1. PURPOSE

1.1. To provide guidelines to students and instructors of the basics of laboratory safety and point out the most common types of safety hazards in a chemistry laboratory at Thompson Rivers University (TRU).

This document is NOT a complete listing of the safety hazards in a chemistry laboratory, or any laboratory, but rather it plays the role of alerting the student to the possible safety hazards in the laboratory.

2. SCOPE

2.1. This procedure applies to students and employees at TRU working in the Chemistry department.

3. PRECAUTIONS

POTENTIAL HEALTH & SAFETY HAZARDS

	HAZARD		TO PROTECT YOURSELF
	RADIATION		Wear required PPE and limit access to a source.
	EXPOSURE to hazardous chemicals		Wear PPE and read the MSDS before use. *MSDSs are available on-line*
	ELECTRICAL HAZARD		Do not look directly at a UV lamp when the lamp is switched on.
	COMPRESSED GAS		Handle with care.

4. ASSOCIATED DOCUMENTATION

Doc. Number	Doc. Title
	Lab Inspection Form
	Incident Investigation Form

5. PROCEDURES AND RESPONSIBILITIES

INSTRUCTORS

5.1. Have charge of a laboratory and authority over students working in the lab.

5.2. The instructor of a laboratory has overall responsibility for safety in the laboratory.

5.3. It is the instructor's responsibility to ensure that students and new employees are aware of safety rules and follow them and that the following training has been provided:

5.3.1. An appropriate safety orientation when individuals are first working in the laboratory,

5.3.2. Generic and specific WHMIS training as needed for chemicals encountered,

5.3.3. Radiation Safety Training,

5.3.4. Training on special or unusual hazards in the lab, and

5.3.5. Training in the use of laboratory specific emergency equipment and emergency response.

5.4. Records of training must be kept on file with Chemistry and a copy sent to OHS.

5.5. Additionally instructors will complete incident investigation reports for every incident or injury that occurs in his/her lab. After the report is complete a copy will be sent to the OHS Department. Incidents to be investigated include, but not limited to:

5.5.1. Spills,

5.5.2. Fires,

5.5.3. Incidents requiring first aid or medical attention, and

5.5.4. Near misses.

STUDENTS

5.6. When in the laboratory students are responsible to:

5.6.1. Follow all applicable safety rules and practices,

5.6.2. Use and wear the required PPE,

5.6.3. Report all incidents,

5.6.4. Report all unsafe conditions, and

5.6.5. Complete recommended occupational health screening programs.

6. GENERAL LABORATORY HEALTH AND SAFETY REQUIREMENTS

6.1. No eating or drinking in the laboratory. Consume food and drink only in properly designated areas.

6.2. Applying cosmetics and handling contact lenses is not allowed in laboratories.

6.3. Use the appropriate personal protective equipment (PPE) at all times. Refer to the PPE procedure for more information.

6.4. Use laboratory equipment for its designated purpose.

6.5. Confine long hair and loose clothing.

6.6. Use a proper pipetting device – **absolutely no pipetting by mouth**.

6.7. Avoid exposure to gases, vapors, aerosols and particulates by using a properly functioning laboratory fume hood.

6.8. Wash hands upon completion of laboratory work and removal of protective equipment including gloves and laboratory coats. A vigorous hand washing with mild soap for 20 seconds is appropriate.

6.9. Fix unsafe conditions (employees) or report to the lecturer conducting the laboratory (students).

6.10. Know the location and correct use of all available safety equipment.

6.11. Determine potential hazards and appropriate safety precautions before beginning new operations and confirm that existing safety equipment is sufficient for this new procedure.

6.12. Avoid disturbing or distracting other workers while they are performing laboratory tasks.

6.13. Ensure visitors to the laboratory are equipped with appropriate safety equipment.

6.14. All hazardous chemicals must be labeled correctly according to Workplace Hazardous Materials Information Systems (WHMIS) requirements.

6.15. Drugs must be stored and dispensed according to the requirements set by the Veterinary Drugs Directorate of Health Canada.

6.16. The Material Safety Data Sheet (MSDS) will be consulted before using an unfamiliar chemical.

6.17. Proper waste disposal procedures will be followed.

6.18. Refer to the on-line Work Alone procedure on the action to be taken if working alone in the building.

6.19. Unattended laboratory work should be kept to a minimum. It must be visited periodically with a sign posted adjacent to the equipment outlining the procedure being done alone with the name and phone number of a contact person. The sign will indicate the date and time the work was started, when it is expected to be completed and when it was last checked.

6.20. When using needles, glass pipettes, glass slides and cover slips, scalpels and appropriate precautions should be taken to avoid percutaneous injuries. These items should be disposed of immediately after use by placing them in an appropriate puncture-resistant container. Bending, recapping or clipping of needles is prohibited. If recapping is absolutely necessary, a mechanical device or the one handed scoop method must be used.

EQUIPMENT

7. ACID/BASE BATHS

7.1. Acid and base baths, often used to clean glassware are very corrosive, with the potential to cause significant injury to the personnel using them. Consideration should be given to substituting an acid/base bath with a bath prepared with a laboratory grade detergent.

7.2. When preparing or handling acid or base baths, ensure that personal protective equipment includes a synthetic rubber apron, safety goggles, a face shield and long synthetic rubber gloves.

7.3. Prepare the bath in a fume hood by first adding cold water, to which a measured amount of acid or base is slowly added.

7.4. Take particular care to prevent splashing during the loading or unloading of the bath.

7.5. When removing items from the bath, empty any residual liquid back into the bath and rinse thoroughly with water.

7.6. Dispose of the spent bath in accordance with hazardous waste disposal procedures.

8. ATOMIC ABSORPTION SPECTROMETERS

8.1. Sample preparation for atomic absorption (AA) procedures often requires handling flammable, toxic and corrosive products. Use the MSDS or other suitable reference and follow the recommended safety precautions. Atomic absorption equipment must be adequately vented, as toxic gases, fumes and vapors are emitted during operation.

8.2. Wear safety glasses for protection against impact.

8.3. Inspect the integrity of the burner, drain and gas systems prior to use.

8.4. Allow the burner head to cool to room temperature before handling.

8.5. Avoid viewing the flame or furnace during atomization unless wearing protective eyewear.

8.6. Handle hollow cathode lamps with care, as they are under negative pressure. Dispose of hollow cathode lamps as hazardous waste to minimize implosion risks.

8.7. Inspect the drain system regularly; empty the drain bottle frequently when running organic solvents.

8.8. Never leave the flame unattended. A fire extinguisher should be located nearby.

8.9. Ensure gas delivery systems incorporate flash arrestors in the gas lines.

9. BLENDERS / GRINDERS / SONICATORS

9.1. When used with infectious agents, mixing equipment such as shakers, blenders, grinders, sonicators and homogenizers can release significant amounts of hazardous aerosols, and should be operated inside a biological safety cabinet whenever possible. Do not use flammable solvents in equipment such as blenders and stirrers as they can also produce a large amount of flammable vapors.

9.2. Ensure equipment is equipped with safety features that minimize leaking and prevent operation if blades are exposed.

9.3. Ensure equipment is selected appropriately for the task being performed, e.g. non-sparking (intrinsically safe) motors are used when dealing with flammable solvents.

9.4. Ensure that any equipment that could move during use is secured to the bench or floor as applicable.

9.5. Ensure equipment is in good condition prior to use.

9.6. Allow aerosols to settle for at least one minute before opening containers.

9.7. Hearing protection may be required when using sonicators or grinders due to the high frequency or high amplitude sound waves produced.

10. CENTRIFUGES

10.1. Use only centrifuges with sealed centrifuge buckets / compartment / rotors.

10.2. Use the safety buckets in the correct manner.

10.3. Use only centrifuges with interlocks that will prevent both the lid from being opened when the rotor is in motion and the centrifuge from starting when the lid is open.

10.4. Do not operate centrifuges in a biological safety cabinet because the motor may produce strong air currents and turbulence, which may disrupt the laminar air flow.

10.5. Ensure that centrifuge tubes are free of hairline cracks, stress lines and chipped rims prior to use.

10.6. Ensure that tube materials are chosen such that they provide the necessary chemical resistance and speed rating.

10.7. Avoid over-filling tubes.

10.8. Cap or stopper centrifuge tubes.

10.9. Use sealed centrifuge buckets (safety cups) or rotors that can be loaded and unloaded in a biological safety cabinet or chemical hood as appropriate.

10.10. Decontaminate the outside of the cups/buckets and rotors before and after centrifugation.

10.11. Inspect the O-rings on rotor lids regularly and replace if cracked or dry. Never operate a centrifuge if the rotor lid is missing its O-ring.

10.12. Ensure that the centrifuge is properly balanced. Load the rotor with samples arranged symmetrically. Opposing tubes must be of equal weight. If necessary, use "water blank" tubes to balance sample tubes of unequal weight. Do not use sight or volume to conclude that tubes are balanced. Use an electronic balance to balance the tubes before using in an ultracentrifuge.

10.13. Procedure for handling a broken tube:

10.13.1. Do not open centrifuge for 30 min if centrifuge does not have sealed buckets / compartment,

10.13.2. Open sealed centrifuge bucket in biological safety cabinet,

10.13.3. Wearing nitrile gloves, remove unbroken tubes and wipe the exterior with 1.0%

hypochlorite. Remove broken glass with forceps and discard into sharps container, and

10.13.4. Soak bucket/rotor in non-corrosive disinfectant. Disinfect centrifuge parts with a non-corrosive disinfectant.

10.14. Ensure that the prescribed speed limitations of the rotor or centrifuge are never exceeded.

10.15. Unless fitted with a suitable exhaust system, do not centrifuge materials capable of creating flammable or explosive vapors.

10.16. Remain with the centrifuge until it has reached its programmed speed.

10.17. Abort the run immediately if you hear abnormal vibration, whining or grinding noises. Check the rotor lid and ensure that samples are balanced.

10.18. At the end of the run, ensure that the rotor and centrifuge are cleaned according to manufacturer's instructions. Never use abrasive cleaners.

10.19. Rotors are easily damaged. Never use metal tools to remove tubes or clean.

10.20. For each rotor, record speed and run time for each run in a logbook such that rotors can be downgraded and discarded as appropriate.

10.21. If the centrifuge is connected to a vacuum pump ensure that the pump exhaust is connected to a trap.

11. DISTILLATION EQUIPMENT

11.1. Hazards involved with distillation procedures include those corresponding to the use of flammable liquids, heat and pressures other than atmospheric pressure.

11.2. Ensure that joints are secured. Vapor leaks can lead to fire, unnecessary exposure and contamination of the workspace.

11.3. Never distil or evaporate organic compounds to dryness unless they are known to be free of peroxides. See 5.165 to 5.169 for information on the hazards of peroxides.

11.4. Continuously stir the distillation mixture to prevent bumping of the solution which can result in the apparatus blowing apart. The use of boiling chips may also prevent bumping if the distillation is being performed at atmospheric pressure.

11.5. Ensure that the heating source used provides even heating of the solution, e.g. heating mantle, ceramic cavity heater. The addition of a thermometer near the centre bottom of the distilling flask may provide an early indication of unexpected exothermic decomposition reactions.

11.6. If the distillation is being performed at reduced pressure, evacuate the apparatus gradually to reduce the possibility of bumping.

11.7. After completing a distillation at reduced pressure, cool the system before slowly introducing air. Introduction of air into a hot system may create an explosive environment.

11.8. Solvent stills are to be set-up in the fume hood.

11.9. Reduced pressure distillation set-ups or those involving the use of particularly hazardous materials are to include appropriate shielding.

11.10. Consider using systems designed to shut down if cooling water fails.

12. GAS CHROMATOGRAPHY

12.1. Gas chromatography (GC) procedures involve the use of compressed gas cylinders and may involve the use of flammable solvents and toxic chemicals. Be familiar with the use and handling of compressed gas cylinders, with hazardous properties, precautionary measures, and handling instructions for any hazardous materials being used. Refer to MSDSs or other reliable reference material. The following guidelines will assist in the safe operation of GCs.

12.2. Ensure that proper eye protection is worn. GC columns are fragile and breakage could result in small projectiles during handling. As well, samples are prepared in various hazardous solvents that could be damaging to the eyes upon contact.

12.3. When cutting a GC column, be sure that the cut is made away from the body.

12.4. Ensure that GC column cutters are capped or otherwise stored to prevent injury when not in use.

12.5. Discard small pieces of GC columns as sharps waste.

12.6. Ensure that the oven is allowed to cool before installing or removing a column or injector or performing any maintenance.

12.7. Ensure that gases are turned off prior to removing or installing a column.

12.8. Test for leaks after the installation of the column and whenever a leak is suspected. This should be done using a technique that will not damage or sacrifice the integrity of the instrument.

12.9. Depending on the detector, the effluent of the instrument may need to be vented or otherwise filtered, e.g. electron capture, mass spectrometer and other non-destructive detectors. Spot ventilation systems accomplish this.

12.10. Electron capture detectors (ECD) have a radioactive source These detectors are not to

be relocated or discarded without permission from the Radiation Safety Officer.

12.11. Ensure that the instrument and gases are turned off, with the power cord disconnected prior to performing any maintenance.

13. HEATING BATHS

13.1. Heating baths are designed to heat materials to constant temperature. They may be filled with a variety of materials including water, mineral oil, sand, glycerin, paraffin or silicone oils, depending on the bath temperature required. Bath temperatures may range up to 300oC. The following are precautions for heating baths.

13.2. Locate on a stable surface, away from flammable and combustible materials including wood and paper.

13.3. Ensure bath has cooled before relocation.

13.4. Ensure baths are equipped with controls that will turn off the power if the temperature exceeds a preset limit.

13.5. Ensure that the thermostat is set well below the flash point of the heating liquid in use.

13.6. Equip with a non-mercury thermometer to allow a visual check of the bath temperature.

13.7. Do not fill over ⅔ full.

13.8. Take care to not allow water to get into oil baths as violent splattering may result.

13.9. Steams baths are often safe alternatives for heating because they provide a consistent temperature that will not exceed 100°C. However care must be taken to prevent scalding due to dermal exposure to the steam or steam lines.

13.10. Water baths are the most common bath found in the laboratory. When using a water bath:

13.10.1. Clean regularly; a disinfectant, such as a phenolic detergent, can be added to the water.

13.10.2. Avoid using sodium azide to prevent growth of microorganisms; sodium azide forms explosive compounds with some metals.

14. HIGH PERFORMANCE LIQUID CHROMATOGRAPHS

14.1. High performance liquid chromatography (HPLC) procedures often require handling of compressed gas (helium) and flammable and toxic solvents. Be sure that you are familiar with the use and handling of compressed gas cylinders. Refer to MSDSs or other reliable reference material. The following guidelines will assist in the safe operation of HPLCs.

14.2. Wear appropriate eye protection. Since the HPLC is operated at high pressures, it is possible for fittings to fail, resulting in a sudden release of solvent.

14.3. Use "elephant trunk" ventilating system above fraction collectors, especially with normal phase HPLC.

14.4. Inspect and empty the waste containers as required.

14.5. Ensure that waste collection vessels are vented.

14.6. Ensure secondary containment of waste containers.

14.7. Never clean a flow cell by forcing solvents through a syringe. Syringes under pressure can leak or rupture, resulting in sudden release of syringe contents.

14.8. High voltage and internal moving parts are present in the pump and autosampler. Switch off the electrical power and disconnect the power cord when performing routine maintenance.

15. MASS SPECTROMETERS

15.1. Mass spectrometers (MS) require the handling of compressed gases and flammable and toxic chemicals. Be sure that you are familiar with the use and handling of compressed gas cylinders. Familiarize yourself with the hazardous properties as well as recommended precautionary measures and handling instructions of any hazardous materials being used, by referring to MSDSs or other reliable reference material.

15.2. Avoid contact with heated parts while the mass spectrometer is in operation.

15.3. Inspect gas, pump, exhaust and drainage system tubing and connections before each use.

15.4. Ensure that pumps are vented outside the laboratory, as pump exhaust may contain traces of the samples being analyzed, solvents and reagent gas.

15.5. Used pump oil is to be handled as hazardous waste.

CHEMICALS

16. BENZENE

16.1. Hazards:

16.1.1. Benzene is a carcinogen (cancer-causing agent).

16.1.2. Very flammable. The pure material, and any solutions containing it, constitutes a fire risk.

16.2. Safe handling:

16.2.1. Benzene should NOT be used at all unless no safer alternatives are available.

16.2.2. If benzene must be used in an experiment, it should be handled at all stages in a fume cupboard.

16.2.3. Wear safety glasses and use protective gloves.

16.3. MSDS online:

16.3.1. All chemicals used within the chemistry labs have material data sheets (MSDS) available by accessing the MSDS online program on the classroom computer desk top.

17. COMPRESSED GASES

17.1. Compressed gases are inherently hazardous due to the high pressure inside the cylinders. Knocking over an unsecured, uncapped cylinder of compressed gas can break the cylinder valve and result in a rapid escape of high-pressure gas that can transform a cylinder into an uncontrollable rocket or pinwheel, causing serious injury and damage. Compressed gases may also have flammable, oxidizing, dangerously reactive, corrosive or toxic properties. Inert gases such as nitrogen, argon, helium and neon can displace air, reducing oxygen levels in poorly ventilated or restricted areas and causing asphyxiation.

Safe Handling and Transport of Gas Cylinders:

17.2. Return unlabeled cylinders unopened to the supplier. Colour coding does not provide sufficient identification.

17.3. When cylinders are not in use or are being transported, regulators are to be removed and the protective cap is to be attached.

17.4. A cylinder cart is to be used for transporting cylinders. Cylinders are to be chained or strapped to the cart.

17.5. Do not ride in an elevator with a gas cylinder. Elevators can be operated safely from the outside. Elevators may not have sufficient ventilation to maintain oxygen levels in the event of a gas leak.

17.6. Ensure that propane tanks designed for outdoor use are not stored or used indoors.

17.7. Label empty cylinders clearly with either “EMPTY” or “MT”.

17.8. Never bleed a cylinder completely empty. Leave a residual pressure of at least 25 psi to prevent contamination or “suck back”.

17.9. Do not lubricate regulators. The mixture of lubricant and oxidizing gases could be explosive.

17.10. Do not expose cylinders to high temperature extremes.

17.11. Do not force, lubricate or modify cylinder valves in any way.

17.12. Cylinders containing flammable gases are to be grounded to prevent accumulation of electrostatic charge.

17.13. Never expose skin or clothing to compressed gas flow as high velocity gas could penetrate the skin leading to serious injury.

17.14. To use a cylinder:

17.14.1. Ensure the pressure regulating valve (adjusting screw) is closed.

17.14.2. Open the cylinder valve slowly.

17.14.3. Open the pressure regulating valve to the desired pressure.

17.15. To shut off the gas:

17.15.1. Close the cylinder valve.

17.15.2. Open the pressure regulating valve to relieve the pressure.

Valves and Regulators

17.16. Verify that the regulator is appropriate for the gas being used and the pressure being delivered. Regulators are not universal and have to be chosen based on the gas and the cylinder in use. Compressed Gas Association (CGA) connector numbers must be the same on the regulator and cylinder valve.

17.17. Label all regulators appropriately and do not use regulators interchangeably with different gases.

17.18. Do not rely on the pressure gauge to indicate maximum pressure ratings; check the regulator's specifications.

17.19. Do not use adaptors or Teflon tape to attach regulators to gas cylinders. Regulator inlet connections are designed to fit the outlet connection of the cylinder valve of a particular gas. Gas tight connections are made using metal-to-metal seals and can be weakened or the lines plugged through the use of Teflon tape.

17.20. Cylinder valve connections on regulators are designed to minimize the chances of using the wrong regulator.

17.21. When tightening the regulator nut and hose connections, always use a cylinder wrench or other tightly fitting wrench. Do not use an oversized wrench, adjustable wrench, pliers or pipe wrench. These tools may damage the fittings and make it impossible to tighten them properly.

Leaks

17.22. Most leaks occur at the valve in the top of the cylinder and may involve the valve threads, valve stem, valve outlet, or pressure relief devices. Lab personnel should not attempt to repair leaking cylinders.

17.23. Where action can be taken without serious exposure to lab personnel:

17.23.1. Move the cylinder to an isolated, well-ventilated area (away from combustible materials if the cylinder contains a flammable or oxidizing gas).

17.23.2. Whenever a large or uncontrollable leak occurs, evacuate the area immediately and call 9-911 and ext. 5139

Storage of Gas Cylinders

17.24. Only cylinders in use may be located in research or teaching labs.

17.25. All cylinders must be secured to a wall, bench or fixed support using a chain or strap placed 2/3 high on the cylinder body. Cylinder stands may be used as an alternative to straps.

17.26. Cylinders should be strapped individually.

17.27. Do not store full and empty cylinders together.

17.28. Oxidizers and flammable gases should be stored in areas separated by at least 20 feet or by a non-combustible wall.

17.29. Cylinders should not be stored near radiators or other heat sources.

17.30. No part of a cylinder should be subjected to a temperature higher than 125o Celsius. A flame should never be permitted to come in contact with any part of a compressed gas cylinder.

17.31. Do not place cylinders where they may become part of an electric circuit.

17.32. Ensure that each cylinder is properly and prominently labeled as to its contents.

Segregation of Gas Cylinders

17.33. As with other chemical storage, certain compressed gases are incompatible with each other. The following system describes the segregation required for compressed gases:

COMPRESSED GAS CYLINDER SEGREGATION AND STORAGE PLAN

X = may not to be stored together
√ = ok to be stored together

	Flammable compressed gases	Oxidizing compressed gases	Non-flammable Toxic compressed gases	Non-flammable, Non-Toxic compressed gases
Flammable compressed gases	√	X	X	√
Oxidizing compressed gases	X	√	√	√
Non-flammable Toxic compressed gases	X	√	√	√
Non-flammable, Non-Toxic compressed gases	√	√	√	√

18. CORROSIVE

18.1. These materials have the ability to damage tissue at the site of contact.

Corrosive Liquids

18.2. Corrosive liquids can be particularly hazardous as they act rapidly upon contact. Examples of common corrosive liquids are:

18.2.1. Strong acids (chromic acid, hydrochloric acid, nitric acid, etc. Hydrofluoric acid may be fatal through inhalation, absorption or ingestion and causes extensive, deep and painful burns. Avoid use if possible.)

18.2.2. Strong bases (aqueous sodium hydroxide, potassium hydroxide, ammonia, etc.)

18.2.3. Strong oxidizing agents (peroxides, etc.)

Corrosive Solids

18.3. Inhalation of corrosive dusts presents a particular hazard as the point of contact and the injured tissue, which may belong to the lungs, is internal, creating significant damage that may be difficult to treat and heal. Examples of corrosive solids are lithium oxide, sodium sulphide and phenol, phosphorus pentoxide, calcium oxide, etc.

Corrosive Gases

18.4. Corrosive gases enter the body through inhalation as well as being readily absorbed through dissolution in skin and eye moisture. Typical examples are listed below:

18.4.1. Ammonia

18.4.2. Hydrogen chloride

18.4.3. Hydrogen fluoride – inhalation, absorption or ingestion may be fatal. Causes extensive, deep and painful burns. Avoid use if possible, however if its use is unavoidable, personnel are to be specifically trained in its use and emergency response procedures and have immediate access to calcium gluconate gel.

18.4.4. Formaldehyde

18.4.5. Bromine

18.4.6. Chlorine

18.4.7. Phosgene

18.4.8. Sulphur Dioxide

Use and Handling of Corrosives

18.5. Specific precautions to take when using or handling corrosive materials include the following:

18.6. Ensure that acids are always added to water and not vice versa.

18.7. Be prepared for heat generation upon diluting or dissolving in water.

18.8. Ensure that all work is completed in a chemical fume hood with adequate ventilation

18.9. Personal protective equipment is to include:

18.9.1. Labcoat,

18.9.2. Goggles,

18.9.3. Appropriate gloves, and

18.9.4. When working with volumes greater than 4 L, a synthetic rubber apron.

19. CRYOGENIC MATERIALS

19.1. Cryogenics are very low temperature materials such as dry ice (CO2(s)), liquefied air, nitrogen, helium, oxygen, argon and neon. The following hazards are associated with the use of cryogenics:

19.1.1. Asphyxiation due to displacement of oxygen (for materials other than liquefied air and oxygen),

19.1.2. Freezing and brittling of materials from extreme cold;

19.1.3. Frostbite,

19.1.4. Explosion due to pressure build-up, and

19.1.5. Condensation of oxygen and fuel such as hydrogen or hydrocarbons resulting in explosive mixtures.

The following are precautions for handling cryogenics:

19.1.6. Always handle these liquids carefully to avoid skin burns and frostbite. Exposure that may be too brief to affect the skin of the face or hands may damage delicate tissues, such as the eyes,

19.1.7. Protect skin and eyes from contact - wear eye protection and insulated gloves,

19.1.8. Wear safety goggles when breaking large pieces of dry ice or using mixtures of dry ice and solvent,

19.1.9. Wear a face shield when removing samples from storage dewars due to the possibility of rupture from pressure build-up,

19.1.10. Use and store in well-ventilated areas. Alarmed oxygen sensors may be required in areas where the volume of gas could result in the displacement of oxygen, thereby causing an asphyxiation hazard,

19.1.11. Keep away from sparks or flames,

19.1.12. Use materials resistant to embrittlement (e.g. rubber tubing),

19.1.13. Watches, rings, bracelets or other jewelry that could trap fluids against flesh, so should not be worn when handling cryogenic liquids,

19.1.14. Never store dry ice in a refrigerator/freezer (especially deep chest freezers). Dry ice will sublimate at -78°C and could asphyxiate the person opening the equipment,

19.1.15. Boiling and splashing always occur when charging or filling a warm container with cryogenic liquid or when inserting objects into these liquids. Perform these tasks slowly to minimize boiling and splashing. Use tongs to withdraw objects immersed in a cryogenic liquid, and

19.1.16. Cylinders and Dewars should not be filled to more than 80% of capacity, since expansion of gases during warming may cause excessive pressure build-up.

20. HIGHLY REACTIVE MATERIALS

20.1.1. Reactive materials are used for various purposes in the lab, often because of their reactive properties. Particular care must be taken to ensure the safe

handling, use and storage of these sensitive chemicals.

Water Reactives

20.1.2. The following situations may occur with water reactive chemicals on contact with water:

20.1.3. Liberation of heat (causing potential ignition of the chemical itself or nearby flammable material),

20.1.4. Release of flammable, toxic, or oxidizing gas,

20.1.5. Release of metal oxide fumes (applicable to water reactive metals), and

20.1.6. Formation of corrosive acids.

20.1.7. Care must be taken to ensure that water reactive chemicals are handled and stored away from sinks, water baths or other sources of moisture.

Examples of water reactive materials include:

Alkali metals including lithium, sodium and potassium	Alkylaluminums including triethylaluminum and Alkyllithiums
Silanes	Magnesium
Aluminum chloride	Phosphorus
Phosphorus pentachloride	Phosphorus pentasulphide
Ferrous sulphide	Maleic anhydride
Sodium borohydride	Acetyl chloride
Chlorosulphonic acid	Phosphoryl trichloride
Sulphur chloride	Sulphuryl chloride
Thionyl chloride	Titanium tetrachloride

21. Pyrophorics

21.1. Pyrophoric chemicals are those which ignite spontaneously upon contact with air. Pyrophorics must be handled within glove boxes and stored in such a way as to prevent exposure to air, e.g. storage under an inert gas or under kerosene.

Examples of pyrophorics include:

Boron	Chromium*
Calcium*	Diborane
Cobalt*	Diethylzinc
Dichloroborane	2-Furaldehyde
Iron*	Lead*

Manganese*	Nickel*
Phosphorus*	Phosphine
Cadmium*	Titanium*
Alkyllithiums	

*Finely divided metals form a pyrophoric hazard.

22. Organic Peroxides

21.2. Although inorganic peroxides can be hazardous, they are generally stable. However, they may generate peroxides in the presence of organic compounds, or can react violently in the presence of water. More hazardous are organic peroxides. Organic peroxides can violently explode when subjected to heat, friction, shock, spark, oxidizing and reducing agents or light. These compounds are very difficult to control in a fire due to their ability to generate their own oxygen upon combustion. They can seriously irritate the skin and eyes upon contact.

21.3. Special consideration should be taken when using any compounds that have the capability of forming peroxides. The following are compound types that can be expected to form peroxides upon prolonged exposure to light or air:

21.3.1. Ethers

21.3.2. Aldehydes, ketones

21.3.3. Compounds containing benzyllic, or allylic hydrogens

21.3.4. Compounds with a vinyl or vinylidene group

21.4. The following is a partial list of compounds that will form peroxides and create a significant peroxide hazard on concentration:

Acetal	p-Dioxane
Cumene	Divinyl acetylene
Cyclohexane	Ethylene glycol dimethyl ether
Cylclooctene	Isopropyl ether
Cyclopentane	Methyl acetylene
Cyclopentene	Methyl cyclopentane
Decahydronaphthalene (Decalin)	Methyl i-butyl ketone
Diacetylene	Tetrahydrofuran (THF)
Dicyclopentadiene	Tetrahydronaphthalene (Tetralin)
Diethylene glycol dimethyl ether (Diglyme)	Vinyl ethers
Diethyl ether	Vinylidene
Diisopropyl ether	Vinylidene chloride

21.5. Specific precautions to take when using, handling and storing peroxygen or peroxide-forming compounds include the following:

21.5.1. purchase and use only the minimum amount required,

21.5.2. mark the receipt date on the container,

21.5.3. mark the date the container was opened on the container,

21.5.4. dilute solutions with inert solvents such as aliphatic hydrocarbons. Avoid the use of aromatic solvents, such as toluene, which can initiate the decomposition of some peroxides,

21.5.5. avoid preparing peroxide solutions with volatile solvents as losses of solvent due to evaporation can cause unwanted concentration of peroxides,

21.5.6. dispense quantities as required. Do not return unused materials to stock container,

21.5.7. do not use metal spatulas,

21.5.8. do not use glass containers with ground glass or metal lids. Use polyethylene containers with screw cap lids,

21.5.9. store and use away from heat, ignition sources and light,

21.5.10.store at the lowest temperature that is above the freezing point of the solution and that will not affect the solubility of solution. This will minimize the rate of decomposition of the peroxides,

21.5.11.dispose after one month of the container being opened or if unopened, by the expiry date,

21.5.12.treat any visible solids around the cap or in the container of peroxygen or peroxide-forming liquids with extreme caution as they could be explosive,

21.5.13.ensure that solutions are free of peroxides before concentration using the tests described below,

21.5.14.if concentration is necessary, avoid evaporating to dryness, and

21.5.15.use a shield when evaporating or distilling any peroxide-forming compounds.

21.5.16. Commercially available peroxide test strips can be purchased from laboratory supply companies. These allow a simple and quick determination of whether peroxides are present in a solution.

21.5.17. Alternatively the following colourimetric test can be performed:

- Prepare a 5 % (w/v) potassium iodide or sodium iodide aqueous solution. (5 g of KI or NaI per 100 mL of water)
- Add a couple of drops of iodide solution prepared above to ~ 2 mL of glacial acetic acid.

- Add ~ 2 mL of the solution in question to the ~ 2 mL of glacial acetic acid/iodide solution.
- Yellow indicates a low concentration of peroxide (<0.01 %). Brown indicates a high/hazardous concentration of peroxide (> 0.01%).

21.5.18. Note that this test method should not be applied to solutions that may contain inorganic peroxides.

22. RECORDS/VERIFICATION OF UNDERSTANDING

22.1. Records:

22.1.1. Lab Inspection Records

22.1.2. Training Records

22.1.3. Incident Investigation Records

22.2. Verification of Understanding:

22.2.1. A training master log will be maintained by ….

23. SUMMARY OF CHANGES

Revision #	Date	Change (include section #)	Issued By
1	2014.03.10	NEW	OHS Officer