using a suitable cart designed for transporting in a secure and upright position
- Prior to transporting cylinders, verify that the regulator is removed, valve closed and safety cap in place
- If you need to move a cylinder between floors, travel using an elevator to ensure it is properly secured. Never leave a cylinder unattended.
- Do not lift cylinders by the cap with magnets, chains or slings, do not pull, drag, drop or slide cylinders
- Never refill a gas cylinder;
- Never use cylinder gas as a source of compressed air;
- Never heat the cylinder to raise the pressure of the gas as this may defeat the safety mechanisms built in by the supplier;
- Never use copper fittings or tubing on acetylene tanks as an explosion may result;
- Remove all pressure from regulators not currently in use;
- For all flammable compressed gas cylinders make sure that a flashback arrestor is installed on the regulator end.
- Bond and ground all flammable compressed cylinders, lines and equipment;
- Keep the cylinder clear of all sparks, flames and heat sources;
- Gas cylinders should never become part of an electrical circuit; and
- Ensure the cylinder, regulator and associated equipment are properly maintained

Supervisors

- Ensure staff, students and visitors know and understand the hazards and risks specific to the compressed gases they are handling, using and ;
- Ensure that compressed gases are used only for their intended purpose and in accordance with defined procedures and rules;
- Ensure that applicable MSDS/SDS and other relevant literature is made readily available to staff and students;
- Provide staff, students and visitors with appropriate personal protective equipment (PPE);
- Maintain appropriate records pertaining to the handling and use of compressed gases including an up-to-date inventory, training records, and reported incidents;
- Provide appropriate supervision of staff and students;
- Investigate reported incidents to determine the cause and to develop effective corrective actions to mitigate further occurrences.

Staff, students and visitors:

- Adhere to defined procedures and rules, and applicable occupational health and safety regulations for the use of compressed gases;
- Know and understand all aspects of ERP, SOP's, MSDS/SDS and appropriate control measures or actions that need to be taken;
- Immediately notify supervisor any identified hazards, deficiencies or unsafe acts or conditions related to compressed gas cylinders

Receiving Gas Cylinders

- Only individuals trained in the transportation of dangerous goods may receive dangerous goods including gas cylinders.
- Read the cylinder label to confirm the gas received is the gas purchased. Never identify the product by the color of the cylinder
- Check the Transport Canada/Department of Transportation (TC/DOT) cylinder markings to confirm the pressures contained in the cylinders
- Thoroughly inspect the cylinders for any obvious damage such as cuts, gouges, burn marks, and obvious dents. The cylinder surface should be clean
- Cylinders with neck threads should have a cap in place over the valve. Remove the cap by hand. Never use a screwdriver, crowbar, or other leverage device to remove the cap;
- Check the cylinder valve to be sure it is not bent or damaged. A damaged valve could leak, fail, or not provide a tight connection
- Ensure the valve is free of dirt and oil, which could contaminate the gas. Dirt particles propelled in a high-velocity gas stream could cause a spark, igniting a flammable gas. Oil and grease can react with oxygen and other oxidizers, causing an explosion
- The MSDS/SDS for the contents of each cylinder must be provided with the gas cylinder
- If any cylinder is received with missing or unreadable labels and markings, tag it out and do not use the cylinder. Contact your supplier and ask for instructions.

Compressed Gas Regulators

- Gas regulators are used to reduce the high pressure of a compressed gas cylinder to safe and useable pressures. They are designed for use with a specific gas, within prescribed pressure ranges.
- Cylinder regulators have a relief device to prevent excessive pressure from developing. High pressure cylinder regulator gauges have a solid-front, safety-back construction. When subject to excessively high pressure, the light-metal safety back will blow off to relieve the pressure.
- Always use the proper regulator for the gas in the cylinder as they are designed to provide the correct flow rate for that particular gas. Using the wrong regulator may cause some gases to react with the materials inside the regulator. For example, materials used in some regulators are not designed for oxygen and could ignite causing a fire or explosion

Gas Cylinder System Maintenance

- Regular inspection and maintenance of regulators is important to ensuring their proper operation and to the safety of individuals working with compressed gases.

Function Testing of Regulators

It is recommended that regulators be function tested every six months.

Testing for Leaks

- A leaking cylinder can pose a serious hazard to individuals working with the gas, and to the facility. Leak detection procedures should be implemented prior to the initial use of any system using compressed gas.
- For systems where toxic or corrosive gases will be used, first test the system with an inert gas before introduction of the hazardous material
- In instances where a cylinder valve is found to be leaking contact the supplier immediately by phone and ask for response instructions.

Compressed Gas Cylinder Disposal

- Hazardous waste is to be disposed of in accordance with the *Hazardous Waste Disposal Standard.*
- Only purchase compressed gas only from manufacturers that agree to take back the empty cylinders;
- Never completely empty the cylinder. Always leave a residual gas pressure of 30 psi. Maintaining a residual pressure in an "empty" compressed gas cylinder helps to prevent back flow or suck back. This is the drawing-back into the cylinder of contaminants or moist air from a higher pressure system or the atmosphere which can lead to serious contamination and corrosion problems within the cylinder;
- Always keep the cylinder valve closed on empty tanks. This practice will help maintain the positive pressure required to prevent back flow. As well, an increase in temperature or a drop in atmospheric pressure can force the contents out of a cylinder, with an open valve, into a work space which could result in hazardous conditions depending on the gas and how much is forced out;

- If the research experiment is over and the cylinder still contains hazardous material, the cylinder should be sent back to the supplier for disposal or arrangements made for its transfer to a colleague that will use the cylinder;
- When a one-time use bottle (lecture bottle) is empty contact the Waste Management Facility at 306-966-8497 for assistance with proper disposal;
- Do not keep gas cylinders in the laboratory beyond the time they are needed. Cylinders have a finite life expectancy. This is especially true for cylinders containing corrosive materials. If you are not using it dispose of it properly;
- If the cylinder is getting close to empty, replace the cap and remove it to the storage area for return cylinders.

The minimum provincial standards for Compressed Gas Cylinders can be referenced in the Occupational Health and Safety Regulations 1996 in REG Sec. 371-373. Also, the 3 rights of all individuals under Saskatchewan Occupational Health and Safety are – The Right to Know, The Right to Participate and the Right to Refuse.

For more detailed information, refer to Safety Resources website under Procedures and Forms, Procedures and Guidelines for a copy of the **Compressed Gas Cylinder Safe Handling, Use and Storage.**

For site and departmental specific Standard Operating Procedures (SOP's) and Emergency Response Plans (ERP's), Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS's) and your roles and responsibilities in the workplace, ask your laboratory manager or supervisor.

NANOPARTICLES/NANOMATERIALS USE

COLLEGE PROTOCOL & TRAINING ACKNOWLEDGEMENT

Date		☐ NEW ☐ RENEWAL #:	
NAME		**CONTACT NUMBER**	
EMAIL			
Lab/Research Name	☐ Pilot Plant (1D04) ☐ Other:	**Lab Room Number(s)**	
PI Name		**PI Phone Number**	
Brief description of NP/NM research			
Current NP/NM SOP Available	☐ YES ☐ NO		

Nanomaterial safety training provided by Safety Resources: http://safetyresources.usask.ca/services/training/index.php

HEALTH AND SAFETY SUMMARY:

- There is increasing use of nanoparticles/nanomaterials (NP/NM) in laboratories in the College of Engineering (CoE) at the University of Saskatchewan. **It is recognized that there are currently unknown risks associated with this work.**
- Because of the relative newness of NP/NM in the laboratory research and occupational setting there is limited data relating to the hazards and health and safety risks to personnel and students using NP/NM. However, some evidence that NP/NM are currently unpredictable in their nature and affects, therefore we must all treat NP/NM as high hazard work until we know better about possible lasting health effects.
- The Principal Investigator (PI) is responsible to ensure compliance with this College Protocol and Training Acknowledgement, as well as ensuring written NP/NM standard operating procedures (SOPs or HAZOPs) are completed and up-to-date.
- **CSA Standard Z12885-12** "Nanotechnologies – Exposure control program for engineered nanomaterials in occupational setting" is available to those working with NP/NM and writing research SOPs **& can be signed out for reference at 1D23.**
- **Annex E of CSA Z12885-12 contains valuable information regarding the use of PPE and fumehoods.**

RECOGNIZED HEALTH, SAFETY & ENVIRONMENTAL HAZARDS:

Toxicity: limited data available, *MODERATE TO HIGH RISK*

Eye Contact: may cause irritation, limited data available, *MODERATE RISK*

Inhalation: causes irritation and is possibly carcinogenic, *HIGH RISK*

Skin Contact: May cause sensitization with prolonged skin contact, limited data available, *MODERATE RISK*

Ingestion: Lower oral acute toxicity, but may irritate gastrointestinal tract, *MODERATE TO HIGH RISK*

RULES FOR WORKING WITH NP/NM IN THE College of Engineering:

1. **Training is required for all users of NP/NM;** including use of this protocol and training document;
2. **Written SOPs (or HAZOP) are required for each specific research activity utilizing or generating NP/NM;**
3. **All NP/NM laboratory research work** is to be performed in a FUMEHOOD (or similar controlled environment);
4. **All NP/NM transport** must be securely contained for any transport within labs and between labs;
5. **All NP/NM waste** must be packaged properly as Hazardous Waste and disposed through the university's Waste Management Facility (WMF);
6. **All NP/NM exposures/leaks/spills** must be reported immediately to CoE Local Safety Committee (LSC);
7. **NP/NM Safety Data Sheets** (SDS or MSDS) must be readily available and followed diligently; and,
8. **Monthly inspection reports** for labs using NP/NM are required to be provided to the CoE LSC for review.

SPECIFIC PROTOCOL FOR ELEMENTS OF NP/NM RESEARCH

CHECK TO ACKNOWLEDGE UNDERSTANDING OF EXPECTATIONS RELATING TO NP/NM RESEARCH WORK:

NP/NM PERSONAL PROTECTIVE PROTECTION (PPE) USE:

- ☐ Wear appropriate lab attire and footwear
- ☐ Wear good quality puncture resistant and chemical-resistant disposable gloves. For added safety a second layer of gloves can be used, as recommended in the CSA Z12885-12 standard
- ☐ Wear chemical safety goggles
- ☐ Avoid contact with eyes, skin or clothing
- ☐ Use appropriate respirator or mask to avoid inhaling NP/NM ☐ **Fit testing completed**
- ☐ Minimize the number of employees handling NP/NM

NP/NM GENERATION, USE, STORAGE & TRANSPORT:

- ☐ All work is to be performed in a FUMEHOOD (or similar controlled environment)
- ☐ Keep tightly sealed in storage and during any transport (use plastic container with secure lid as secondary containment); utilize secondary containment and rolling carts, as appropriate
- ☐ Store in a cool, dry and well labelled area ('nanoparticles storage area')
- ☐ Do not store together with a) acids, b) oxidizing agents or c) halogens
- ☐ Minimize NP/NM handling whenever possible

PROPER NP/NM WASTE DISPOSAL:

- ☐ NP/NM waste material shall be classified and coded as **'nanoparticle hazardous waste'**, and depending on the type of waste it can be either:
  1) Double wrapped in sealed polythene bags, and placed in a sturdy card board box or in a plastic pail with a gasket sealed lid and labelled with orange hazardous waste labels, (contaminated disposable gloves, clothing, wipe down cloths, etc.)
  2) Placed in a sturdy cardboard box or plastic pail with a gasket sealed lid, and labelled with orange hazardous waste labels, (unused material already in the supplier's container)
- ☐ Complete the Hazardous Waste Disposal Form and contact Waste Management Facility to pick up the waste

CLEANING MINOR NP/NM SPILLS OR LEAK REMEDIATION PROCEDURES:

- ☐ Secure the area before initiating clean up procedures
- ☐ If exposure is expected, then wear your respirator with HEPA cartridges during clean up procedures
- ☐ Wear chemical safety goggles
- ☐ Wear good quality puncture resistant and chemical-resistant disposable gloves
- ☐ Avoid raising any airborne particulates
- ☐ Use good 'wet-wiping' techniques and/or use designated vacuum cleaner, with approved HEPA filter
- ☐ Wipe up spilled material and place the contaminated wet wipes and gloves in a double bag, seal properly and dispose of through the University of Saskatchewan Waste Management Facility
- ☐ Wash spill site with hot soapy water and dispose of all NP/NM contaminated waste water through the University of Saskatchewan Waste Management Facility

NP/NM Research Specific SOP(s):

- ☐ SOP(s) are Current (Date: _____) ☐ Includes emergency shutdown procedure(s)
- ☐ SOP(s) are Posted (Location: _____)
- ☐ MSDS or SDS are readily available: (Location: _____)
- ☐ SOP(s) Reviewed by College of Engineering Local Safety Committee (Date: _____)

RESEARCHER/GRADUATE STUDENT ACKNOWLEDGEMENT:

SIGNATURE	**X**	**DATE**	

SUPERVISOR REVIEW AND APPROVAL:

NAME		**ROLE**	☐ **PI** ☐ **LSC** ☐ **Other**
SIGNATURE	**X**	**DATE**	

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CHEMICAL AND BIOLOGICAL ENGINEERING

WORKING AFTER HOURS POLICY AND PROCEDURE

Personnel (including students, faculty and researchers) may need to conduct laboratory work after hours when and where assistance is not readily available. In these situations, additional precautions are necessary to minimize the risk of a workplace injury as well as to ensure a reasonably appropriate response to an emergency. Therefore a formal working after hours plan is required in these situations.

This policy and related procedures have been developed in compliance with the University of Saskatchewan's Working Alone Policy 3.12: http://www.usask.ca/university_secretary/policies/health/3_12.php

WORKING AFTER HOURS POLICY:

Researchers and students in the Department of Chemical and Biological Engineering must have a Working After Hours Plan completed prior to conducting work in any laboratories outside of regular departmental hours (6:00 PM - 8:00 AM, Monday to Friday; and on holidays and on weekends). *The planning worksheet is on the last page.*

Formal written plans for working after hours must be developed by the supervisor together with the worker. Plans are laboratory specific; therefore personnel will have more than one active plan if they work in more than one lab.

Plans generally include an arrangement for faculty supervisor(s) to maintain regular communication with personnel working after hours, an outline of expected work activities, a job safety analysis that must be completed in consultation with supervisor, as well as the identification of prohibited activities.

All plans must be reviewed by the chair or a member of the Department Safety Committee, prior to the commencement of work activities. Also, depending on the nature of the work additional documentation may be required, such as a summary of research activities, the provision of training records and/or relevant standard operating procedures. If there is evidence that shows a plan is not adequate or effective in protecting the health and safety of workers working after hours then this shall be brought to the attention of the faculty supervisor for further review and amendment.

RESPONSIBILITIES:

The Department Head or Chair of the Department Safety Committee is responsible to ensure departmental personnel observe these policies and procedures.

Research Supervisors (i.e. faculty supervisors, principal investigators and lab mangers) shall review laboratory and research activities conducted under their direction to identify all individuals who will be required to work after hours. Supervisors are then required to develop written plans for all identified personnel working after hours. This must be done together with the worker. Once the plan is approved and in place, supervisors are expected to ensure workers adhere to the specific conditions and prohibitions in the plan.

Research supervisors shall also make efforts to minimize the need to work after hours. If work activities are risky, hazardous or require any special provisions, then supervisors must take all reasonable steps necessary to protect the health and safety of researchers and students. This may include ensuring that more than one worker is present and/or scheduling the work during regular working hours.

Personnel who Work After Hours must help to develop their individual working after hours plan(s). They are then responsible to comply with the conditions in the plan and to follow all related standard operating procedures and safe work practices.

Laboratory Managers and Technicians shall review all working after hours plans for their lab(s), as well as conduct a job safety analysis with the worker to help identify acceptable and prohibited activities. Further, lab technicians will provide training related to standard operating procedures (SOPs) to all personnel conducting research after hours within a laboratory or laboratories under the technician's control.

WORKING AFTER HOURS PROCEDURE:

To create a safe work plan for working after hours, the steps described below must be followed:

a) *The Worker must have first completed the required Employee Orientation Training and Laboratory Safety Course(s), provided by Workplace Safety and Environmental Protection (WSEP).*

b) The supervisor and worker shall complete the *Working After Hours* form together. Completion of this form requires a job safety analysis (JSA), identifying and satisfying lab training requirements, and listing any prohibited activities; (completion of this form creates the basic working after hours plan for an individual worker in a specific laboratory). The supervisor may sign the plan at this time.

c) The supervisor or worker shall then submit the plan to the chair or co-chair of the Department Safety Committee for review and approval.

d) If there is any concern about a working after hours plan, it shall be amended by the worker and supervisor and resubmitted to the Department Safety Committee Chair or Co-Chair. Work cannot start until the concern is resolved and the plan is acceptable.

e) The plan is then signed by the worker, supervisor, and laboratory manager with copies provided to the Department Safety Committee prior to the commencement of work activities. The supervisor will retain the signed original plan and a copy is maintained in the lab where activity is taking place.

f) Any additions or changes to the plan must be agreed upon by the worker, supervisor, and laboratory technician and approved by the Department Safety Committee Chair or Co-Chair. Additions and changes must be detailed in writing and signed as an amendment to the original plan, with copies provided to the Department Safety Committee prior to the commencement of work activities. A copy of the amended plan must be maintained in the lab where activity is taking place.

Please follow the steps below to address any concerns that arise during the implementation of the plan:

a) The worker shall discuss concerns with the supervisor and vice versa and concern must be addressed as soon as possible.

b) If concerns cannot be resolved in a timely manner, then the Department Safety Committee must be informed in writing or through an email communication.

Work cannot resume until concern is resolved and a new plan is developed (refer to and complete step f from previous section with regard to amendments).

c) All related emails and other documents should be printed, initialed, dated and attached to the original plan.

d) The planning worksheet has an expiry date. A new worksheet must be submitted by the worker to replace the expired one.

WORKING AFTER HOURS PLAN

LABORATORY WHERE WORK WILL BE CONDUCTED		☐	
WORKER'S NAME		**PHONE**	
SUPERVISOR'S NAME		**PHONE**	
LAB TECHNICIAN'S NAME		**PHONE**	
DURATION-(Maximum 60 days)	**From:** _____	**Until:** _____	

1. **IT IS THE RESPONSIBILITY OF THE WORKER AND SUPERVISOR TO IDENTIFY HAZARDOUS AGENTS AND ACTIVITIES WHICH ARISE FROM THE CONDITIONS AND CIRCUMSTANCES OF THE WORK TO BE COMPLETED AFTER HOURS.**
2. **IT IS EXPECTED THAT ONLY WORK(S) THAT CANNOT BE REASONABLY COMPLETED DURING NORMAL WORKING HOURS BE CONSIDERED.**
3. **HANDLING HAZARDOUS SUBSTANCES, USING HAZARDOUS EQUIPMENT AND/OR PERFORMING HAZARDOUS ACTIVITIES ARE PROHIBITED UNLESS IDENTIFIED AND APPROVED BY YOUR SUPERVISOR.**

DESCRIBE THE COMMUNICATION PLAN: (Supervisor and Worker)

(Include the names of people involved, as well as times and intervals for regular check-ins)

Enter data here

☐ The phone numbers above are for regular communication, check-ins and to report any emergency as per the communication plan described in the box above.

☐ Regular communication will also involve text messaging or email. If so, then enter the email address and/or phone number where text messages will be sent and received:

NAME		TEXT OR EMAIL TO	
NAME		TEXT OR EMAIL TO	

DESCRIBE PROPOSED WORK ACTIVITIES: (Supervisor and Worker)

CLASSIFICATION:	EXAMPLES:	APPLICABLE?	BRIEFLY DESCRIBE PROPOSED WORK ACTIVITIES BELOW:
Low Hazard Activities	• Data analysis • Use of computers • Use of low hazard materials • Use of low hazard tools and/or equipment	☐ Yes ☐ No	Enter data here

CLASSIFICATION:	EXAMPLES:	APPLICABLE:	
Moderate Hazard Activities	• Use of hazardous materials, chemicals or poisonous gases • Use of high temperature or high pressure • Use of power tools and equipment • Use of ladders • Physical labour	☐ Yes ☐ No	Enter data here ☐ **Standard Operating Procedures (SOPs) are readily available**
Prohibited Activities	• Entering confined spaces • Hoisting materials • Working at heights • Working in or over water	***NOT APPLICABLE***	

Additional Research Summary Provided and attached to this form? ☐ Yes ☐ No

JOB SAFETY ANALYSIS: (Worker, Supervisor and Lab Manager/Technician)

*(The following job safety analysis or JSA **is to be completed together with the laboratory technician** to determine the work activities that are acceptable in the lab as well as to identify and satisfy training requirements)*

WORK ACTIVITIES	RELATED HAZARDS	HAZARD CONTROL MEASURES	SOP

LIST OF SPECIFIC RESTRICTIONS AND/OR PROHIBITED ACTIVITIES	Please note that sleeping inside a laboratory is prohibited.
	Food and drink are also prohibited inside laboratory.
	No shorts, open toed shoes or sandals.

PERSONAL PROTECTIVE EQUIPMENT (PPE) REQUIRED	

ACKNOWLEDGEMENTS ♦

WORKER'S SIGNATURE		**DATE**	

SUPERVISOR'S SIGNATURE		**DATE**	

LAB TECHNICIAN'S SIGNATURE		**DATE**	

DEPARTMENT SAFETY COMMITTEE CHAIR NAME		**CONTACT**	
LOCAL SAFETY COMMITTEE MEMBER SIGNATURE		**DATE**	

♦ *Work may not commence until the laboratory technician (and, as necessary, the Local Safety Committee member) sign to acknowledge awareness of the plan. By signing they are not approving or authorizing the plan. When the worker and supervisor sign this record, they approve and agree to abide by the conditions set out in the plan. Comments and/or concerns may be raised by anyone acknowledging this plan. Steps shall be taken to resolve all concerns prior to the commencement of work activities.*

REVIEWER COMMENTS/CONCERNS/FOLLOW-UP: (use additional pages as necessary)

Research SOP & ERP

Laboratory Room Number: Add Room Number
SOP & ERP Name: Name of Research Project
SOP & ERP Creator: Name & Contact Number
Area Supervisor: Name & Contact Number
Date of Latest Revision: Add Date

CBE Laboratory SOP & ERP Template – June 2016

(See Appendix for Instructions and Additional Information)

Contents:

Research SOP & ERP

Laboratory Room Number: Add Room Number
SOP & ERP Name: Name of Research Project
SOP & ERP Creator: Name & Contact Number
Area Supervisor: Name & Contact Number
Date of Latest Revision: Add Date

GENERAL INFORMATION

Research Synopsis

Add here (or cut and paste)

Known Hazards

List Physical Hazards:

Heavy items, work at heights, over water, moving components, high temperature, high pressure, glassware, etc.

List Chemical Hazards:

Compressed gases, high hazard, toxic, flammable, explosive (list all hazardous chemicals)

List **Biological Hazards:**

Biological hazards, Level I Permit, Level II Permit, any human pathogens (delete if not applicable)

List Radiological Hazards:

Radiation hazards (delete if not applicable)

Safety Data Sheets Location

Note readily available location of Safety Data Sheets (or equivalent MSDSs or PSDSs)

Emergency Response Equipment Location

Equipment:	Location:
First Aid Kit	Add location
Fire Extinguisher	Add location
Spill Kit	Add location
Emergency Gas Shutoff	Add location (as applicable)
Eyewash and Shower	Add location

Required Training

Formal: Lab Safety Course, Lab Orientation, WHMIS, other formal training (high voltage, biosafety, radiation safety)

Lab-specific: using this SOP and ERP, nanomaterials training form, other lab-specific training

Additional: first aid, respirator fit testing

Required Personal Protective Equipment

Standard laboratory attire (long pants and closed-toe shoes, hair back, no jewelry)

Hardhat in Pilot Plant (1D04)

Eye protection: add type

Gloves: add type

Other: hearing protection, fall protection, type of respirator

Research SOP & ERP

Laboratory Room Number: Add Room Number
SOP & ERP Name: Name of Research Project
SOP & ERP Creator: Name & Contact Number
Area Supervisor: Name & Contact Number
Date of Latest Revision: Add Date

STANDARD OPERATING PROCEDURE

(Cut and paste existing SOP(s); or follow steps below)

Description of Required Equipment

Fumehood: or other controlled environment required

Lab equipment: bench-top or mobile equipment used, note location of logbook

Compressed Gases: note compressed gases used and location

Procedural Steps

1) **Set up:** add chronological steps (include things to watch for, calibrations, etc.)

2) **Experimental procedure:** add chronological steps (note critical steps in detail)

3) **Monitoring or data acquisition:** add chronological steps

4) **Clean up:** add chronological steps (note issues to inspect and report before next time)

Research SOP & ERP

Laboratory Room Number: Add Room Number
SOP & ERP Name: Name of Research Project
SOP & ERP Creator: Name & Contact Number
Area Supervisor: Name & Contact Number
Date of Latest Revision: Add Date

EMERGENCY RESPONSE PROCEDURE

(Cut and paste existing ERP or Experimental Set-up Showdown Procedure; AND complete sections below)

ERP for Scenario #1

Describe emergency response when NO audible alarm is sounding

ERP for Scenario #2

Describe emergency response when audible alarm IS sounding

Minor Spill Response Plan and Procedure

Describe spill response procedure (AS APPLICABLE)

Containing Hazardous Materials

Describe plan for safely containing all hazardous materials

Research SOP & ERP

Laboratory Room Number: Add Room Number
SOP & ERP Name: Name of Research Project
SOP & ERP Creator: Name & Contact Number
Area Supervisor: Name & Contact Number
Date of Latest Revision: Add Date

Local Responsibilities and Contact Information

NAME	TITLE & DEPARTMENT	WORK (OFFICE) PHONE	HOME (CELLULAR) PHONE	PRIME DUTIES & TASKS
ADD	Researcher	ADD	ADD	• Develop and use Lab/research-specific ERP and experimental set-up shutdown procedures • See responsibility list
ADD	Supervisor or Principal Investigator	ADD	ADD	• Review and approve Lab/research-specific ERP and experimental set-up shutdown procedures • See responsibility list
ADD	Lab Occupants	ADD	ADD	• Use Lab/research-specific ERP and experimental set-up shutdown procedures • See responsibility list
Richard Blondin	CBE Safety Committee Representative	306-966-**4711**		• Provide advice
	Safety Resources	306-966-**4675**	306-966-**5555** (afterhours)	• Provide advice
Facilities Management Division	Customer Service Centre (FMD)	306-966-**4496**	306-966-**5555** (afterhours)	• Verify ventilation system operation • Verify emergency power operation
Local Emergency Dispatch	Protective Services	306-966-**5555** (call 24/7)		• Initiate and support emergency response • Establish perimeter
Municipal Emergency Responders	• Ambulance • Fire • Police	**911 from mobile or 9-911 from U of S landline**		• Emergency responders
Andrea Book	Chief Building Warden (CoE)	306-966-**5388**	See Building ERP for cellular	• Help coordinate building evacuation
Veronica Bendig	Building Coordinator (CoE)	306-966-**5104**	See Building ERP for cellular	• Coordinate college response • Provide status updates to building occupants • Confirm WCC notified

Research SOP & ERP

Laboratory Room Number: Add Room Number
SOP & ERP Name: Name of Research Project
SOP & ERP Creator: Name & Contact Number
Area Supervisor: Name & Contact Number
Date of Latest Revision: Add Date

APPROVAL & ACKNOWLEDGEMENTS

Principal Investigator (Supervisor) Approval of this SOP and ERP

Name	Title	Signature	Date

Researchers & Students who have Reviewed, Understand & Use this SOP and ERP

Name	Supervisor	Signature	Date

Research SOP & ERP

Laboratory Room Number: Add Room Number
SOP & ERP Name: Name of Research Project
SOP & ERP Creator: Name & Contact Number
Area Supervisor: Name & Contact Number
Date of Latest Revision: Add Date

APPENDIX

Instructions

1) Complete all **yellow highlighted** areas in all sections, and delete if not applicable.
2) Use Resources below for assistance.
3) Area Supervisor (PI) must review and sign to approve this SOP & ERP prior to commencing related work.

Resources

- For assistance please talk to your supervisor, or email Safety Management System Specialist
- Link to Access to Building Emergency Response Plan and other college safety/security resources: http://engineering.usask.ca/service-and-support/safety-security.php
- Link to University Safety Resources: http://safetyresources.usask.ca/

Sample Emergency Scenario A – NO High Level Alarm Sounding

Emergency Conditions:

- A hazardous gas smell has been detected
- There is an unusual or strong smell of H_2S gas (rotten egg) originating from the pilot plant.
- The H_2S alarm is NOT sounding.

Emergency Response Procedure:

1) Evacuate all except two research personnel, including one standing by an open door and restrict entry to the lab.
2) Should the researcher in the lab appear to be in distress, the person on watch is to proceed with "Scenario B: High Level Alarm Sounding", pull the alarm and evacuate the building. They are NOT to attempt a rescue.
3) The person by the open door is to notify all members of the following call-out list: SEE CALL OUT LIST
4) If a personal multi gas detector reads more than 10 ppm H_2S, experimental systems are to be shut down immediately. Instructions for reactor shut down are contained in Appendix 1.
5) If the reason for the gas release is because of exhaust system failure or leaking in the experimental set-up, the system should be shut down immediately.
6) If the High Level H_2 or H_2S or CO Alarm activates at any time, proceed with "Scenario B: High Level Alarm Sounding", pull the alarm and evacuate the building.

Sample Emergency Scenario B – High Level Alarm IS Sounding

Emergency Conditions:

- The high level alarm is sounding indicating greater than _____.

Emergency Response Procedure:

1) Close all doors and evacuate the laboratory immediately.
2) Leave the building **PULLING A FIRE ALARM** on the way out.
3) On building exit, proceed directly to the front main entrance of the Engineering Building.
4) Report all known information about the incident to attending Emergency Response Personnel. Additionally, provide instructions on reactor shutdown.

ERP Responsibilities

The following responsibilities are delineated to ensure that emergency situations arising from work performed in any laboratory are minimized and responded to properly:

Supervisor or Principal Investigator

- Ensure the development, maintenance and periodic revision of Standard Operating Procedures for safety systems and laboratory operations
- Ensure the development, maintenance and periodic revision of the Emergency Response Plan
- Ensure inspection and maintenance of laboratory equipment containing hazardous substances, or that otherwise pose a hazard to health or safety
- Ensure the provision of PPEs for all employees as necessary
- Ensure access to MSDSs for all hazardous substances in the laboratory
- Ensure the provision of training for all laboratory occupants and users with regard to:
    - SOPs
    - The ERP
    - MSDSs
    - PPE use and maintenance
    - Safety systems parameters and operation
    - Equipment use and maintenance
- Ensure that documentation and log books are kept for all training, safety systems monitoring, equipment inspection and calibrations
- Personally inspect training records and logs periodically to ensure compliance with SOPs

Researchers and Laboratory Occupants

- Read, ensure understanding of, and follow all laboratory SOPs specific to your work and general laboratory safety
- Read and ensure understanding of the ERP
- Read MSDSs for all hazardous substances in the laboratory prior to use of the substances
- Inspect and ensure adequacy of PPE and use them as required
- Attend all prescribed safety training
- Keep accurate records per prescribed frequencies in the laboratory SOPs
- Perform duties in a safe manner to protect the life and health of yourself, your coworkers and other occupants of the laboratory and the Engineering building

Chief Building Warden

- Ensure evacuation of the building if the situation dictates
- Liaise with laboratory, facility, University and emergency response personnel, ensuring that pertinent information is passed

Related Documents

Ensure the **College of Engineering Orientation Checklist** is completed.

As necessary, ensure the **Compressed Gas Use SOP** and/or **Nanomaterials Training Form** is used and readily available whenever applicable.