Laboratory Safety Manual including the Chemical Hygiene Plan

2015

PART I. LABORATORY SAFETY MANUAL

1.0 INTRODUCTION

1.1 The University of Notre Dame strives to make the research and teaching environment one in which hazards are known and the associated risks are minimized by proper procedures, protocols and equipment. It is the University's intention to protect the health and safety of students, employees and the public by providing access to information regarding the safe handling of chemicals and other hazards that are present in the workplace.

2.0 PURPOSE

2.1 This document provides key information on the practices and procedures that shall be implemented to maintain compliance with state, federal, and local regulations required for the use and storage of hazardous chemicals (Part II - Chemical Hygiene Plan) and other laboratory safety hazards (Part I – Laboratory Safety Manual). Part III – Laboratory Support and Emergency Personnel Responsibilities covers safety equipment and engineering control inspections.

3.0 SCOPE

3.1 This Laboratory Safety Manual applies to all personnel who work in Notre Dame laboratories that have chemical and/or physical hazards.

3.2 This Laboratory Safety Manual does not include specific requirements for work with radioactive materials, lasers or biological agents. Specific procedures for work with these materials are addressed via the University's Radiation Safety Manual and Biosafety Manual respectively.

4.0 RESPONSIBILITIES

4.1 Risk Management and Safety (RMS)

- 4.1.1 Acts as resource to lab personnel regarding Personal Protection Equipment (PPE).
- 4.1.2 Acts as a resource to review experimental setups for safety considerations.
- 4.1.3 Provides training as appropriate and acts as resource for Safety Coordinators, Principal Investigators, Principal Lab Contacts, Managers

and Supervisors, and safety committees concerning the requirements of the program and their responsibilities.

4.1.4 Conducts audits of laboratories, tracks corrections of deficiencies and validates laboratories as described in the Laboratory Integrated Safety Plan (LISP).

4.2 Principal Investigator (PI)

4.2.1 Successfully completes laboratory safety training if performing work in the lab. Work is defined as physically performing experiments or otherwise using laboratory equipment or materials, it further includes any active oversight, e.g., physically present in a lab providing direction for experimentations or other activities. It does not include providing advice or guidance while not present in the lab.

4.2.2 Responsible to comply with all federal, state, local and University regulations, guidelines and procedures.

4.2.3 Informs all employees and students that safety and health are highest priorities; and informs them about safety and health policies, rules, regulations and procedures, as well as their specific responsibilities, as determined by the Laboratory Safety Committee.

4.2.4 Sets expectations and requires that safety equipment, devices, personal protective equipment, and apparel are provided and maintained, and are properly used by individuals present in the laboratory, including those supervised by others.

- The expectation shall be set that individuals working under the PI or supervisor complete training and operate under the relevant expectations and requirements when present or using equipment in other laboratories.

4.2.5 Ensures lab specific training is provided to lab personnel as defined by the Local Safety Plan. Ensures this training is documented. (See Section 7.1.4.)

4.2.6 Ensures that any required lab specific Safety Protocols, as defined by the LISP, have been developed and approved by the Local Safety Committee and made available to laboratory personnel.

4.2.7 Ensures that there is a process for all laboratory personnel to be aware of the hazards of the operations in the lab.

4.2.8 Ensures notification is made to RMS and Facilities when structural changes in the laboratory are made.

4.3 Laboratory Worker

4.3.1 Is responsible for planning and conducting all operations in accordance with established chemical hygiene and safety procedures and developing good personal safety habits.
4.3.2 Successfully completes laboratory safety training.
4.3.3 Uses appropriate safe work practices, personal protective equipment and engineering controls at all times.
4.3.4 Promptly reports unsafe conditions to their supervisor, lab manager/principal lab contact, Department Safety Coordinator, or RMS as soon as any unsafe condition is noticed.
4.3.5 Is familiar of the location and use of all available emergency safety equipment.

5.0 RISK ASSESSMENT (See Appendix G)

5.1 Evaluate the potential hazards associated with the work to ensure safe practices are developed for the experimental work.
5.2 This includes hazards that may be posed by chemicals, biological and radioactive materials, equipment, physical hazards and conditions.

- Hazardous materials
- 4 Routes of exposure – inhalation, injection, ingestion, and skin absorption
- Physical hazards
- Equipment items
- Electrical Hazards
- Thermal Hazards

6.0 EMERGENCY PROCEDURES

6.1 Emergency Action Plans
6.1.1 Each department or unit shall (if necessary with the assistance of RMS):

- Identify designated assembly point(s) for evacuation.
- Identify designated severe weather assembly point(s).
- Develop procedures to account for department personnel upon evacuation.
- Identify any special needs regarding evacuation and work with Notre Dame Fire Department (NDFD) to develop a plan of action.
- Make available the emergency action plan to all lab personnel.

6.1.2 Principal Investigators shall train lab personnel on emergency evacuation and severe weather procedures and document the training.

6.1.3 Lab personnel shall:

- Become familiar with the emergency action plan for the laboratory and/or department.
- Notify the supervisor of any special needs that could impact evacuation or sheltering in place.
- Upon evacuation, check-in with department per department procedure.

6.2 Emergency Reporting Procedures

6.2.1 Notre Dame Security Police shall be called for all emergencies.

- FOR ALL EMERGENCIES DIAL 911 from campus phones or **DIAL 574-631-5555** from a cellular or off-campus phone.

6.2.2 When reporting an emergency, provide the following information:

- Location of emergency
- Name of victim, if any
- Name of caller
- Phone number of caller where caller can be reached during response
- Facts concerning the emergency (fire, accident, injury, etc.)

6.3 Injury Accidents

6.3.1 Report all injuries, no matter how minor, to supervisor or department safety coordinator.

6.3.2 If medical attention is required, report to appropriate medical facility or call 911 or 574-631-5555 (cell phone) for assistance.

6.4 Fires

6.4.1 Individuals are not required to fight fires; but those who choose to do so may fight small, incipient stage fires (no bigger than a wastepaper basket) as long as they have been trained in the proper use of fire extinguishers by NDFD.

- Call 911 before using the fire extinguisher and if possible activate the building fire alarm system.
- If you have been trained in the use of a fire extinguisher, fight the fire from a position where you can escape, only if you are confident that you will not be injured. Hands on Training can be requested by contacting NDFD at 631-6200.

6.4.2 Fire that is large or spreading:

- Activate the fire alarm to alert building occupants. Call 911.

- If possible, shut down any equipment that may add fuel to the fire.
- Do not turn off any hoods in the immediate area, as they will tend to keep the area free from smoke and fumes.

6.4.3 If evacuation is necessary:

- Close the door behind you to prevent the fire's spread.
- Evacuate the building and await the arrival of NDSP and NDFD. Be prepared to inform them of the exact location, details of the fire, and chemicals that are stored and used in the area.
- Do not re-enter the building until you are told to do so by NDFD.

6.5 Emergency Laboratory Contact Information Sign

6.5.1 Each lab shall post an Emergency Laboratory Contact Information Sign outside the lab on or near all entry doors.

6.5.2 The purpose of the Emergency Laboratory Contact Information sign is to provide an easily recognizable and consistent means of displaying essential information about the status and contents of laboratories, primarily for the benefit of emergency responders.

6.5.3 The sign is to be completed and posted on the outside of all doors leading into areas where there are potential hazards. Update the information on the signs as changes occur in the lab.

6.5.4 The sign can be downloaded from the RMS Laboratory Safety Website: Emergency Contact Sign.

7.0 LAB WORKER TRAINING

7.1 All laboratory personnel shall be trained on the hazards present in their work area. This may include but is not limited to Laboratory Fundamentals, PPE, radiation safety, laser/UV, and/or biosafety level 1-2.

7.1.1 Training is required prior to the start of laboratory work. Some topics require annual refresher training, e.g., Laboratory Fundamentals Safety Training. Reference Appendix D for the Laboratory Training Matrix and Needs Assessment. This includes training criteria and frequency.

7.1.2 Initial Laboratory Fundamentals Training is available online or provided by the Chemical Hygiene Officer or qualified designee.

7.1.3 The training shall include:

- Physical and health hazards of chemicals in the work area
- Handling of hazardous materials - acquisition to disposal
- Fire extinguisher training
- Personal protective equipment

- Interpretation of a Safety Data Sheet (SDS) and where to find SDSs
- Engineering controls
- Emergency procedures
- Personal hygiene
- Location, availability and contents of the written Chemical Hygiene Plan
- Signs and symptoms associated with exposure associated to hazardous chemicals used in the laboratory

7.1.4 PIs or qualified designees are required to provide lab specific training when personnel start working and any time there is a change of work that introduces a new hazard. This training shall be documented and records maintained by the PI or department.

7.2 Training Needs Assessment/Training Matrix

7.2.1 The PI or designee shall develop a training needs assessment for each lab member. See Appendix D for a Sample Training Needs Assessment/Training Matrix.

7.2.2 A current Training Needs Assessment shall be maintained for each lab member by the PI.

7.2.3 This training needs assessment shall be reviewed annually by the PI or designee.

7.3 Training Records

7.3.1 Lab Specific training records shall be maintained per the University Record Retention requirements.

- These records may be retained electronically or in hard copy format.

8.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

8.1 Purpose

8.1.1 Use of Personal Protective Equipment (PPE) is to protect employees from risk of injury or death by creating a barrier against workplace hazards.

8.1.2 Personal protective equipment is not a substitute for good engineering or administrative controls or good work practices, but shall be used in conjunction with these controls to ensure the safety and health of employees.

8.2 Minimum PPE when personnel are in Notre Dame laboratories with hazards include the following:

8.2.1 Eye protection – This includes safety glasses, goggles, or face shield meeting the rating standards of ANSI Z87.1 1989. The ANSI designation shall be imprinted on the equipment by the manufacturer.

8.2.2 Long pants or skirt (to the ankle).

8.2.3 Shirts with the equivalent or greater coverage of a T-shirt.

8.2.4 Closed-toe/closed-heel/hard sole shoes.

8.2.5 Minimum PPE requirements may be downgraded to remove eye protection when all eye hazards (chemical/physical) are eliminated and this is documented on the PPE hazard assessment (Section 8.3.2).

8.3 General PPE Requirements

8.3.1 PI or designee shall perform an annual PPE assessment for their laboratory.

8.3.2 PI shall ensure that all required PPE is readily available to researchers and that all PPE is properly used in the laboratory. The PPE Assessment tool shall be used. See Appendix E.

8.3.3 Lab personnel shall be informed of required PPE and trained on the use of all lab required PPE.

- All lab personnel shall sign a PPE certification form initially and when changes occur.
- The PPE Assessment and Certification documents shall be maintained by the laboratory PI as per the University of Notre Dame's records retention requirements.
- Additional information can be obtained by reviewing the OSHA Personal Protective Equipment Standard, 29 CFR § 1910.132.

8.4 Eye Protection

8.4.1 Safety glasses and chemical splash goggles shall comply with ANSI Occupational and Educational Eye and Face Protection Standard (Z87.1).

8.4.2 Standard eyeglasses without side shields do not meet ANSI standards and shall not be used as safety eyewear.

8.4.3 Safety glasses, goggles, or face shields shall always be worn when eye hazards are present.

8.4.4 Students and visitors shall be provided with eye protection before entering a laboratory.

8.4.5 When performing activities such as using a microscope, safety glasses do not have to be worn.

8.4.6 Chemical Splash Goggles shall be used when a chemical splash hazard exists.

- Goggles can be worn over regular eyeglasses.
- Goggles equipped with indirect vents are recommended to prevent fogging. Direct venting goggles shall not be used where there is a chemical splash hazard.
- Face shields shall be worn when maximum protection from flying particles and harmful liquids is necessary. These shall be used in conjunction with goggles or safety glasses. Face shields shall meet ANSI Z87.1.

8.5 Hand Protection

8.5.1 Skin contact with chemicals may result in irritation, burns, or absorption of the chemical into the blood stream.

8.5.2 Appropriate gloves for the hazardous material shall be used.

- Refer to Glove Compatibility Chart to determine the appropriate chemical glove type to use.
- Use thermal gloves for heat or cryogenic work e.g. dry ice transfer.

8.5.3 Proper use of gloves

- Gloves shall be changed any time the integrity of the glove is compromised.
- Disposable gloves shall not be reused.
- Gloves shall be removed prior to handling non-contaminated objects such as telephone or door knobs.
- Gloves shall be removed prior to leaving the laboratory.

8.6 Body Protection

8.6.1 When working with chemicals, a lab coat or chemical resistant apron shall be worn.

8.6.2 When working with pyrophoric materials and under some circumstances, flammable materials, a fire resistant lab coat is required. See Appendix F for details.

8.6.3 Lab coats shall be stored away from personal clothing.

8.6.4 Cleaning of lab coats

- Lab coats shall not be taken home or other non-commercial launder mat to clean.
- Labs shall establish a process for proper cleaning through St. Michael's Laundry or other service.

8.7 Foot Protection

8.7.1 Closed-toed/Closed heeled/hard soled shoes shall be worn at all times in labs where chemical or physical hazards are present. Perforated shoes, flip-flops, ballerina flats, sandals or cloth sneakers shall not be worn in laboratories or where mechanical work is conducted.

8.7.2 Chemical resistant overshoes or boots may be used to avoid possible exposure to corrosive chemical or large quantities of solvents or water that might penetrate normal footwear (e.g., during spill cleanup). Leather shoes tend to absorb chemicals and may have to be discarded if contaminated with a hazardous material.

8.7.3 Protective foot wear (steel-toed, electric hazard, etc.) shall be used when working in areas where there is a danger of foot injuries due to falling or rolling objects or objects piercing the sole, and where feet are exposed to electrical hazards. Protective footwear shall comply with one of the following consensus standards: ASTM F-2412 or ANSI Z41.

8.8 Respirators

8.8.1 When chemical substitution and effective engineering controls are not possible, respirators may be necessary.

8.8.2 The OSHA Respiratory Protection Standard at 29 CFR 1910.134 shall be complied with for all personnel who are required or volunteer to wear a respirator. See the University's Respiratory Protection Program.

8.8.3 RMS shall be contacted before purchasing or using respiratory protection.

8.8.4 Dust masks may require participation in the Respiratory Protection Program although it may be limited.

- When selecting a dust masks for the first time, consult with RMS to determine what level of participation in the respiratory protection policy is required.
- Minimally the University's Respiratory Protection Program's Appendix E "Information to Employees Who Wear Respirators for Voluntary Use" form shall be signed and returned to RMS.

8.9 Hearing protection

8.9.1 Hearing protection is required in high (>85 dBA) noise areas.

8.9.2 Use appropriate protection such as ear muffs or ear plugs when exposed to high noise levels. Consult RMS.

8.9.3 Contact RMS where there are concerns about the noise level in the area.

9.0 EMERGENCY EQUIPMENT

9.1 Fire extinguishers

9.1.1 Fire extinguishers shall be provided within 30 feet of travel and located along normal paths of travel.

9.1.2 Access shall be maintained and the location shall be conspicuously marked.

9.1.3 The fire extinguisher type and size shall be selected for the appropriate hazards. If the lab does not have a fire extinguisher and one is needed, contact NDFD for type and size.

9.1.4 There are several types of fire extinguishers available.

- Class A - use for ordinary combustible materials such as paper, wood, cardboard, and most plastics.
- Class B - use with fires that involve flammable or combustible liquids such as gasoline, kerosene, grease and oil.
- Class C -use with fires that involve electrical equipment, such as appliances, wiring, circuit breakers and outlets.
- Never use water to extinguish class C fires. The risk of electrical shock is far too great!
- Combination fire extinguishers
  - ABC for any Class A, B or C type fire.
  - BC for fires involving flammable liquids or electrical equipment.
- Class D – use with fires that involve combustible metals, such as magnesium, titanium, potassium and sodium.

9.2 Fire Alarms

9.2.1 Fire alarms shall be provided along normal paths of travel, along exit routes.

9.3 Safety Showers and Eyewashes

9.3.1 A highly visible sign shall be installed near the safety showers and eyewashes.

9.3.2 Location:

- All of the units shall be within 10 seconds of hazard. For strong corrosives, eyewash shall be immediately adjacent.
- All of the travel path to the units shall be free of obstructions. Example: A doorway prohibiting immediate use of equipment is not permitted.

9.3.3 Inspections

- Lab personnel conduct inspections:
  - Eyewashes – monthly to ensure flow, eye pieces covered and not blocked. These inspections shall be documented.
  - Safety showers – monthly to ensure access is not blocked.

9.3.4 Reporting a problem

- It is the responsibility of the PI or their designee to initiate a work order for any safety shower or eyewash that is not properly working and to follow-up on the work orders. If the safety shower or eyewash is not functioning, immediately contact the departmental safety coordinator and RMS.

10.0 GENERAL SAFETY PROCEDURES

10.1 All mechanical equipment shall have adequate guarding.

10.2 Use mechanical pipetters or aspirators.

10.3 Housekeeping

10.3.1 Work areas shall be kept clean and free from obstructions.

10.3.2 Aisles shall be clear and at least 28 inches wide (minimum). Aisles shall be at least 36 inches wide in high traffic or high hazard areas.

10.3.3 Items > 15lbs shall not be stored above 6 ft. Nothing shall be stored on top of refrigerators or freezers.

10.3.4 A stepstool or ladder shall be available to retrieve items that are not stored within arm's reach.

10.3.5 Emergency exits shall be kept unlocked from the inside.

10.3.6 Labs that have humidifiers to maintain desired atmospheric conditions shall develop a process to clean the humidifiers per manufacturer's specifications or at least annually.

10.4 Hygiene

10.4.1 Eating and drinking is prohibited in the laboratory when hazardous materials are present.

10.4.2 Long hair and loose clothing shall be confined.

10.4.3 The application of makeup, including lip balm, shall be prohibited in the laboratory when hazardous materials are present.

11.0 ELECTRICAL SAFETY

11.1 All wiring shall be completed by a qualified electrician.

11.2 Equipment with frayed or exposed wiring shall not be used.

11.3 Cords should be kept out of work areas. If this situation is unavoidable, cords must be secured to the floor with tape, cord molding, or protection strips.

11.4 Wires shall not be stretched across other equipment.

11.5 Personnel should know location of circuit breakers.

11.6 Extension cords shall not be used as a substitute for fixed or permanent wiring.

- 11.6.1 Extension cords may be used for temporary applications only. "Temporary" generally means associated with a one-time job or with a transient condition (less than 90 days).
- 11.6.2 Permanent wiring shall be installed for long-term or repetitive needs. An extension cord may be used while awaiting permanent wiring.
- 11.6.3 Extension cords may not be daisy-chained (one extension cord plugged into another extension cord).
- 11.6.4 Damaged extension cords shall be replaced. They shall not be spliced or repaired with electrical tape.
- 11.6.5 All temporary cords shall bear the approval marking of UL. Look for the UL® Mark or equivalent safety standard listing on extension cords. This means that representative samples of the cord have been tested for foreseeable safety hazards for their intended purpose.
- 11.6.6 Extension cords are to be unplugged when not in use.

12.0 UNATTENDED OPERATIONS

12.1 Lab personnel shall consult with the Principal Investigator if planning to run an unattended operation.

12.2 Caution is to be used for unattended operations:

- 12.2.1 A sign shall be posted on the lab door to communicate appropriate warnings and precautions. Unattended operation sign is available for download at the RMS Laboratory Safety Website.
- 12.2.2 Potential equipment and facility failures should be anticipated, and containment provided for release of hazardous chemicals.
- 12.2.3 All reaction vessels or hood sash shall be labeled with the contents.

13.0 LABORATORY SECURITY

13.1 Laboratories shall be closed and locked when no one is present or within eyesight.

13.2 Unknown persons should not be permitted into a secure area.

13.3 NDSP at 911 or 574-631-5555 shall be contacted if:
- 13.3.1 Suspicious persons are seen in or around laboratories.
- 13.3.2 Unusual events are seen or discovered.
- 13.3.3 If items are discovered missing from the laboratory.

14.0 GLASSWARE

14.1 Inspect all glassware for defects and cracks. Weak glass can cause severe accidents through cuts, leaking hazardous chemicals or imploding under vacuum.

14.2 Always use lubricant when inserting glass tubing or glass thermometers into rubber stoppers.

14.3 Fire polish all cut glass tubing and rods.

14.4 Vacuum distillations or evaporations shall be shielded in case of implosion. Only round-bottom flasks shall be used for vacuum distillations. Erlenmeyer flasks may implode.

14.5 Exercise care in removing frozen glass stoppers.
- 14.5.1 First try soaking glass stopper in hot water to expand the glass.
- 14.5.2 Slowly apply minimal pressure with the thumbs working around the glass stopper.
- 14.5.3 If it is necessary to remove the stopper by tapping, wrap the stopper in a cloth or paper towel and protect your hands with gloves in case of breakage

15.0 INSTRUMENTS

15.1 Never attempt to operate a machine or instrument until you have been properly instructed in its use.

15.2 Keep the area around instruments and equipment clear of obstructing materials.

15.3 All belt driven equipment shall have a belt guard to prevent hands and clothing from being pulled between belt and pulley (i.e. vacuum pumps).

15.4 Equipment with frayed electrical cords shall be repaired before use.

15.5 Do not leave oil and boiling water baths unattended. Take precautions to contain any hot oil and water spills.

16.0 SHARPS

16.1 Sharps include: razor blades, syringes, needles, scalpel blades, and Pasteur pipettes.

16.2 Eliminate the use of sharps whenever possible.

16.3 Use needles with self-storing sheaths or those designed to protect the user.

16.4 Always keep sharps in view and open one needle at a time.

16.5 Use appropriate gloves.

16.6 Never bend, shear, or break disposable needles or remove from disposable syringes.

16.7 Do not recap needles. If absolutely necessary to recap, use the one hand method.

16.8 Sharps Disposal

16.8.1 Dispose of the sharps immediately in appropriate sharps containers.
16.8.2 Place disposal container close to work area.
16.8.3 Do not reach into the sharps disposal container
16.8.4 Do not remove the lid from the sharps disposal container.
16.8.5 Do not overfill the sharps container.
16.8.6 Consult Infectious Waste Guidelines for proper disposal of sharps/sharps containers.

17.0 REFRIGERATORS AND FREEZERS

17.1 The potential hazards posed by laboratory refrigerators and freezers involve vapors from the contents, the possible presence of "incompatible chemicals and spillage".

17.2 All refrigerators shall be labeled "No Food or Drink" or "No Food or Drink to be Stored in this Refrigerator" or "Refrigerator for Food Only" are available on the RMS Laboratory Safety website.

17.3 Only refrigerators and freezers specified for laboratory use shall be utilized for the storage of chemicals.

17.3.1 These refrigerators have been constructed with special design factors, such as heavy-duty cords and corrosion resistant interiors to help reduce the risk of fire or explosions in the lab.

17.3.2 Standard refrigerators have electrical fans and motors that make them potential ignition sources for flammable vapors.

17.3.3 Flammable liquid-approved refrigerators are designed with spark-producing parts on the outside to avoid accidental ignition. If refrigeration is needed inside a flammable-storage room, use of an explosion-proof refrigerator is required. Flammable liquids shall not be stored in a domestic refrigerator.

17.3.4 Frost-free refrigerators are not recommended in laboratories because:

- Many of them have a drain or tube or hole that carries water and possibly any spilled materials to an area near the compressor that may spark.
- Electric heaters used to defrost the freezing coils can also spark.

17.4 All materials in refrigerators or freezers shall be labeled with the contents, date of opening (if time sensitive) and nature of any potential hazard.

17.4.1 Since refrigerators are often used for storage of large quantities of small vials and test tubes, a reference to a list outside of the refrigerator could be used.

17.4.2 Labels and ink used to identify materials in the refrigerators shall be water-resistant.

17.5 Container storage

17.5.1 All containers shall be sealed, preferably with a cap and placed in secondary containers, or catch pans shall be used.

17.5.2 Chemicals shall not be stored on their sides.

17.5.3 Lab refrigerators shall not be used for food storage or preparation.

17.6 Loss of electrical power can produce extremely hazardous situations.

17.6.1 Flammable or toxic vapors may be released from refrigerators and freezers as chemicals warm up and/or certain reactive materials may decompose energetically upon warming.

17.6.2 Proactive planning can avoid product loss and hazardous situations in event of an extended power outage.

17.6.3 Dry ice or alternate power sources can be used to prevent refrigerator and freezer contents from warming.

18.0 LOCK-OUT/TAG-OUT

18.1 To ensure that no unexpected energization, start-up or release of stored energy occurs during routine maintenance and servicing of machines and equipment, the equipment shall be locked-out. Laboratory personnel who conduct such work shall be required to take Lock-Out/Tag-out Safety training as specified in the Lock-Out/Tag-Out Policy.

PART II. CHEMICAL HYGIENE PLAN

19.0 INTRODUCTION FOR PART II

19.1 To assist academic institutions and businesses in enhancing the safety of laboratory personnel, the Occupational Safety and Health Administration (OSHA) published standard 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" (OSHA Laboratory Standard).

19.2 The OSHA Laboratory Standard's intent is to ensure that laboratory personnel are apprised of the hazards of the chemicals in their work area, and that appropriate work practices and procedures are in place to protect laboratory personnel from chemical health and safety hazards. This information is required to be documented in a Chemical Hygiene Plan.

20.0 SCOPE

20.1 This Chemical Hygiene Plan applies to all personnel who work in Notre Dame laboratories who handle and/or may be exposed to hazardous chemicals and other hazards in research and teaching laboratories.

21.0 RESPONSIBILITIES UNDER THE CHEMICAL HYGIENE PLAN (CHP)

21.1 Risk Management and Safety (RMS)

21.1.1 Acts as resource to lab personnel regarding safe handling of chemicals, personal protective equipment (PPE), spill cleanup, and safety for experimental set-ups.

21.1.2 Provides training as appropriate and act as resource for Safety Coordinators, PIs, Managers and Supervisors, and safety committees concerning the requirements of the program and their responsibilities.

21.2 The Chemical Hygiene Officer (Lisa Phillips, 574-574-631-5037 or email Lisa Phillips)

21.2.1 Works with Safety Coordinators and laboratory contacts to develop and implement chemical hygiene practices and policies in the laboratories as needed.

21.2.2 Aids in determining the proper level of PPE required in a laboratory.

21.2.3 Ensures that appropriate training is available to laboratory personnel.

21.2.4 Provides environmental monitoring when exposure levels may exceed regulatory limits.

21.2.5 Approves the procurement of DHS Select Agents to ensure that facilities and training is adequate for the chemicals requested.

21.2.6 Stays up to date on legal requirements concerning regulated substances in the laboratory.

21.2.7 Reviews the CHP annually to ensure that it is up to date with applicable regulatory requirements.

21.3 The Institutional Biosafety Committee (IBC)

21.3.1 Reviews grant proposals with regard to DHS Select Agents or hazardous materials use.

21.3.2 Reviews reports on non-compliance with these regulations with personnel involved and if necessary take administrative action to ensure the provisions of these regulations are met.

21.4 Principal Investigator

21.4.1 Responsible for chemical hygiene in his/her laboratory(ies).

21.4.2 Monitors and approves the procurement, use and disposal of chemicals used in the laboratory.

21.4.3 Informs all employees and students that safety and health are priorities; and inform them about safety and health policies, rules, regulations and procedures, as well as their specific responsibilities, as determined by the LSC.

21.4.4 Ensures lab specific training is provided to lab personnel as required and made available to them. Ensures this training is documented. See Section 7.

21.4.5 Ensures lab specific Safety Protocols, as defined by the LISP, have been developed and approved by the Department Safety Committee and made available to laboratory personnel.

21.4.6 Ensures there is a chemical inventory available (hard copy or electronic) of chemicals in his/her lab and ensures it is available.
21.4.7 Assigns the designated area(s) for use with select agents and/or carcinogens in his/her laboratory as appropriate.

21.5 Laboratory Worker
21.5.1 Is responsible for planning and conducting all operations in accordance with established chemical hygiene procedures and developing good personal chemical hygiene habits.
21.5.2 Successfully completes laboratory safety training.
21.5.3 Is aware of the hazards of the chemicals they are working around or with, and safe storage, handling and disposal procedures.
21.5.4 Uses appropriate safe work practices, personal protective equipment and engineering controls.
21.5.5 Follows departmental and laboratory SOPs.
21.5.6 Reports unsafe conditions/incidents to their PI, Lab Manager/Principal Lab Contact, Department Safety Coordinator, or RMS.

22.0 CHEMICAL AND HAZARD IDENTIFICATION

22.1 Chemical Manufacturer Safety Information
22.1.1 Includes physical and health hazard information and is provided in the chemical label and the Safety Data Sheet.

22.2 Labels
22.2.1 The manufacturer's label shall be kept intact.
22.2.2 Do not intentionally deface or obscure the label or the hazard warnings until the container has been completely emptied.
22.2.3 When a chemical is transferred from the original container into a secondary container for storage, the new container shall be labeled with the name of the product, the chemical concentration if applicable and the primary hazard warnings.
22.2.4 Hazard warning labels can be downloaded from RMS Laboratory Safety website.

22.3 Safety Data Sheets (formerly known as Material Safety Data Sheets – MSDS)
22.3.1 SDS's shall be maintained by the laboratory if received. They may be maintained electronically.
22.3.2 SDSs are sometimes difficult to interpret. For more information about understanding and using an SDS, see the OSHA's Quick Card on Hazard

Communication Safety Data Sheets OSHA SDS, OSHA Labeling and Pictograms

22.3.3 If an SDS is not on hand, check the RMS web page for SDSs for connections to on-line sources of SDSs. If the SDS cannot be found, contact the manufacturer or distributor at the number listed on the container label and request an SDS. If the manufacturer does not provide one within a few days or you don't have manufacturer information, contact RMS @ 574-631-5037 for assistance.

23.0 CHEMICAL PROCUREMENT, INVENTORIES, STORAGE, HANDLING AND DISPOSAL

23.1 Procurement

23.1.1 All CDC Select Agents shall have the approval of the Institutional Biosafety Committee (IBC) or designee prior to use.

- Prior to use, an IBC Hazardous/Infectious Materials Document shall be submitted to the IBC.
- Proper storage and handling procedures shall be identified.
- Adequate facilities to safely handle the material and designated area for carcinogen use in the laboratory shall be established.

23.1.2 A safety data sheet (SDS) shall be requested for all hazardous chemicals if the SDS is not available online.

23.1.3 No container shall be accepted without an adequate identifying label.

23.1.4 The label shall include as a minimum the substance name, appropriate hazard warning, and precautionary measures.

23.1.5 Bulk quantity chemicals that are subdivided shall be placed in containers that are labeled with the minimum information as stated above.

23.1.6 For procurement of radioactive materials consult the Radiation Safety Manual.

23.2 Inventory

23.2.1 Each Principal Investigator shall ensure a chemical inventory is maintained and updated annually. The inventory shall include all chemicals in his/her laboratory(ies). Specifically, the inventory shall:

- Note the location of the chemical (minimally this shall include the building name and lab number).
- The name of chemical and synonyms (if referenced in the lab) and if needed, any other information that reveals the precise chemical designation and composition of the substance.
- The approximate quantity of the chemical.

23.2.2 A copy shall be available (hard copy or electronic) when requested by RMS or a regulatory representative.

23.3 Chemical Storage

23.3.1 Hazardous chemicals and liquids shall be stored below 6 feet.

23.3.2 Chemicals shall not be stored on hard-to-reach shelves or in hard to reach cupboards.

23.3.3 Chemicals shall be placed on shelving or in cabinets with labels facing forward. Labels shall be readable and in English.

23.3.4 Best practice recommends that chemical shelves be made of a chemically resistant material.

23.3.5 Consult SDS for storage recommendations.

23.3.6 Whenever possible, chemicals shall be segregated by hazard class. Consult Appendix C and the list of Common Incompatible Chemicals for storage options.

23.3.7 Avoid stockpiling chemicals.

- Purchase only what is needed.
- Use older stock first.
- Discard chemicals, which are no longer needed or that have expired.
- Consult Safe Handling of Time Sensitive Chemicals for additional information on expiration time frames.

23.3.8 Hallways shall not be used as storage areas for chemicals.

23.3.9 Following best practice, ventilation hoods shall not be used for storage of chemicals, unless they are part of the experiment being conducted in the ventilation hood at that time. The exception is storage in a ventilation hood that is specifically designed for that purpose and experimental procedures are not being conducted.

23.4 Chemical Handling

23.4.1 Prior to use, laboratory workers shall review the safety and health hazard data of all the chemicals that will be used. RMS SDS Webpage.

23.4.2 Close caps securely.

23.4.3 Never use unlabeled chemicals.

23.4.4 Never use expired chemicals.

23.4.5 Add acid or strong bases to water.

23.4.6 Labels (See Section 7.2):

- Be sure all labels are securely attached and legible. Keep chemicals in their original container if possible. Label all

secondary containers to avoid unknown chemicals and/or inadvertent reaction.

23.5 Transporting Chemicals

23.5.1 Use bottle carriers to transport chemicals between labs.

23.5.2 The preferred method to transport multiple chemicals between laboratories is on a clean cart.

23.5.3 The materials themselves shall be in sealed containers, clearly labeled with the content's name and applicable hazard(s). The cart should be leak-proof and have at least a 2 inch lip to prevent the container from sliding off and to contain any spills.

23.5.4 When loading a cart, the lower section shall be filled first. Chemicals shall be placed in the center of the cart to maintain balance.

23.5.5 The chemicals shall be kept in their shipping container until the chemicals reach the designated storage/use location.

23.5.6 If being carried by hand or transported on a cart that does not meet the recommendations above the container shall be sealed, clearly labeled as above, and packaged within ANOTHER tightly sealed, clean, leak-proof, shatter-proof container OR packaged as it was when first shipped to the laboratory.

23.6 Flammable Liquids

23.6.1 Flammable and combustible liquids vaporize and form flammable mixtures with air when in open containers, when leaks occur, or when heated.

23.6.2 To control these potential hazards, several properties of these materials, such as volatility, flashpoint, flammable range and auto ignition temperatures shall be understood.

23.6.3 An explanation of these terms and other properties of flammable liquids are available in the Laboratory Flammable/Combustible Liquid & Compressed Gas Handling/Storage Procedure.

23.6.4 Information on the properties of a specific liquid can be found in that liquids safety data sheet (SDS), or other reference material.

23.6.5 Review the List of flammables and combustibles by class to assist with storage compliance.

23.7 Spill Response

23.7.1 Laboratories are required to have appropriate spill response materials for the types of chemicals that they work with.

23.7.2 Lab personnel shall clean up spills within the lab if it is safe to do so:

- Spill is small enough for lab personnel to handle.

- Lab personnel have appropriate PPE.
- Lab personnel know what the chemical is.

23.7.3 If laboratory personnel cannot clean up the spill, call 911 or 574-631-5555 (Cell phone) for emergency response assistance.

23.8 Chemical Disposal Procedures

23.8.1 Waste Containers:

- All waste containers shall be labeled with the chemical name or constituents, percentage of chemicals if mixture, and the word Waste or Hazardous Waste (e.g. Waste Acetone, Waste mixed acids, Hazardous Waste Mixed Solvents 10% halogenated).
- Chemical containers must be covered/closed at all times unless directly adding waste. (Open funnels cannot rest in open bottles.)
- Waste containers shall not be stored in the sink.
- Waste containers stored on the floor shall be placed in secondary containment.
- Prior to pick up by RMS for disposal, chemicals containers must be labeled with a properly completed chemical discard tag.

23.8.2 Waste Pick Schedule

23.8.3 For additional information, chemical disposal procedures in the Hazardous Waste Procedure located on the RMS Laboratory Safety Website.

24.0 COMPRESSED GAS CYLINDERS

24.1 Types of Compressed gases

24.1.1 Compressed gases are usually divided into six basic categories, with some gases falling into more than one classification. The categories are as follows:

- Flammable Gases
- Oxygen and Oxidizing Gases
- Acid and Alkaline Gases
- Highly Toxic Gases
- Cryogenic Liquefied Gases
- Inert Gases

24.2 Handling and Storage Gas Cylinders

24.2.1 Laboratory Flammable/Combustible Liquid & Compressed Gas Handling/Storage Procedure for more information.

24.3 Leaking Cylinders

24.3.1 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.

24.3.2 Lab personnel shall not attempt to repair leaking cylinders.

24.3.3 Where action can be taken without serious exposure to lab personnel move the cylinder to an isolated, well-ventilated area (away from combustibles if the cylinder contains flammable or oxidizing gas).

24.3.4 Whenever a large or uncontrollable leak occurs, evacuate the area and immediately contact NDSP at 911from a campus phone or 574-631-5555 from a cell phone.

24.4 Empty Cylinders

24.4.1 Remove the regulator and replace the cylinder cap.

24.4.2 Mark the cylinder as "empty" or "MT" and store in a designated area for return to the supplier.

24.4.3 Do not store full and empty cylinders together.

24.4.4 Do not have full and empty cylinders connected to the same manifold. Reverse flow can occur when an empty cylinder is attached to a pressurized system.

24.4.5 Do not refill empty cylinders. Only the cylinder supplier shall refill gases.

24.4.6 Lecture bottles, if non-returnable, shall be disposed of through RMS.

25.0 GENERAL PRINCIPLES FOR CONTROLLING CHEMICAL EXPOSURES

25.1 The hierarchy of hazard controls includes:

25.1.1 Elimination (including substitution): remove the hazard from the workplace.

25.1.2 Engineering controls include designs or modifications to equipment, ventilation systems, and processes that reduce the potential for exposure.

25.1.3 Administrative controls alter the way the work is done, including timing of work, policies and other rules, and work practices such as standards and operating procedures.

25.1.4 Personal protective equipment is worn by individuals to reduce exposure such as contact with chemicals or exposure to noise.

25.2 Engineering Controls

25.2.1 The use of engineering controls is the preferred method for reducing worker exposure to hazardous chemicals. Examples include but not limited to:

- Isolation or enclosure of a process or operation.
- Use of wet methods to reduce generation of dusts or other particulates.
- General dilution ventilation.
- Local exhaust, including the use of ventilation hoods and glove boxes.

25.2.2 Evaluation of control measures

- Air sampling for evaluating exposure to chemical substances shall be conducted periodically or as required by regulation.
- Air sampling shall be conducted if there is reason to believe that exposure levels for regulated substances exceed the action level, or in the absence of an action level, the permissible exposure level (PEL).
- The PEL is a legal limit in the United States for exposure of an employee to a chemical substance or physical agent. For chemicals, the chemical regulation is usually expressed in parts per million (ppm), or sometimes in milligrams per cubic meter (mg/m3).
- The University follows the ACIGH or most restrictive established limit.
- Results of any air sampling studies shall be communicated with the affected laboratory, unit and/or department and records shall be maintained by RMS.

25.3 Work Practice and Administrative Controls

25.3.1 Using good laboratory work practices help to eliminate the risk of exposure to chemicals. Examples include but are not limited to:

- Limit access to lab when hazardous work is being conducted.
- Training of lab personnel.
- Administrative controls involve rotating job assignments and adjusting work schedules so that workers are not overexposed to a chemical.
- Administrative controls can be used in conjunction with engineering controls and PPE controls to minimize exposures.

25.4 Personal Protective Equipment (PPE)

25.4.1 When engineering and administrative controls are not feasible to minimize exposure, personal protective equipment, including gloves, eye protection, respirators and other protective clothing shall be used. See Section 8 - Personal Protective Equipment for more information.

25.4.2 Hygiene Practices shall be used to reduce the likelihood of accident or chemical exposure. Hands shall be washed:

- After removing gloves.
- Before leaving the laboratory area as soon as reasonably possible.

26.0 VENTILATION HOODS AND LABORATORY VENTILTATION

26.1 Best practice determines hood face velocity to be 80-100 linear feet per minute for safe operation.

26.2 Necessity of chemical ventilation hoods.

26.2.1 A ventilation hood is used to control exposure of the hood user and lab occupants to hazardous or odorous chemicals and prevent their release into the laboratory.

26.2.2 A secondary purpose is to limit the effects of a spill by partially enclosing the work area and drawing air into the enclosure by means of an exhaust fan. This inward flow of air creates a dynamic barrier that minimizes the movement of material out of the hood and into the lab.

26.2.3 In a well-designed, properly functioning ventilation hood, only about 0.0001% to 0.001% of the material released into the air within the hood escapes from the hood and enters the laboratory.

26.2.4 The determination that a ventilation hood is necessary for a particular experiment shall be based on a hazard analysis of the planned work. This includes:

- A review of the physical characteristics, quantity and toxicity of the materials to be used;
- The experimental procedure;
- The volatility of the materials present during the experiment;
- The probability of their release; and
- The number and sophistication of manipulations.

26.3 Good work practices

26.3.1 A check of the hood survey sticker to determine where the sash be positioned for optimum containment shall be performed whenever feasible.

26.3.2 Adequate planning and preparation are important. The hood user shall design experiments so that sash position is maintained whenever hazardous materials might be released.

26.3.3 The hood user shall check the magnehelic gauge if available or other hood performance indicator and compare its reading to the reading indicated on the hood survey sticker.

- The red pointer indicates the pressure in the exhaust duct for the fume hood. Check to see that the pointer meets or is past the signal flag or target that indicates sufficient exhaust pressure in the duct and inflow at the face of the fume hood when the sashes are in the proper position.
- If the reading differs significantly from that on the sticker, the hood may not be operating properly. If the arrow is below the target there could be a mechanical problem, and the hood should not be used with hazardous materials; contact the building manager or Maintenance to verify if the exhaust system is working properly.
- It is recommended to use a visual indicator to verify that the hood airflow is inward. A tissue or Kimwipe taped to the sash or inside the hood provides a qualitative indicator of direction of airflow.
- Items contaminated with odorous or hazardous materials shall be removed from the hood only after decontamination or if placed in a closed outer container to avoid releasing contaminants into the laboratory air.
- When using cylinders containing highly toxic or extremely odorous gases, obtain only the minimal practical quantity necessary for the experiment.
  - Consider using a flow-restricting orifice to limit the rate of release in the event of equipment failure.
  - In some circumstances, exhaust system control devices or emission monitoring in the exhaust stack may be appropriate.

26.4 To optimize the performance of the ventilation hood, it is recommended to adhere to the practices below:

26.4.1 Mark a line 6 inches behind the sash and keep all chemicals and equipment behind that line during experiments. This will help to keep materials from escaping the hood when disturbances like air currents

from people walking past the hood, etc., interfere with airflow at the face of the hood.

26.4.2 Provide catch basins for containers that could break or spill, to minimize the spread of spilled liquids.

26.4.3 Keep the sash completely lowered any time an experiment is in progress and the hood is unattended. Lowering the sash not only provides additional personal protection, but it also results in significant energy conservation.

26.4.4 Visually inspect the baffles (openings at the top and rear of the hood) to be sure that the slots are open and unobstructed.

26.4.5 Place large or bulky equipment near the rear of the ventilation hood. Large items near the face of the hood may cause excessive air turbulence and variations in face velocity.

26.4.6 Keep the hood sash clean and clear.

26.4.7 Check area around the hood for sources of cross drafts, such as open windows, supply air grilles, fans and doors. Cross drafts may cause turbulence that can allow leaks from the hood into the lab.

26.4.8 Extend only hands and arms into the hood and avoid leaning against it. If the hood user stands up against the face of the hood, air currents produced by turbulent airflow may transport contaminants into the experimenter's breathing zone.

26.4.9 Clean all chemical residues from the hood chamber after each use.

26.4.10 All electrical devices shall be connected outside the hood to avoid electrical arcing that can ignite a flammable or reactive chemical when present in the hood.

26.4.11 Do not use a hood for any function for that it was not intended. Certain chemicals or reactions require specially constructed hoods. Examples are perchloric acid or high pressure reactions.

26.5 Ventilation hood limitations

26.5.1 Particulates: A ventilation hood is not designed to contain high velocity releases of particulate contaminants unless the sash is fully closed.

26.5.2 Pressurized systems: Gases or vapors escaping from pressurized systems may move at sufficient velocity to escape from the ventilation hood.

26.5.3 Explosions: The hood is not capable of containing explosions, even when the sash is fully closed. If an explosion hazard exists, the user shall provide anchored barriers, shields or enclosures of sufficient strength to deflect or contain it. Such barriers can significantly affect the airflow in the hood.

26.5.4 Perchloric Acid: A conventional ventilation hood shall not be used for perchloric acid digestions. Perchloric acid vapors can settle on ductwork, resulting in the deposition of perchlorate crystals. Perchlorates can accumulate on surfaces and have been known to detonate on contact, causing serious injury to researchers and maintenance personnel. Specialized perchloric acid hoods, made of stainless steel and equipped with a wash-down system shall be used for such work.

26.5.5 Horizontal Sliding Sashes: The hood user shall never remove sliding sashes. Horizontal sash hoods are designed and balanced with no more than half the face open at any time. Removal of sashes may reduce the face velocity below acceptable levels.

26.5.6 Use of tubing to channel exhaust to the hood from equipment located some distance away is not an effective control method.

26.5.7 Connections to the Exhaust System: Occasionally, a researcher may need local exhaust ventilation other than that provided by an existing ventilation hood.

- A new device may not be connected to an existing ventilation hood without the explicit approval of the department's facilities manager or Maintenance.
- Adding devices to even the simplest exhaust system without adequate evaluation and adjustment may result in decreased performance of the existing hood and/or inadequate performance of the additional device.

26.6 Hood Performance Indicators

26.6.1 Each hood has a survey sticker with important information to help determine whether the particular hood is functioning properly and is appropriate for the work to be performed.

- If the survey sticker is out of date, contact RMS to recertify.
- Do not use the hood until recertified by RMS.

26.6.2 Continuous Monitoring Devices

- Many ventilation hoods on campus are equipped with static pressure gauges (magnehelic) that measure the difference in static pressure across an orifice in the duct, or between the laboratory and the ventilation hood exhaust duct.
- The gauge is a flow rate indicator with a scale that reads in units of pressure, rather than velocity.
- Changes in the magnehelic reading are not linearly proportional to changes in face velocity.

- The pressure gauge shall only be used as an index of hood performance.

26.6.3 Hood Survey Sticker

- When the hood survey is completed, a dated hood survey sticker is affixed on the hood. Each hood should have a survey sticker. It is placed at the sash height that provides the maximum face velocity.
- Do not use a hood that has no survey sticker. If a survey is needed, call RMS at 574-631-5037.
- If a hood user believes that the hood is not performing adequately, the user shall check for obstructions and remove or modify them. Look for large quantities of equipment in the hood, paper or other material drawn into the exhaust slots. Contact RMS at 574-631-5037 to survey hood flow rate.
- For more information refer to the Hood Testing Procedure.

26.7 Other Laboratory Exhaust Systems

26.7.1 Many laboratories use equipment and apparatus that can generate airborne contaminants, but cannot be used within a fume hood. Examples include gas chromatographs, ovens, and vacuum pumps. Other exhaust systems may be required to be used.

26.7.2 Such systems shall not be installed without explicit approval of the building facility manager and/or Facilities.

26.8 Local Exhaust Ventilation (Snorkels or Elephant Trunks)

26.8.1 An elephant trunk is a flexible duct or hose connected to an exhaust system.

26.8.2 It can only capture contaminants that are very close to the inlet of the hose, typically less than a distance equal to one half of the diameter of the duct.

26.8.3 Elephant trunks can be effective for capturing discharges from gas chromatographs, pipe nipples or the end of tubing.

26.8.4 Effectiveness of the elephant trunk shall be carefully evaluated by RMS and Facilities before they are used to control releases of hazardous substances.

26.9 Canopy Hoods

26.9.1 A canopy hood in a laboratory is constructed in a similar fashion to the overhead canopy hoods seen in kitchens. It works best when thermal

or buoyant forces exist to move the contaminant up to the hood capture zone.

26.9.2 Canopy hoods are designed such that the contaminated air passes through the individual's breathing zone and airflow is easily disrupted by cross currents of air. They shall only be used for exhaust of non-hazardous substances.

26.10 Toxic Gas Cabinets

26.10.1 Highly toxic or odorous gases shall be used and stored in gas cabinets.

26.10.2 A gas cabinet will prevent the gas from contaminating the laboratory.

26.10.3 Gas cabinets shall be connected to laboratory exhaust ventilation using hard ducting. See Flammables and Combustibles Procedure.

26.11 Glove Boxes

26.11.1 Glove boxes consist of a small chamber with sealed openings fitted with arm-length gloves. The materials are placed inside the chamber and manipulated using the gloves. These are to be used per manufacturer's specifications.

27.0 ACCIDENTS INVOLVING HAZARDOUS CHEMICAL EXPOSURES

27.1 Reporting Accidents and Injuries

27.1.1 All accidents, injuries, or near-misses shall be reported to the supervisor or Principal Investigator.

27.1.2 Notre Dame RMS encourages a culture of reporting all accidents, incidents and near misses.

- Incident/Accident investigations are conducted to work towards safer working environments and practices.
- These investigations are not to assign blame or responsibility for an accident.
- All employee injuries shall be reported to your departmental office so the appropriate forms can be completed.
- A Supervisor's First Report of Injury shall be sent to Risk Management within 48 hours of the incident. Any Questions, call the Claims Specialist at 631-7532.

27.2 Hazardous Chemical Exposures to skin

27.2.1 Take immediate first aid action and seek medical attention at the Wellness Center or the University Health Services as appropriate.

- If transportation is needed, call NDSP at 911 (campus phone) or 574-631-5555 (cell phone).
- Explain carefully what chemicals were involved. If able, bring the appropriate SDS.

27.3 First Aid Procedure

27.3.1 Immediately flush with water for no less than 15 minutes using drench hose, sink or safety shower as appropriate.

- While rinsing, quickly remove all contaminated clothing or jewelry. Seconds count. Do not waste time because of modesty.
- Use caution when removing pullover shirts or sweaters to prevent contamination of the eyes.
- Never use solvents to wash skin. They remove the natural protective oils from the skin and can cause irritation and inflammation. In some cases, washing with a solvent may facilitate absorption of the toxic chemical.

27.3.2 Check the Safety Data Sheet (SDS) to determine if any delayed effects can be expected.

27.3.3 Consult with RMS regarding the laundering or discarding of contaminated clothing. St. Michael's Laundry shall launder clothes as necessary. Garments or accessories that cannot be decontaminated shall be discarded.

27.3.4 For flammable solids on skin, first brush off as much of the solid as possible, then proceed as described above.

27.3.5 Labs working with hydrofluoric acid shall have 2.5% calcium gluconate gel available in the laboratory.

- A tube can be obtained through the University Health Center -St. Liam's Pharmacy.

27.4 Chemicals in Eyes

27.4.1 Immediately flush eye(s) with water for at least fifteen minutes. The eyes should be forcibly held open to wash, and the eyeballs should be rotated so all surface area is rinsed. The use of an eye wash fountain is desirable so hands are free to hold the eyes open. If eyewash is not available, pour water on the eye, rinsing from the nose outward to avoid contamination of the unaffected eye.

27.4.2 Remove contact lenses while rinsing. Do not lose time removing contact lenses before rinsing. Do not attempt to rinse and reinsert contact lenses.

27.4.3 Seek medical attention regardless of the severity or apparent lack of severity.

27.5 Chemical Inhalation

27.5.1 Close containers, open windows or otherwise increase ventilation, and move to fresh air.

27.5.2 If symptoms, such as headaches, nose or throat irritation, dizziness, or drowsiness persist, seek medical attention by calling NDSP or going to the Wellness Center or University Health Services. Explain carefully what chemicals were involved.

27.5.3 Review the SDS to determine what health effects are expected, including delayed effects.

27.6 Accidental Ingestion of Chemicals

27.6.1 Immediately go to the Wellness Center or University Health Services - St. Liam's or contact the Poison Control Center at 800-962-1253 for instructions.

27.6.2 Do not induce vomiting unless directed to do so by a health care provider.

27.7 Accidental Injection of Chemicals

27.7.1 Wash the area with soap and water and seek medical attention.

27.8 Thermal Burns

27.8.1 Immerse the burned area in cold water or apply ice and seek medical attention.

27.9 Clothing/Hair fires

27.9.1 If your clothing catches fire, drop to the floor and roll to smother the fire.

27.9.2 If a co-worker's clothing catches fire, get the person to the floor and roll him or her to smother the flames.

27.9.3 A safety shower can be used to put out the flames. If possible, remove burning(ed) clothing.

28.0 MEDICAL CONSULTATION POLICY

28.1 Laboratory workers shall seek medical attention by contacting 911 or 574-631-5555 under the following conditions:

28.1.1 If the individual experiences signs or symptoms associated with a hazardous chemical to that he or she may have been exposed in the laboratory.
28.1.2 Where exposure monitoring reveals an exposure level routinely above the OSHA action level or permissible exposure limit.
28.1.3 Whenever a spill, leak, explosion or other occurrence results in the likelihood of a hazardous chemical exposure to a laboratory worker.

28.2 Medical exams
28.2.1 All medical exams shall be performed by or under the direction of University Health Services or Wellness Center staff and provided at no cost to the worker, without loss of pay.

29.0 RECORDKEEPING

29.1 Medical Records
29.1.1 Shall be retained by the appropriate medical facility for employment plus 30 years from the time of separation.

29.2 Safety Data Sheets
29.2.1 SDS shall be retained for 30 years from the time of separation.

29.3 Industrial Hygiene Monitoring
29.3.1 Records shall be retained by RMS for 30 years from the time of separation.

PART III. LABORATORY SUPPORT AND EMERGENCY PERSONNEL RESPONSIBILITIES

30.0 NOTRE DAME FIRE DEPARTMENT (NDFD) OR DESIGNEE

30.1 Fire Extinguisher Inspections

30.1.1 Monthly inspections:

- The extinguisher is in its designated location.
- Access is maintained.
- The pin is in place and attached by an unbroken wire.
- No indication of physical damage.

30.1.2 These inspections shall be documented and maintained by NDFD.

30.1.3 Annual servicing and maintenance is performed by the Notre Dame Fire Department or its authorized representative.

- A complete and thorough examination, including the mechanical parts, the amount and condition of the extinguishing agent, and the agent's expelling device.
- These activities shall be documented and maintained by NDFD.

30.2 Fire Alarms

30.2.1 Fire alarms shall be provided along normal paths of travel, along exit routes and inspected annually by the NDFD or its authorized representative.

30.3 Smoke or heat detectors

30.3.1 Smoke or heat detectors shall be inspected annually by the NDFD or its authorized representative.

30.3.2 Fire Suppression Systems

- The fire suppression system shall be selected based on the hazards.
- Inspections shall take place annually by the NDFD or its authorized representative.

31.0 FACILITIES

31.1 Safety Showers and Eyewashes

31.1.1 Eyewashes and safety showers shall meet ANSI Z358.1 and shall be installed per manufacturer instructions.

31.1.2 Control Valve

- Shall remain open without use of hands.
- Valves shall be simple to activate and be activated within 1 second or less.

- Shall be resistant to corrosion.

31.1.3 A highly visible sign shall be installed near the safety showers and eyewashes.

31.1.4 Water supply

- Shall be tepid (luke warm).
- Flow controlled so not injurious to user.
- Flow rate shall be 20 gallons per minute for showers for 15 minutes.
- Flow rate shall be 0.4 gallons per minute for eyewashes.

31.1.5 Location:

- Of the units shall be within 10 seconds of hazard, for strong corrosives, eyewash shall be immediately adjacent.
- Of the travel path to the units shall be free of obstructions. Example: A doorway prohibiting immediate use of equipment is not permitted.

The area where the eyewash is installed shall be designed with enough room so that eyelids can be held open with hands while eyes are in flushing stream.

31.1.6 Maintenance Inspections

- Annually conduct a documented inspection per ANSI Z358.1 for eyewashes and safety showers. At a minimum the inspection shall ensure:
  - The water is tepid (luke warm).
  - The water flow is controlled so not injurious to user.
  - The water flow rate is 20 gallons per minute for showers for 15 minutes.
  - The water flow rate is 0.4 gallons per minute for eyewashes for 15 minutes.
  - Eyewashes are capable of providing flushing fluid to both eyes simultaneous.

31.2 Ventilation Hoods

31.2.1 Maintenance

- Routine maintenance is completed by Facilities on items such as belts and fans.

31.2.2 Risk Management and Safety Hood Evaluation.

- RMS surveys each ventilation hood annually.
- The hood survey includes measuring face velocity of the ventilation hood with the sash in the Standard Operating Configuration (SOC).

- For more information, refer to the Hood Inspection Procedure.

APPENDIX A – DEFINITIONS

Action Level - A concentration designated in 29 CFR Part 1910 for a specific substance, calculated as an 8-hour time-weighted average, that initiates required activities.

American Conference of Industrial Hygienists (ACGIH) professional association of industrial hygienists and practitioners of related professions who are charged with investigating, recommending, and annually reviewing exposure limits for chemical substances.

ANSI Standards - American National Standards Institute (ANSI) an organization for voluntary standardization that OSHA refers to regarding to rules, guidelines or characteristics for activities or their results.

Chemical Hygiene Officer -An employee who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan.

Chemical Hygiene Plan - A written program developed and implemented that sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in the laboratory. This plan shall be reviewed and updated at least annually.

Designated Area - An area that may be used for work with select carcinogens, reproductive toxins or substances that have a high degree of acute toxicity. The designated area may be the entire laboratory, an area of the laboratories or a device such as a hood.

Hazardous Chemical - A material where studies conducted in accordance with established scientific principles indicate that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, agents that act on the hematopoietic systems and agents that damage the lungs, skin, eyes, or mucous membranes.

Laboratory Under Chemical Hygiene Plan- A facility where the laboratory use of hazardous chemicals occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis

Laboratory Scale - Work with substances in that the containers are used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person.

Laboratory Use of Hazardous Chemicals - Handling or use of such chemicals in that all of the following conditions are met.

- Chemical manipulations are carried out on a laboratory scale.
- Multiple chemical procedures or chemicals are used.
- The procedures involved are not part of a production process nor in any way simulate a production process, i.e.: pilot plant or manufacturing process.
- Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous materials.

Laboratory Worker - An individual who conducts research and/or teaching activities in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Medical Consultation - A consultation that takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Principal Investigator (PI) - Faculty member or designee of department chair.

Principal Laboratory Contact (PLC) – PI or designee who acts as the liaison between the lab and RMS

Reproductive Toxins -Chemicals that affect the reproductive capabilities including chromosomal damage (mutation) and effects on fetuses (teratogeneses).

Select Agents and Toxins - Biological agents and toxins that the Departments of Health and Human Services (HHS) and Agriculture (USDA) have determined to have the potential to pose a severe threat to public health and safety, to animal or plant health, or to animal or plant products. The current list of select agents and toxins can be found at 42 CFR §§ 73.3, 73.4, 9 CFR §§ 121.3, 121.4, and 7 CFR § 331.3.

Select Carcinogen - Any substance that meets one of the following criteria:

- It is regulated by OSHA as a carcinogen; or

- It is listed under the category, known to be carcinogens, in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
- It is listed under group 1 (carcinogenic to humans) by the International Agency for Research on Cancer Monographs (IARC)(latest edition) or
- It is listed in either Group 2A or 2B by IARC or under the category, reasonably anticipated to be carcinogenic by NTP, and causes statistically different tumor incidence in experimental animals in accordance with any of the following criteria:
    - After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10mg/m;
    - After repeated skin application of less than 300mg/kg of body weight per week; or
    - After oral dosages of less than 50mg/kg of body weight per day

APPENDIX B -REFERENCES

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American Conference of Governmental Industrial Hygiensts. (1995). *Industrial Ventilation, A Manual of Recommended Practice* (22nd. ed.). Cincinnati, OH: ACGIH.

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OSHA Fact Sheet- Laboratory Safety. (2011). Retrieved November 1, 2013, from OSHA.gov: https://www.osha.gov/Publications/laboratory/OSHAfactsheet-laboratory-safety-chemical-hygiene-plan.pdf

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APPENDIX C –CHEMICAL STORAGE GROUP CLASSIFICATION CHART

Chemical Storage Group Classification System

Should be used in conjunction with specific storage conditions taken from manufacturer's label and SDS

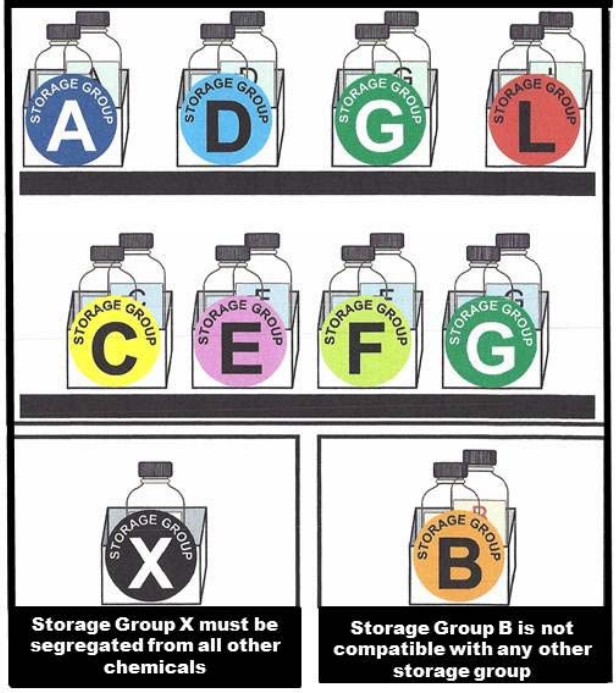
STORAGE GROUPS

Store chemicals in separate secondary containment and cabinets

A	Compatible Organic Bases
B	Compatible Pyrophoric & Water Reactive Materials
C	Compatible Inorganic Bases
D	Compatible Organic Acids
E	Compatible Oxidizers including Peroxides
F	Compatible Inorganic Acids not including Oxidizers or Combustible
G	Not Intrinsically Reactive or Flammable or Combustible
J*	Poison Compressed Gases
K*	Compatible Explosive or other highly Unstable Material
L	Non-Reactive Flammable and Combustible, including solvents
X*	Incompatible with ALL other storage groups

*Storage Groups J, K and X: Contact RMS @ 1-5037
For specific storage - consult manufacturer's SDS

If space does not allow Storage Groups to be kept in separate cabinets the following scheme can be used with extra care taken to provide stable, uncrowded, and carefully monitored conditions.



Storage Group X must be segregated from all other chemicals

Storage Group B is not compatible with any other storage group

Adapted with permission from Stanford University

APPENDIX D – SAMPLE TRAINING NEEDS ASSESSMENT / TRAINING MATRIX (Reviewed Annually)

An editable electronic copy is available on the RMS Lab Safety Website.

Laboratory Training Matrix / Needs Assessment	Accident Reporting	Aerial Lift Platform	Biosafety Level (BSL) 1 & 2	BSL-3 Training	Chemical Specific Training	Bloodborne Pathogens (BBP)	Confined Space Entry Authorized	DOT & IATA Shipping - Biological	DOT & IATA Shipping - Chemicals	Dry Ice Shipping	Electrical Work Qualified	Electrical Work Unqualified	Emergency Action Plan	Fall Protection/Arrest	Fire Extinguishers	Golf Cart	Hearing Conservation	Hot Work	Laboratory Fundamentals Safety: Includes access to medical records, electrical, laser, PPE, radiation, RCRA	Ladder Safety	Laser/UV	Lockout Tagout	Medical Records (Access To)	Overhead Cranes and Hoists	Powered Industrial Truck (Forklift)	PPE	Radiation Safety	Radioactive Materials Shipping	Respiratory Protection	Resource Conservation and Recovery Act (RCRA) - HazWaste
Frequency of Training in Years *R = Initial and as Needed* **Shaded Columns Indicate Training Required by ALL.**	R	R	1	1	R	1	1	2	3	3	R	R	1	R	1	R	1	R	1	R	1	R	1	3	3	1	1	2	1	R
Regulatory Requirement 10 CFR (Radiation) 29 CFR 1910 & 1926 (Safety/Health) 40 CFR (Environmental) 49 CFR (DOT)	N/A	29 CFR 1926.454	CDC -BMBL/NIH Guidelines on Biosafety	CDC - BMBL	29 CFR 1910.1200	29 CFR 1910.1030	29 CFR 1910.146	49 CFR 173	49 CFR 173	49 CFR 173	29 CFR 1910.332	29 CFR 1910.332	29 CFR 1910.38	29 CFR 1926.503	29 CFR 1910.157	N/A	29 CFR 1910.95	29 CFR 1910.252	29 CFR 1910.1450	29 CFR 1926.1053	ANSI Z136	29 CFR 1910.147	29 CFR 1910.1020	29 CFR 1910.179	29 CFR 1910.178	29 CFR 1910.132	29 CFR 1910.1096 10 CFR Part 20 410 IAC 5	49 CFR 173	29 CFR 1910.134	40 CFR 265
UND Document #	N/A	UND Proc	BIOL01	BIOL01	CHP	BIOL02	UND Proc	SAFE01	SAFE01	SAFE01	N/A	N/A	N/A	UND Proc	CHP	UND Proc	UND Proc	N/A	CHP	UND Proc	RAD01	UND Proc	N/A	UND Proc	UND Proc	SAFE03	RAD02	RAD02	SAFE04	N/A
Trainer	RMS	RMS	Online	BSL-3 Lab Mgr	Lab	Online	RMS	Online	Online	Online	Consultant	Online	RMS	RMS	Online/NDFD	Online	RMS	RMS	Online	RMS	RMS	RMS	Online	RMS	RMS	Online/RMS	RMS	online/CD	RMS	Online
Lab Personnel by Name Place an "X" the training column if training is needed.																														

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Below is guidance on training topics listed in the training matrix. This information is designed to help determine who must attend and how often the training is required.

Training Course	Criteria requiring training
Accident/Injury Reporting	Full or part time employees must be trained on the University Accident and Injury Reporting Process.
Aerial Platform Lift Operation	Any employee that operates an aerial platform lift shall take this training. This training is online or classroom training and includes a demonstration of knowledge. This training is required initially and if the equipment or hazards change.
Biosafety Level I & II	Anyone working in labs that contain Risk Group 1 & 2 biohazards including but not limited to infectious materials, human cell/tissues/blood, bacteria, fungi, parasites, and toxins. It is required annually by the CDC/NIH.
Biosafety Level III	Anyone working in labs that contain Risk Group 3 biohazards or vectors infected with Risk Group 2 agents. There includes a learning module and hands-on training. It is required by the CDC/NIH annually. Hands on training is offered by the lab manager.
Bloodborne Pathogens	Anyone who works with or around human blood or other potentially infectious materials (OPIM) is required to take this training annually.
Chemical Specific Training	Anyone working with specific chemicals such as acids & basis (Hydrofluoric acid {HF}, sulfuric, sodium hydroxide, formaldehyde etc.), pyrophoric, water reactives, etc., is required to be trained on the hazards of the chemicals they are working with. Training can be accomplished in a number of ways. This category is included to prompt lab personnel to consider what the personnel are working with and what training is necessary. This training is required initially.
Confined Space Entry Authorized	Anyone that participates in the entry of a confined space either as an entrant who does the work, an attendant who observes, or an employee who supervises is required to take this training. This training is required annually and is provided by RMS.
DOT/IATA Shipping Biological Substances	Any worker who is involved in shipping/receiving and/or packing biohazardous materials. It is required by the DOT (Department of Transportation) and IATA (International Air Transportation Association) every two (2) years.
DOT/IATA Shipping of Chemicals	Any employee that is involved in shipping/receiving/ and/or packing hazardous chemicals in excepted quantities (<30 mls of most chemicals). If there is a need to ship larger quantities of hazardous chemicals to ship domestically or internationally RMS can provide a link to other online training. This training is required every three (3) years.
Dry Ice Shipping	Required for anyone shipping (hazardous or nonhazardous materials on dry ice by truck or air). This training is required every three (3) years.
Electrical Work Qualified	Anyone that may work with electrical equipment that has exposed, unprotected, live electricity over 50 volts. If maintenance on equipment that is electronically energized or other work where it can be reasonably anticipated that an incidental exposure to live electricity exists is included. This training is required initially and if the hazards change.
Electrical Work Unqualified (Awareness) (Included in Laboratory Fundamentals)	This is required for all full and part time personnel at ND. It covers basic electrical safety. This is included in the Laboratory Fundamentals course.
Emergency Action Plan (Included in Laboratory Fundamentals)	This is required for all employees at the university. This training is required annually and is included in the Laboratory Fundamentals.
Fall Protection / Arrest System Safety	Any employee that may work at heights greater than 4 feet without engineered fall protection such as guardrails, mobile stairs, etc., are required to take this training and be equipped with an approved fall arrest systems. This training is required initially and if the hazards change.
Fire Extinguisher Training	This training is required for all personnel and is required annually. Some lab personnel may be required to take the hands on fire extinguisher training as well.
Hearing Conservation	Anyone exposed to high levels of noise which could either exceed 85 decibels (dBA) or exceeds shorter term noise levels that are higher is required to take this training. RMS will inform those who require this by occupation, however, if your staff is exposed to unusually loud noise levels, please contact RMS for an evaluation to determine the need for training if an evaluation has not already been completed. This training is required annually.
Hot Work	Anyone who does work involving burning, welding, or similar operation that is capable of initiating fires or explosions. Hot work also includes other activities with the potential to create a source of ignition such as cutting, brazing, grinding, soldering, or hot riveting. This training is required initially and when the hazards change.
Laboratory Fundamentals which includes Laser Safety and Access to medical records.	Anyone who works in a lab that has hazards at Notre Dame. It covers access to medical records, PPE, Injury reporting, emergency response, chemical hazards, labeling, general electrical safety, hazardous waste requirements and laser safety. This is required annually. NOTE that this also satisfies Hazard Communications training.
Ladder Safety	Anyone using ladders is required to take this training. This includes, fixed ladders, step ladders that are higher than 3 feet, and extension ladders. Approved portable staircases are exempt. This training is required initially or when the hazards change.
Laser Safety (Included in Laboratory Fundamentals)	Required for anyone working with or in the hazard zone of lasers Class IIIB or IV. This is required initially.
Lockout-Tagout	Anyone performing maintenance or servicing on equipment that has real or potential energy of any kind that could cause an injury from unintended energization. If a task requires an energy source to be turned off in order to safely work on it, training is required. This training is required initially and any time there is a hazard change.
Medical Recordkeeping (Access To) (Included in Laboratory Fundamentals)	All full and part time employee of the University have a right to know how to access Occupational Heath medical records and are required to take this training. This is required annually, see Laboratory Fundamentals.
Overhead Crane & Hoists	This is required for any worker who uses cranes and hoists, whether it is fixed or mobile. This training is required every three (3) years.
Personal Protective Equipment (PPE) (Included in Laboratory Fundamentals)	All personnel who conduct research/work in a hazardous environment or with hazardous materials shall be trained on the PPE required to minimize exposure to the hazard. This training is included in the Laboratory Fundamentals course and is required annually.
Powered Industrial Truck (Forklift) Operator	This is required for anyone who operates a forklift or other similar vehicle. This training is required every three (3) years which includes a practice driving test.
Radiation Safety Training	This training is required for lab personnel who work with radioactive materials or with radiation producing machines e.g., x-ray equipment. It is also required for personnel who work in these areas. The training includes radiation terminology and regulations regarding storage, use, contamination control, personal exposure and exposure monitoring. Radioactive waste management at the University is also covered. All trainees receive "hands-on" instruction in the use of a survey meter. All users of radioactive materials and personnel who work in radioactive material labs are required by UND's NRC license to receive this training. Users of radiation producing machines are required by State of Indiana to receive this training.
Radioactive Materials Shipping	Anyone involved in shipping/receiving and/or packing hazardous chemicals, biological or radioactive materials for transportation. It is required by the DOT (Department of Transportation/IATA) every two years.
Resource Conservation and Recovery Act (RCRA) - HazWaste (Included in Laboratory Fundamentals)	Any personnel who generate hazardous waste or handle waste must successfully complete instruction that teaches them to perform their duties in a way that ensures the ND's compliance with the hazardous waste rules. This training is included in the Lab Fundamentals course and is required initially.
Respiratory Protection Program	Anyone doing work that requires the use of a respirator. This training is required annually.

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APPENDIX E – PPE HAZARD ASSESSMENT AND PPE CERTIFICATION FORM

Personal Protective Equipment (PPE)
Hazard Assessment

Laboratory (Building Name and Room Number): _____

Name of PI Responsible for the Laboratory: _____

Description of the Task being Evaluated: _____

Name of Person Completing PPE Assessment: _____

		HAZARD																				
		PHYSICAL										CHEMICAL					BIOLOGICAL					Other
		Mechanical				Thermal			Radiation			Particulate		Liquid								
		Blows, Cuts, Impact Crushing	Stabs, Cuts	Vibration	Slips and Falls or Falls from Heights	Heat / Fire / Flash Fire	Cold	Electrical	Non-ionizing	Ionizing	Noise	Particles – Dust, Fibers	Fumes/Mist	Immersion	Splashes, Sprays	Gases, Vapors	Bacteria	Viruses	Fungi	Parasites	Human Tissue or Body Fluids	Other Hazards Specify: _____
BODY PART POTENTIALLY AFFECTED	Eyes																					
	Face																					
	Fingers / Hands																					
	Respiratory																					
	Ears																					
	Arms																					
	Legs																					
	Foot																					
	Head																					
	Whole Body / Torso																					

Page **1** of **2**

University of Notre Dame
Lab Personnel PPE Knowledge Certification

Minimum PPE required for all laboratories with hazards unless otherwise noted include: Safety Glasses, Enclosed Shoe, Pants or Skirt to the Ankles, and Shirt with coverage equal to or greater than a T-Shirt. Departments and/or PIs can make the minimum PPE requirements more stringent.

By signing below, I certify that I understand the minimum PPE requirements in the lab and have read the PPE hazard assessment which may change the minimum PPE requirements. I understand the limitations of the PPE, how to put on and take off, care for and maintain this PPE.

Printed Name	Signature	NetID	Date

APPENDIX F – FLAME RETARDANT LAB COAT USE REQUIREMENTS

Flame retardant lab coats shall be worn by personnel conducting experiments or otherwise working with the quantities of the materials and in the conditions noted below.

Additionally, flame retardant lab coats shall be worn by personnel in close proximity to the individual performing the work.

Material[+]	Quantity Being Used*	Conditions Temperature of Material & Ignition Source
Pyrophoric Materials (Air Reactive Materials)	Any	Any
Water Reactive Materials (Release flammable gas)	Any	Any
Flammable Gases	Any	Any
Explosive Materials	Any	Any
Class IA Flammable Liquid FP <73°F & BP <100°F	>100 mL	Any
Class IB Flammable Liquid FP <73°F & BP >100°F	>1 L	Any amount when working in close proximity to an ignition source
Class IC Flammable Liquid FP ≥73°F – <100°F	>2 L	1. Equal to or greater than the material's FP & 2. When working in close proximity to an ignition source

[+] *A list of common flammable material is available on the RMS web site.*

**If the hazard of the material has been eliminated through a system design e.g., chemical is in a completely enclosed system then the flame retardant PPE is not required.*

Note
When working with lesser quantities or in lesser conditions lab coats shall be made of cotton or cotton blend.

Definitions and Abbreviations

1. **Boiling Point (BP)** – The temperature at which a liquid boils and turns to vapor.
2. **Close Proximity** (personnel) – This is the distance determined by the researcher where if a flash occurred a second person could be affected. As a guideline, consider anyone within 10 feet of the work within close proximity.
3. **Close proximity** (vapors to an ignition source) – This is the distance determined by the researcher that a vapor from an open container could reasonably be expected to migrate to an ignition source and be ignited. Consider 5 feet from an open container to an ignition source as close proximity.
4. **Flash Point (FP)** – The minimum temperature at which a liquid or a solid emits vapor sufficient to form an ignitable mixture with air near the surface of the liquid or the solid.
5. **Ignition Source** – Any open flame, spark, or heat generating piece of equipment in close proximity of the flammable liquid being used. Heat generating equipment includes but is not limited to hot plates, heat guns, drying ovens, incubators, heating mantels, etc.
6. **Pyrophoric (Air Reactives)**
   For pyrophoric materials, oxidation of the compound by oxygen or moisture in air proceeds so rapidly that ignition occurs. Many finely divided metals are pyrophoric, and their degree of reactivity depends on particle size, as well as factors such as the presence of moisture and the thermodynamics of metal oxide or metal nitride formation. Other reducing agents, such as metal hydrides, alloys of reactive metals, low valent metal salts, and iron sulfides, are also pyrophoric.
   Examples:
   - Alkali metals (potassium, cesium)
   - Finely divided metal dusts (nickel, zinc, titanium)
   - Hydrides (barium hydrides, diborane, diisobutyl aluminum hydride).
7. **Water Reactives**
   Water-reactive materials are those that react violently with water. Alkali metals (e.g., lithium, sodium, and potassium), many organometallic compounds, and some hydrides react with water to produce heat and flammable hydrogen gas, which ignites or combines explosively with atmospheric oxygen. Some anhydrous metal halides (e.g., aluminum bromide), oxides (e.g., calcium oxide), and nonmetal oxides (e.g., sulfur trioxide), and halides (e.g., phosphorus pentachloride) react exothermically with water, resulting in a violent reaction if there is insufficient coolant water to dissipate the heat produced.
   Other examples:
   - Anhydrides (acetic anhydrides)
   - Carbides (calcium carbide)
   - Halides (Acetyl chloride, titanium chloride, stannous chloride)
   - Hydrides (sodium hydride)
   - Organometallics (tetramethyl aluminum)

- Sodium oxides
- Peroxides (sodium peroxide)
- Phosphides (aluminum phosphide) and
- Others (chlorosulfonic acid, aluminum tribromide).

APPENDIX G – RISK ASSESSMENT

Date: _____ **PI Name:** _____

Task: _____ **Person Completing:** _____

Location:

Laboratory
Risk Assessment Tool

This Risk Assessment tool assists in:
***IDENTIFYING the hazards of the task**
***ASSESSING the risk of exposure to the hazard**
***IDENTIFYING CONTROLS for the hazards**

Complete this for any new laboratory processes when extremely hazardous materials or operations are used or desired or there is a significant change to an experiment.

Instructions - Review the list and identify the hazards involved in the process or experiment. The hazards are listed under the "Laboratory Hazards" column. Compare each hazard to the list of criteria and choose the appropriate rating. Determine the types of controls (Engineering, Administrative, and/or PPE) that will be used. The tool will calculate a Risk Priority Number (RPN). The RPN can range from 0 to 9 with 9 representing the highest risk.

When complete with Ranking Chart - Review the Controls Matrix to determine if additional controls and/or approvals are required The risk assessment should be available (paper or electronic) for personnel who will be working on the task.

Laboratory Experiment Risk Ranking

Hazards			Controls						Risk Priority Number (RPN)
Laboratory Hazards	Severity of Hazard	Specify Hazard	Engineering Controls (-1.5)	Specify Engineering Controls	Administrative Controls (-1)	Specify Administrative Controls	PPE (-0.5)	Specify PPE Controls	
Flammability	N/A		N/A		N/A		N/A		N/A
Toxicity	N/A		N/A		N/A		N/A		N/A
Corrosivity	N/A		N/A		N/A		N/A		N/A
Reactivity	N/A		N/A		N/A		N/A		N/A
Pressure or Pressure Reactions (Gas only)	N/A		N/A		N/A		N/A		N/A
Explosive	N/A		N/A		N/A		N/A		N/A
Equipment	N/A		N/A		N/A		N/A		N/A
Live Electrical	N/A		N/A		N/A		N/A		N/A
Temp of Working Environment	N/A		N/A		N/A		N/A		N/A
Thermal Contact	N/A		N/A		N/A		N/A		N/A

Controls Matrix

Ranking	RPN	Controls
Low	<4	No Additional Controls Required
Medium	4 - 5.5	PI Approval PPE Assessment Standard Operating Procedure (SOP) Training
High	>5.5	All of Controls Listed for Medium Ranking Job Safety Analysis Safety Coordinator or Oversight Committee Approval

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Laboratory Risk Assessment Tool				
LABORATORY PROCESS RISK CRITERIA		CONTROLS DEFINED		
Hazard	Severity of Hazard	Engineering Controls (-1.5)	Administrative controls (-1.0)	PPE (-0.5)
Flammability	3 - <0 .5L (Class II/III) FP>100F 5 - 0.5L - 1 L (Class IB/IC) BP<100F 7 - <500 ml Class IA, FP< 73F and BP >100F 7 - Class III if heated over FP 9 - >500ml Class IA FP< 73F and BP >100F 9 - Class I, II if heated over FP 9 - >1L Class IB FP< 73 and BP >100F 9 - > 2L Class IC FP > 73-<100F	Hood, Glove Box, Blast Shield, Biosafety Cabinet, etc.	Written SOPs Training	Eye Protection (Specify type) Gloves (Specify type) Lab Coat (Flame Retardant or standard) Other (Apron, Respirator, etc.)
Toxicity	3 - Irritant 5 - Carcinogen/Sensitizers 7 - Reproductive Hazards 7 -Poison Inhalation Hazard (pesticides, chlorine gas, CO, CO2, etc.) 9 - Acute toxics LD <50mg/kg or LC50 in air of 200 parts per million by volume (refer to SDS for Exposure limits)	Hood, Glove Box, Blast Shield, biosafety cabinet, other	Written SOPs Training	Eye Protection (Specify type) Gloves (Specify type) Lab Coat (Flame Retardant or standard) Other (Apron, Respirator, etc.)
Corrosivity	3 - Acids with Ka <1 and concentration <2M 3 - Bases with Kb <1 and concentration < 2M 5 - Acids with Ka <1 and concentration >2M 5 - Bases with Kb <1 and concentration > 2M 5 - Acids with Ka >1 and concentration <2M 7 - Bases with Kb >1 and concentration <2M 7 - Acids with Ka >1 and concentration >2M 7 - Bases with Kb >1 and concentration >2M 7 -HF <500 ml in use 9 - HF > 500 ml in use See Chart for Common Acids and Bases	Hood, Glove Box, Blast Shield, Biosafety Cabinet, Other	Written SOPs Training	Eye Protection (Specify type) Gloves (Specify type) Lab Coat (Flame Retardant or standard) Other (Apron, Respirator, etc.)
Reactivity	5 - Unstable/ Time Sensitive 7 - Air Reactive <100mg 7 - Water Reactives <100mg 9 - Air Reactive ≥100 mg 9- Water Reactive ≥100 mg	Hood, Glove Box, Blast Shield, Biosafety Cabinet, Other	Written SOPs Training	Eye Protection (Specify type) Gloves (Specify type) Lab Coat (Flame Retardant or standard) Other (Apron, Respirator, etc.)
Pressure or Pressure Reactions (Gas only)	5 - Low - See Chart in Definitions 5 - Sub atmospheric (Vacuum) 9 - High pressure - See Chart in Definitions	Hood, Blast Shield, Engineered Guarding Around Pressure Vessel; Rated Vessel, Pressure Relief Device, etc.	Written SOPS Training Equipment certifications & inspections	Eye Protection (Specify type) Gloves (Specify type) Lab Coat (Flame Retardant or standard) Other (Respirator, etc.)
Explosive	5 - DOT hazard 1.6 7 - DOT hazard 1.4, 1.5 9 - DOT hazard 1.1, 1.2, 1.3	Engineered Bwlast Shield or Containment for orst Case Explosive Potential	Written SOPs Training	Eye Protection (Specify type) Gloves (Specify type) Lab Coat (Flame Retardant or standard) Other (Respirator, etc.)
Equipment	3 - Rotating Equipment - Guarded 5 - Microtomes, Lathes 9 - Rotating equipment, Unguarded	Guarding by physical barrier or distance (>7 feet)	Written SOPs Training	Eye Protection (Specify type) Gloves (Specify type) Lab Coat Other

Corrosivity Table

K_a and K_b Values

Name of Acid	Acid	K_a	Name of Base	Base	K_b
Sulfuric acid	H_2SO_4	large	hydrogen sulfate ion	HSO_4^-	very small
Hydrochloric acid	HCl	large	chloride ion	Cl^-	very small
Nitric acid	HNO_3	large	nitrate ion	NO_3^-	very small
Hydronium ion	H_3O^+	55.5	water	H_2O	1.8×10^{-16}
Hydrogen sulfate ion	HSO_4^-	1.2×10^{-2}	sulfate ion	SO_4^{2-}	8.3×10^{-13}
Phosphoric acid	H_3PO_4	7.5×10^{-3}	dihydrogen phosphate ion	$H_2PO_4^-$	1.3×10^{-12}
Hexaaquairon(III) ion	$Fe(H_2O)_6^{3+}$	6.3×10^{-3}	pentaaquahydroxoiron(III) ion	$Fe(H_2O)_5OH^{2+}$	1.6×10^{-12}
Hydrofluoric acid	HF	7.4×10^{-4}	fluoride ion	F^-	1.4×10^{-11}
Formic acid	HCO_2H	1.8×10^{-4}	formate ion	HCO_2^-	5.6×10^{-11}
Benzoic acid	$C_6H_5CO_2H$	6.3×10^{-5}	benzoate ion	$C_6H_5CO_2^-$	1.6×10^{-10}
Acetic acid	CH_3CO_2H	1.8×10^{-5}	acetate ion	$CH_3CO_2^-$	5.6×10^{-10}
Hexaaquaaluminum ion	$Al(H_2O)_6^{3+}$	7.9×10^{-6}	pentaaquahydroxoaluminum ion	$Al(H_2O)_5OH^{2+}$	1.3×10^{-9}
Carbonic acid	H_2CO_3	4.2×10^{-7}	hydrogen carbonate ion	HCO_3^-	2.4×10^{-8}
Hydrogen sulfide	H_2S	1×10^{-7}	hydrogen sulfide ion	HS^-	1×10^{-7}
Dihydrogen phosphate ion	$H_2PO_4^-$	6.2×10^{-8}	hydrogen phosphate ion	HPO_4^{2-}	1.6×10^{-7}
Hypochlorous acid	HClO	3.5×10^{-8}	hypochlorite ion	ClO^-	2.9×10^{-7}
Ammonium ion	NH_4^+	5.6×10^{-10}	ammonia	NH_3	1.8×10^{-5}
Hydrocyanic acid	HCN	4.0×10^{-10}	cyanide ion	CN^-	2.5×10^{-5}
Hexaaquairon(II) ion	$Fe(H_2O)_6^{2+}$	3.2×10^{-10}	pentaaquahydroxoiron(II) ion	$Fe(H_2O)_5OH^+$	3.1×10^{-5}
Hydrogen carbonate ion	HCO_3^-	4.8×10^{-11}	carbonate ion	CO_3^{2-}	2.1×10^{-4}
Hydrogen phosphate ion	HPO_4^{2-}	3.6×10^{-13}	phosphate ion	PO_4^{3-}	2.8×10^{-2}
Water	H_2O	1.8×10^{-16}	hydroxide ion	OH^-	55.5
Hydrogen sulfide ion	HS^-	1×10^{-19}	sulfide ion	S^{2-}	1×10^{5}

Pressure Table

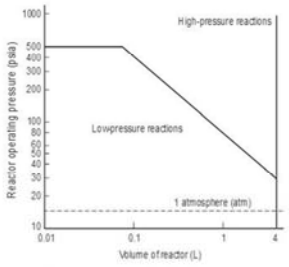
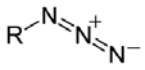


FIGURE C.4.5 Pressure Classification of Reactions.

LABORATORY PROCESS RISK CRITERIA		CONTROLS DEFINED		
Hazard	Severity of Hazard	Engineering Controls (-1.5)	Administrative controls (-1.0)	PPE (-0.5)
Live Electrical	3 - Live electrical work <50 volts 9 - Live electrical work >50 volts	Guarding by: Distance, Shielding, or Physical Barrier Guarding	Written SOPS Training on Qualified Electrical Work & SOPs	Eye Protection (Specify type) Electrical Rated Gloves (Specify type) Electrically Rated Other PPE (Face Shield, etc.)
Temp of Working Environment	5 - Personnel Exposed to Ambient Working Temperatures below 45 F or greater than 90 F	Heater for cold environments AC for hot environments	Written SOPs Training Controls on Time in Spent in the Environment	Eye Protection (Specify type) Gloves (Specify type) Lab Coat Other - cool vests, thermal clothing, etc.
Thermal Contact	5 - Heated equipment (drying oven, hot plate, etc.) 7 - Open Flame 7 - Cryogenic or Boiling	Hood, glove box, cryogenic rated vessels; splash shield.	Written SOPs Training	Eye Protection (Specify type) Gloves (Specify type - insulated) Lab Coat (FRC or std) Other

APPENDIX H – AZIDE COMPOUNDS

INFORMATION ON AZIDE COMPOUNDS



Azides are energy-rich molecules with many applications. Sodium azide, for example, is used as a preservative, mutagen, biocide, and assay reagent. Organic azides are capable of a great diversity of organic reactions and are important components in Chemistry.

Caution, however, should be exercised when using azides. Both organic and inorganic azides can be heat and shock sensitive and can explosively decompose with little input of external energy.

ORGANIC AZIDE STABILITY

Each chemical you intend to work with must be individually evaluated. Below are some general guidelines to consider when working with organic azides.

Carbon to Nitrogen Ratio

The total number of nitrogen atoms in your organic azide should not exceed that of carbon. Use the following equation to help evaluate if your azide is stable enough to work with, with N equal to the number of atoms: [1]

$$(N_C + N_O) / N_N \geq 3$$

- *n*-nonyl azide (C/N=3) is the smallest organic azide that can be isolated and stored in its pure form (up to 20 grams).[2]
- Azides with a C/N ratio greater than one and no more than 3 can be synthesized and isolated but should be stored below room temperature at no more than 1M concentration and at a maximum of 5 grams of material.[2]
- Organic azides with C/N<1 should never be isolated. It may be synthesized if the azide is a transient intermediate species AND the limiting reagent in the reaction mixture AND has a maximum quantity of 1 gram.[2]

Rule of Six

Alternatively, follow the "rule of six:" six carbons (or other atoms of about the same size) per energetic functional group (azide, diazo, nitro, etc.) should provide enough dilution to render the compound relatively safe to work with given appropriate controls and safety procedures.[3]

In general, olefinic, aromatic, or carbonyl azides are much less stable than aliphatic azides.[3]

STORAGE AND WASTE MANAGEMENT

Storage

- Store synthesized azides below room temperature and away from sources of heat, light, pressure, and shock.
- Store sodium azide away from carbon disulfide, bromine, dimethyl sulfate, nitric acid, and heavy metals and their salts.
- Avoid water and strong acids which can lead to the formation of potentially explosive hydrazoic acid and its toxic vapors.

Waste

- Store azide waste in a container designated only for azide waste.

HEALTH HAZARDS

There is little toxicological information available on organic azides. However, information on sodium azide indicates that exposure through inhalation, skin absorption, or ingestion can be highly toxic. According to the Centers for Disease Control:

- Exposure to small amounts of sodium azide can result in rapid breathing, restlessness, dizziness, weakness, headache, nausea, vomiting, rapid heart rate, red eyes, clear drainage from the nose, cough, skin burn, and blisters.
- Exposure to large amounts of sodium azide may also cause convulsions, low blood pressure, slow heart rate, loss of consciousness, lung injury, and respiratory failure leading to death.

Safety Precautions

Planning for Use

- Write a Standard Operating Procedure for your experiment and review it with your principal investigator, using it as an opportunity to fully evaluate the hazards associated with your procedure and the materials you will be working with. Based on this evaluation, it may be determined that some of the safety precautions in this section are not applicable.
- Seek pre-approval from your principal investigator if you plan to increase the usage or storage amounts of azide.
- Conduct dry runs to eliminate safety problems that may arise before azides are actually used.
- Use the smallest amount of azide possible for your experiment.

Controls

- Personal protective equipment must be worn, including a lab coat, safety glasses, and gloves with adequate chemical resistance.
- Conduct the experiment behind a blast shield in a ventilation hood with the sash positioned as low as possible. If use of a blast shield is not feasible, use a face shield.
- Keep the hood clear of any unnecessary chemicals and equipment. Clearly label your containers, and post a sign on the ventilation hood as notification that there is an azide experiment in progress.
- These precautions should be used for the whole duration of the experiment, including set up, work up, and clean up.

Conditions to Avoid

- Do not work alone.
- Do not use halogenated solvents for sodium azide reactions, such as methylene chloride and chloroform, as they can result in the formation of potentially explosive diazidomethane and triazidomethane, respectively.[1]
- Do not concentrate azide-containing reaction mixtures through rotary evaporation or distillation.
- Do not use metal spatulas for weighing and transferring azides.
- Do not expose organic azides to ground glass joints as this may cause the azide to decompose explosively.

References:

[1]Bräse, S., Gil, C., Knepper, K., Zimmermann, V. "Organic Azides: An Exploding Diversity of a Unique Class of Compounds," *Angew. Chem. Int. Ed.*, 2005, *44*, 5188-5240.

[2]University of California Santa Barbara. "Laboratory Safety Fact Sheet #26: Synthesizing, Purifying, and Handling Organic Azides"

[3]Kolb, H.C., Finn, M.G., Sharpless, K.B. "Click Chemistry: Diverse Chemical Function from a Few Good Reactions," *Angew. Chem. Int. Ed.*, 2001, *40*, 2004-2021.

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Hydrofluoric Acid Information Sheet

Hydrofluoric acid, a solution of hydrogen fluoride gas (HF) in water, is one of the most corrosive and dangerous chemicals encountered in the laboratory. Exposure to HF can cause severe tissue damage and even death. Deaths have been reported from concentrated acid burns (i.e., 50% or stronger solutions) to as little as 2.5% Body Surface Area[1]. In lower concentrations, symptoms may be delayed. The following special safety precautions are necessary when using this chemical, regardless if using dilute or concentrated HF.

BEFORE WORKING WITH HF

1. Standard Operating Procedure (SOP):
- Develop a SOP which is a set of written instructions that describes in detail how to perform a laboratory process or experiment safely and effectively.
- Plan the operation to eliminate risk of HF splash/ spray.
- Perform a "dry run" of procedure to identify and correct potential hazards.

2. Health & Safety Training:
- Lab personnel must receive:
  - Lab safety training
  - Lab-specific training which includes hazards of HF, safety precautions, and emergency procedures. The SOP, Safety Data Sheet (SDS), and this fact sheet can be used for such training.
- Keep training records for at least one year.

3. Engineering Controls & Safety Equipment:
- Ensure the nearest emergency safety shower / eyewash is accessible and has been tested in the last month.
- Ensure laboratory fume hood has been certified within the last 12 months and is functioning properly (check sticker on fume hood and inward airflow).

4. First Aid Procedures:
- Post SU HF First Aid Instructions in labs that store or use HF solutions or gas; see back page.
- Ensure 2.5% calcium gluconate gel intended for dermal exposures is available in laboratory.
  - Ensure gel has an effective shelf life of at least one year.
  - Create a system to refresh your supply of gel before the expiration date.
  - Gel can be purchased through many lab safety supply vendors, including University Health Services Pharmacy (574-631-6574).

WORKING WITH HF SOLUTIONS

1. Engineering Controls:
- Work in a fume hood with the sash opening minimized—sash must not be opened beyond the stickered arrow.

2. Work Practices:
- Purchase and use smallest quantities necessary.
- Establish designated area for HF use and post sign "Hydrofluoric Acid Use Area."
- Do not work alone; others present in the laboratory must be familiar with the operation's hazards and emergency procedures.
- Add acid to water, not water to acid.
- Do not use glass, ceramic, or other incompatible containers with HF.
  - Ensure secondary containment
  - Ensure segregation of incompatible chemicals.
- Store below eye level.

3. Personal Protective Equipment (PPE):
- Check PPE for damage before using.
- Wear appropriate PPE, which minimally includes:
  - Goggles and face shield.
  - Butyl rubber or neoprene gloves.
  - Verify glove selection based on concentration and Using the Glove Compatibility Chart. Neoprene long-sleeve apron if splash/spray is possible.
  - Lab coat and closed-toe shoes.

EMERGENCIES

1. Personnel Exposures:
- See the HF First Aid Instructions on following page for personnel exposures.

2. Spills:
- Immediately call 911 or 631-5555 (from cell phone) to report an HF spill that is health threatening, or is greater than 30 mls, or if it will take longer than 15 minutes to clean-up.

[1] http://emedicine.medscape.com/article/773304-overview

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HYDROFLUORIC ACID FIRST AID INSTRUCTIONS

POST THIS SHEET IN THE ROOM WHERE THE HYDROFLUORIC ACID IS USED OR HANDLED.

Location of calcium gluconate gel:

Building and Room: _____

Exact Location in Room: _____

Hydrofluoric acid (HF) exposure is very toxic and can be fatal if not treated immediately. HF is absorbed quickly; however, damage/symptoms can occur hours to days later. **Any person exposed to HF must have immediate first aid, followed by immediate medical treatment from a physician.** When seeking medical attention **bring a copy of the HF Safety Data Sheet** to the Wellness Center or University Health Services.

SKIN EXPOSURE	EYE EXPOSURE
1. Immediately flush affected area with water for 15 minutes under emergency shower or other water source. Remove all contaminated clothing while flushing with water. 2. After flushing, apply calcium gluconate to burn site with clean, gloved hand. Continue massaging gel into the burned area of skin for up to 20 minutes. 3. For emergency medical assistance, call: • 911 from campus phone phones • 574-631-5555 from cell phone	1. Immediately flush eyes with water for at Least 15 minutes under emergency eyewash or other water source. If only one eye is affected, be careful not to flush contaminated water into the other eye. 2. For emergency medical assistance, call: • 911 from campus phone phones • 574-631-5555 from cell phones • If possible, provide continuous irrigation during transport.
INHALATION	**INGESTION**
1. For emergency medical assistance, call: • 911 from campus phone phones • 574-631-5555 from cell phones.	1. Rinse mouth with cold water. Do not induce vomiting. 2. If the victim is conscious, have them drink lots of water to dilute the acid. 3. For emergency medical assistance, call: • 911 from campus phone phones • 574-631-5555 from cell phones

INFORMATION ON CYANIDE COMPOUNDS

CN^-

Cyanide is listed as extremely hazardous substances, under 40 CFR parts 302 and highly toxic materials, under OSHA 29 CFR 1910.1200 Appendix A. Personnel using cyanide must be trained in the health hazards, personal protective measures and emergency first aid treatment procedures. Hydrogen cyanide is a colorless gas with a faint, bitter, almond like odor, while sodium cyanide and potassium cyanide are both white solids. Cyanide compounds are used in many industrial applications, but their use in academic research laboratories is usually on a small scale.

HEALTH HAZARDS

Cyanide is a fact acting poison, which when exposed to can cause severe breathing difficulty, convulsions and/or death. Routes of exposure are inhalation, skin absorption and ingestion.

Low level exposures may result in:

- Shortness of breath
- Convulsions
- Loss of consciousness

Short-term, high level exposures may result in:

- Irritation of eyes, nose and throat
- Headache
- Shortness of breath
- Damage to central nervous, cardiovascular, and/or respiratory system

Long-term, low level exposures may result in:

- Deafness
- Vision problems
- Nose bleeds
- Loss of muscular coordination
- Harm to thyroid gland

SAFETY PRECAUTIONS

Planning for use

- Complete all appropriate lab specific training.
- Write a Standard Operating Procedure for your experiment and review it with your principal investigator, using it as an opportunity to fully evaluate the hazards associated with your procedure and the materials you will be working with. Based on this evaluation, it may be determined that some of the safety precautions in this section are not applicable.
- Seek pre-approval from your principal investigator if you plan to increase the usage or storage amounts of cyanide compounds.
- Use the smallest amount of cyanide possible for your experiment.
- Purchase and maintain a cyanide antidote kit.
- Maintain the Safety Data Sheet (SDS) in the laboratory where cyanide is used.

Controls

- Personal protective equipment must be worn, including a lab coat, safety glasses, and gloves with adequate chemical resistance.
- Conduct the experiment in a certified ventilation hood with the sash positioned as low as possible.
- Work areas shall be labeled "Cyanide Materials in Use"
- Keep the hood clear of any acids.
- Personnel shall not work alone while using cyanide. Limit cyanide usage to normal business hours.

STORAGE AND WASTE MANAGEMENT

Storage

- Ensure that all cyanide containers are properly labeled.
- Store in tightly closed containers, in a secured (preferably locked) and well-ventilated area away from water, moisture and steam.
- Cyanide must be stored separately from strong acids such as hydrochloric, sulfuric, and nitric and acid salts as their interaction releases highly flammable and toxic hydrogen cyanide gas.
- Cyanides are not compatible with oxidizing agents (e.g. perchlorates, peroxides, permanganates, nitrates, chlorine, bromine and fluorine); amines; calcium hydroxide; caustic ammonia; sodium carbonate; iron and magnesium. These must be segregated and stored away from cyanide.

Waste

- Waste materials should be kept in a closed and properly labeled container within a certified ventilation hood or Satellite Accumulation Area (SAA) within the laboratory.
- Cyanide waste should be collected independently of other waste types.
- Never add any acidic compounds to a cyanide waste container.
- All gloves, matting, and any other potentially contaminated material must also be collected and labeled as hazardous waste.
- Please note that cyanide is an Environmental Protection Agency (EPA) P-Listed (acutely toxic) material and the bottle it was received in, even when empty, must also be managed and collected as hazardous waste.
- When ready for disposal, please complete the chemical discard tag and attach to the container. Waste will be picked up during the regularly scheduled pick-up.

EMERGENCY PROCEDURES

- Exposure to cyanide is a serious medical emergency and onset of symptoms after cyanide exposure is very rapid.
- Contact NDSP at 911 from a campus phone or 574-631-5555 from a cell phone immediately if there is a spill or injury/exposure involving cyanide.

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APPENDIX K – WARM AND COLD ROOM SAFETY

WARM & COLD ROOMS - SAFE WORK PRACTICES

Uses: Warm and cold rooms, also referred to as environmental rooms, are designed to control temperature and humidity. Cold rooms can function as low as 35°F and warm rooms up to 120°F. They are used primarily for the growth of cells and organisms storage, but also for general chemistry and biology.

Ventilation: Environmental rooms typically have a closed air circulation. The only source of fresh air is when the door is opened and closed. Therefore, because environmental rooms have contained atmospheres, **the release of toxic substances from spills or vaporization poses potential occupational health and safety hazards to occupants.**

USE AND STORAGE

Do not conduct work with or store the following materials and equipment in environmental rooms:

- ***Particularly Hazardous Chemicals*** (i.e., highly acutely toxic chemicals, carcinogens, reproductive toxins): Can result in personnel exposure due to the lack of exhaust ventilation.
- ***Volatile flammable solvents***: Exposed circulation fan motors and electrical lab equipment are potential ignition sources.
- ***Volatile acids:*** Can corrode coiling coils in refrigeration systems.
- ***Asphyxiants*** (e.g., compressed gases such as nitrogen or carbon dioxide): May displace oxygen due to limited ventilation rate, resulting in an oxygen-deficient environment.
- ***Dry Ice***: An oxygen-deficent environment can occur from the release carbon dioxide gas.
- ***Open flame*** (e.g., Busen burners).
- ***Food or Beverage:*** They can become contaminated by chemicals or biological organisms. (This includes unopened bottles of beer and other beverages!)

PREVENTING MOLD GROWTH

Unabated mold growth on environmental room surfaces may lead to mycological contamination of research projects and pose potential health problems from inhalation of spores. Spores can also be tracked out of the room and around the entire floor of the building. Minimizing mold growth requires the control of moisture in the environmental room:

- Keep door firmly shut – if left open, water condensation on surfaces increases due to high relative humidity, promoting mold growth.
- Immediately clean up spilled laboratory liquids (e.g., buffers and media). Moisture may lead to rust, corrosion or degradation of environmental room integrity (e.g., shelves).
- Promptly dispose of wet or damp organic materials (e.g., paper products, cardboard, miscellaneous trash, etc.).
- Store paper products (e.g., Kim wipes) in closed plastic container. Do not use or store cardboard boxes or other absorptive material in cold rooms.

REPORTING PROBLEMS

- Report any leaks and maintenance issues to:
  - Maintenance 631-7701
- Report health & safety concerns to your Department Safety Coordinator or RMS @ 631-5037

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APPENDIX L – ROTARY EVAPORATOR (ROTOVAP) SAFETY

ROTOVAP SAFETY

The purpose of a rotary evaporator (also called rotovap) is to remove l organic chemicals, usually solvents, from reaction mixtures. The solvent is removed under vacuum, is trapped by a condenser and collected for reuse or disposal.

HAZARDS

- **Implosions** may result from use of glassware that contains flaws, such as star-cracks.
- **Explosions** may occur from concentrating unstable impurities during evaporation, for example when rotavapping an ethereal solution containing peroxides. This can also occur when taking certain unstable compounds, such as organic azides and acetylides, nitro-containing compounds, molecules with strain energy, etc. to dryness.
- Contact with rotating parts may result from the entanglement of loose clothing, hair or jewelry. Under these circumstances, the winding action of the rotating parts can draw the users into the apparatus resulting in breakage of glassware, burns, and chemical exposure.
- Extra caution must also be applied to operations with air reactive materials, especially when under vacuum. A leak can draw air into the apparatus and a violent reaction can occur.

STANDARD OPERATING PROCEDURE GUIDANCE

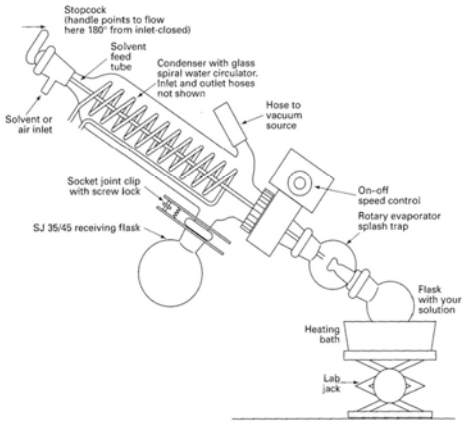
The following information may be integrated into a lab-specific standard operating procedure (SOP) for centrifuge use.

1. Planning for Use

   A. **Complete lab-specific training for the rotovap.**

   Wear appropriate PPE: Including safety eyewear, gloves, lab coat, and appropriate street clothing (i.e., closed-toe shoes). Ensure gloves are compatible with hazard(s). Make sure hair is tied back.

   B. **Inspect rotovap**:
   - Check glassware for cracks and imperfections. Do not use if any are noticed.
   - Use shatter-proof collection bulb.
   - Use safety netting or tape around the condenser.
   - Collection flask should be empty and clean prior to use to prevent accidental mixing of
   - incompatible chemicals.
   - Use clamps to secure flask and bump trap.



2. Rotovap Operation

   A. Make sure that your flask is no more than about half full. If the flask contains too much solvent is more likely to "bump," a term used when the solvent evaporates too quickly, causing the liquid to splash up into the bump trap, or other parts of the rotovap.

   B. Adjust the level of the rotovap so that the instrument is at its highest setting. Squeeze the handle and lift gently.

   C. Adjust the tilt of the rotovap if the flask will not fit properly. The flask should be at an angle, but not be tilted too far such that solvent is touching the lip of the flask. To adjust, pull the knob toward you, and then set the tilt of the instrument. Once the rotovap is adjusted, release the knob. Note: the tilt knob is particularly crucial when using very large flasks.

   D. Check the bath temperature. It is best to keep the temperature between about 27–30 ºC. For less volatile solvents, such as ethyl acetate, the temperature will need to be about 30 ºC, or even slightly higher. Be careful: if the bath is too warm the solvent will bump.

   E. Attach the flask to the bump trap using a Keck clamp. The bump trap is designed to capture any of the solvents that splashes up.

F. Immerse the bottom of the flask in the bath by turning the height adjustment lever and gently lowering the flask into the bath. Usually the flask is lowered such that the liquid level is even with the water level of the bath. If the flask is not placed in a bath, it will become cold while the solvent evaporates. (This phenomenon is observed when rubbing alcohol evaporates off of the skin.) If the solvent becomes cold, it will take longer to evaporate.

G. Turn on the rotation. Turn the knob slowly; the speed increases as the knob is turned further to the right. Rotation allows the liquid in the flask to splash up onto the sides of the round bottom flask, allowing more surface area to be exposed and speeds evaporation. Rotation also helps to prevent bumping.

H. The aspirator vacuum is turned on. On most models, the on/off control is managed by turning a stopcock at the top of the condenser. This stopcock is later used to vent the setup after the solvent is removed.

I. One all the solvent is evaporated (or whatever the desired point is), the vacuum is released and the flask is raised out of the water bath. Rotation (spinning) is discontinued.

J. Clean bump trap and empty receiving flask as appropriate.

EMERGENCY RESPONSE

1. Hazardous Material Spill/Exposure

   A. **Turn off rotovap immediately**.

   B. **Follow spill, exposure, and incident reporting instructions as outlined in section 5.2 of the Chemical Hygiene Plan**

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APPENDIX M – CENTRIFUGE SAFETY

CENTRIFUGE SAFETY

The centrifuge is a commonly used tool in laboratory research. It uses centrifugal force to separate substances in liquid or solid media according to particle size and density differences.

Hazards presented by all centrifuges, including microcentrifuges, if used and/or maintained improperly include:

- **Physical hazards**: Mechanical stress, metal fatigue, and corrosion of the rotor over time
- **Exposure hazards**: Aerosolization of biological, chemical, or radioactive materials

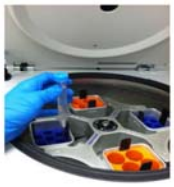
STANDARD OPERATING PROCEDURE GUIDANCE

The following information may be integrated into a lab-specific standard operating procedure (SOP) for centrifuge use.

1. Planning for Use

   A. **Complete lab-specific training for the centrifuge.**

Wear appropriate PPE: Including safety eyewear, gloves, lab coat, and appropriate street clothing (i.e., closed-toe shoes). Ensure gloves are compatible with hazard(s).



   B. **Inspect centrifuge**:
   - Ensure tubes are rated for intended use (speed, temperature, and chemical resistance)
   - Rotor compatible with centrifuge and seated on drive correctly
   - Rotor and safety cups/buckets free of cracks and deformities
   - Rotor O-ring not cracked, missing, or worn
   - Safety cups/buckets attached correctly and able to move freely

   Contact a qualified service technician if inspection identifies centrifuge components requiring repair or replacement.

   C. **Prepare centrifuge tubes for loading**:
   - Inspect centrifuge tubes before use.
   - Follow manufacturer's filling limits for tubes. Do not overfill or under fill tubes.
   - For biohazardous materials, disinfect outside of tubes prior to removal from biosafety cabinet and loading into rotor.

   When centrifuging hazardous materials, use tightly capped tubes and/or sealable safety cups or rotors that can be loaded and unloaded in a ventilation hood or biosafety cabinet, depending on hazard.

   D. **Use in-line filter**: For high speed centrifuges and ultracentrifuges to prevent contamination of vacuum pump and pump oil. Provide secondary containment for vacuum pump.

2. Centrifuge Operation

   A. **Balance centrifuge**
   - If balance tube not available, refer to Figure 1.

   B. **Start run**
   - Do not leave centrifuge until full operating speed is reached and appears to be running safely without incident.
   - Stop centrifuge immediately if you notice any unusual noises or shaking. Confirm rotor is balanced.

   To prevent rotor failure, do not exceed maximum speed and maximum mass limits for the rotor. You must reduce rotor speed if sample density calculations indicate maximum mass limits will be exceeded; contact manufacturer for guidance.

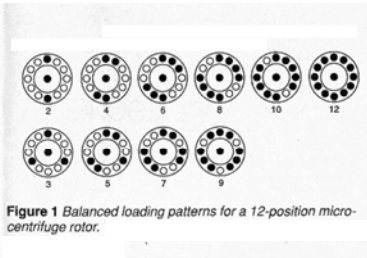


Figure 1 *Balanced loading patterns for a 12-position micro-centrifuge rotor.*

3. Sample Removal

   A. **Stop run**: Ensure centrifuge comes to complete stop before opening cover.

   When centrifuging hazardous materials, wait at least 10 minutes after run to allow aerosols to settle before opening centrifuge.**Check for leaks/spills**: In samples, rotor, safety cups/buckets, and centrifuge well.

B. **Open sealable tubes/safety cups/rotors**: Wear appropriate PPE and open inside ventilation hood or biosafety cabinet, depending on hazard.

CENTRIFUGE MAINTENANCE

1. Preventive Maintenance

Establish preventive maintenance schedule: Including regular cleaning of centrifuge

A. interior to prevent damage and avoid costly repairs. Reference centrifuge operator's manual or contact manufacturer for guidance.

Equipment repair and adjustments shall only be conducted by qualified service technicians.

B. **Maintain log book:** For all high speed centrifuges and ultracentrifuges include run dates, durations, speeds, total rotor revolutions, and notes on rotor condition.

Retire rotors after manufacturer's recommended life span except where annual stress test demonstrates absence of structural flaws. Note: Rotor life span may be reduced or warranty voided if autoclaved; contact manufacturer for guidance.

Mechanical failure of an ultracentrifuge
By permission of Cornell University

2. Centrifuge Disposal

A. For biohazardous materials, clean/disinfect centrifuge and remove/cross out biohazard sticker. Attach note on centrifuge describing what has been done.

B. For radioactive materials, request radiation safety survey and signage be
C. fore disposal of centrifuge.

EMERGENCY RESPONSE

1. Mechanical Failure

A. **Turn off centrifuge immediately and unplug power cord**.

Do not use centrifuge again until inspected by qualified service technician.

2. Hazardous Material Spill/Exposure

A. **Turn off centrifuge immediately**.

Keep centrifuge cover closed for at least 30 minutes to reduce aerosolization of hazardous material.

B. **Follow spill, exposure, and incident reporting instructions as outlined in section 5.2 of the Chemical Hygiene Plan**

Remember:

- Conduct rotor or safety cup/bucket cleanup in nearest biosafety cabinet or ventilation hood, depending on hazard.
- Use tongs or forceps to avoid contact with sharp-edged debris.
- Avoid alkaline cleaners for aluminum centrifuge components.
- Avoid abrasive wire brushes for cleaning.

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APPENDIX N – GAS CYLINDER HAZARDS

Asphyxiation: The primary hazard associated with inert gases.

- Because inert gases may be colorless and odorless, they can escape into the atmosphere undetected and quickly reduce the concentration of oxygen below the level necessary to support life.
- The use of oxygen monitoring equipment is strongly recommended for enclosed areas where inert gases are being used.

Fire and Explosion: Fire and explosion are the primary hazards associated with flammable gases, oxygen and other oxidizing gases.

- Flammable gases can be ignited by static electricity or by a heat source, such as a flame or a hot object.
- Oxygen and other oxidizing gases do not burn, but will support combustion of organic materials.

Chemical Burns: Corrosive gases can chemically attack various materials, including fire-resistant clothing.

- Some gases are not corrosive in their pure form, but can become extremely destructive if a small amount of moisture is added.
- Corrosive gases can cause rapid destruction of skin and eye tissue.

Chemical Poisoning: Chemical poisoning is the primary hazard of toxic gases. Even in very small concentrations, brief exposure to these gases can result in serious poisoning injuries. Symptoms of exposure may be delayed.

High Pressure: All compressed gases are potentially hazardous because of the high pressure stored inside the cylinder. A sudden release of pressure can cause injuries and property damage by propelling a cylinder or whipping a line.

Dropping or dragging a cylinder could cause serious injury.