

UNIVERSITY OF
NOTRE DAME

Chemical Hygiene Plan and Laboratory Safety Manual

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1.0 INTRODUCTION

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

This document provides key information on the practices and procedures that shall be implemented to maintain a safe laboratory environment and ensure compliance with state, federal, and local regulations required for the use and storage of hazardous chemicals in laboratories. The Occupational Safety and Health Administration (OSHA) published standard 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" (OSHA Laboratory Standard), which is used as a reference for this Chemical Hygiene Plan.

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 documented in this Chemical Hygiene Plan.

3.0 SCOPE

This Chemical Hygiene Plan and Laboratory Safety Manual applies to all personnel in University of Notre Dame laboratories who handle and/or may be exposed to chemical and/or physical hazards. For the purpose of this plan, this would apply to all those who are physically present in the laboratory, physically performing experiments, using laboratory equipment or materials, and/or directly supervising those who are present in the laboratory. Note that the requirements laid out in this document supersede any requirements of departmental plans.

This Chemical Hygiene Plan and 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, Laser Safety Manual, and Biosafety Manual.

4.0 RESPONSIBILITIES

4.1 Risk Management and Safety (RMS) including the Chemical Hygiene Officer

4.1.1 Acts as a resource to lab personnel regarding safe handling of chemicals, personal protective equipment (PPE), and spill cleanup.

4.1.2 Acts as a resource to review experimental setups for safety considerations.

4.1.3 Provides training as appropriate and acts as a resource for Safety Coordinators, Principal Investigators (PIs), Principal Lab Contacts (PLCs), Laboratory Safety Officers (LSOs), 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).

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

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

4.1.7 Ensures that appropriate training is available to laboratory personnel.

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

4.1.9 Approves the procurement of CDC Select Agents (See Appendix A) to ensure that facilities and training is adequate for the chemicals requested.

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

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

4.1.12 Fume hood evaluation

- RMS surveys each ventilation hood at least 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 Laboratory Hood Testing Procedure.

4.2 Colleges, Departments, and Notre Dame Research

4.2.1 Provide support to RMS

4.2.2 Work with PIs to ensure all aspects of the program are adhered to.

4.3 Principal Investigator (PI), Laboratory Instructor, and Core Facility Directors

4.3.1 Successfully completes laboratory safety training.

4.3.2 Complies with all federal, state, local and University regulations, guidelines and procedures.

4.3.3 Is responsible for chemical hygiene in their laboratory(ies).

4.3.4 Enforces University, Departmental, and Laboratory policies and procedures regarding safe laboratory practices. Leads by example.

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

4.3.6 Ensures there is a chemical inventory (hard copy or electronic) of chemicals in their lab and ensures that it is available and up to date with appropriate chemical information.

4.3.7 Assigns the designated area(s) for use with select agents and/or particularly hazardous chemicals (PHS; carcinogens and/or reproductive hazards and highly toxic chemicals) in their laboratory as appropriate.

4.3.8 Informs all employees, students and visitors that safety and health are the highest priorities, through the communication of safety and health policies, rules, regulations, and procedures, as well as their specific responsibilities, as determined by the Laboratory Safety Advisory Committee (LSAC).

4.3.9 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, as well as when working in other laboratories.

4.3.10 Ensures lab specific training is provided to lab personnel. Ensures this training is documented by storing it in a central, accessible location, either online or physically in the lab. (See Section 7.1.4.)

4.3.11 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.

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

4.3.13 Ensures notification is made to RMS and Utilities and Maintenance before structural changes in the laboratory are made.

4.4 Laboratory Personnel

4.4.1 Plans and conducts all operations in accordance with established chemical hygiene and safety procedures and develops good personal safety habits.

4.4.2 Successfully completes laboratory safety training.

4.4.3 Uses appropriate safe work practices, personal protective equipment and engineering controls at all times.

4.4.4 Is aware of the hazards associated with chemicals and equipment they are working with or near. Understands and utilizes safe storage, handling, and disposal procedures for these chemicals.

4.4.5 Follows departmental and laboratory SOPs.

4.4.6 Promptly reports unsafe conditions to their laboratory instructor, PI, lab

manager, principal lab contact, Department/Unit Safety Coordinator, or RMS as soon as any unsafe condition is noticed.

4.4.7 Learns the location and use of all available emergency safety equipment.

4.5 Notre Dame Fire Department (NDFD) or Authorized Designee

4.5.1 Fire Extinguisher Inspections

4.5.1.1 Monthly inspections to verify:

- 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.

4.5.2 These inspections shall be documented and maintained by NDFD.

4.5.3 Servicing and maintenance is performed annually.

- 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.

4.5.4 Fire Alarms

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

4.5.5 Smoke or heat detectors

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

4.5.5.2 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.

4.6 Utilities and Maintenance or Authorized Designee

4.6.1 Safety Showers and Eyewashes

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

4.6.1.2 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.

4.6.1.3 A highly visible sign shall be installed near the safety showers

and eyewashes.

4.6.1.4 Water supply

- The water is tepid (60 °F -100 °F).
- The water flow is controlled so not to be 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.

4.6.1.5 Location:

- The units shall be within 10 seconds of hazard; for strong corrosives, eyewash shall be immediately adjacent.
- 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.

4.6.1.6 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 (60 °F – 100 °F).
- The water flow is controlled so not to be 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 simultaneously.

4.6.2 Ventilation Hoods

4.6.2.1 Routine maintenance is completed by Utilities and Maintenance on items such as belts and fans.

4.7 The Institutional Biosafety Committee (IBC)

4.7.1 Reviews procedures and proposals with regard to CDC Select Agents.

4.7.2 Reviews non-compliance reports on these regulations with personnel involved and takes administrative action, if necessary, to ensure provisions of these regulations are met.

5.0 RISK ASSESSMENT (See Appendix C)

5.1 A Risk Assessment shall be completed by the PI or designee to evaluate the potential hazards associated with the work to ensure safe practices are developed. The Risk Assessment Tool (Appendix C) is an option for conducting lab risk assessment. Risk shall be re-evaluated bi-annually or any time significant changes are made to material use and/or the experiment.

5.2 This tool evaluates risk associated with:

- Inhalation, injection, ingestion, and skin absorption exposure routes;

- Hazardous materials;
- Physical hazards;
- Equipment hazards;
- Electrical hazards; and,
- Thermal hazards.

6.0 EMERGENCY PROCEDURES

6.1 Emergency Action Plans

6.1.1 Each department or unit shall (with the assistance of RMS, if necessary):

- Identify designated evacuation assembly point(s);
- 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; and,
- Make the emergency action plan available to all personnel.

6.1.2 Principal Investigators shall ensure emergency evacuation and severe weather procedures training is completed by lab personnel and documented.

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; and,
- 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 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 where caller can be reached during response; and
- Facts concerning the emergency (e.g., fire, accident, injury).

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 Wellness Center or the University Health Services as appropriate or call 911 or 631-5555 (cell phone) for assistance.

6.3.3 Medical Providers:

Lab Personnel Status	ND Wellness Center	UHS/St. Liam's Hall	After Hours
Students (Grad or Undergrad) enrolled in a class		X	St. Liam's
Undergrad students in a research lab as part of a class		X	St. Liam's
Any paid (Salary or stipend, including paid grad and undergrad students) lab personnel	X		Med Point 24 – 6913 N. Main St. Granger
Non-ND personnel (volunteers/visitors)	Report to their medical provider.		

Specific examples of common situations for graduate and undergraduate students:

- Rotating graduate students injured in a lab due to a lab-related incident should go to the Wellness Center.
- Undergraduates working in a research lab for independent lab credit that is not part of a class should go to the UHS/St. Liam's.
- Students, graduate or undergraduate, who require medical assistance that is NOT related to an injury or condition stemming from an incident in the lab should go to UHS/St. Liam's regardless of pay status.
- Undergraduates and graduate students who get injured in the lab or office while not working (eg. not actively participating in lab work at the time of the injury) should go to UHS/St. Liam's.

6.4 Fires

6.4.1 Individuals are not required to fight fires; but trained personnel who choose to do so may fight small, incipient stage fires (no bigger than a wastepaper basket). Online training is available through *eNDeavor*. Hands on Training can be requested by contacting NDFD at 574-631-6200.

- Call 911 before using the fire extinguisher and if possible, activate the building fire alarm system.
- 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.

6.4.2 If evacuation is necessary:

- Close the door behind you to prevent the fire's spread, but leave unlocked if possible
- 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 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.

7.0 **LABORATORY PERSONNEL TRAINING**

7.1 All laboratory personnel shall be trained on the hazards present in their work area before the start of laboratory work.

7.1.1 Refer to Appendix D for the Laboratory Training Needs Assessment (TNA). (See also 7.2.1) This includes training criteria and frequency. Some topics require annual refresher training (e.g., Laboratory Safety Training).

7.1.2 Online Fire Extinguisher Training is required annually for anyone working in the laboratory. Hands on Extinguisher Training is available upon request from NDFD.

7.1.3 Laboratory Safety Training is available online through *eNDeavor* or provided by the Chemical Hygiene Officer or qualified designee.

7.1.4 All personnel working in laboratories must take Lab Safety Training. This training must be completed annually. Additionally, faculty and staff must also take Incident Reporting and Access to Medical Records Training online.

7.1.5 The training shall include:

- Physical and health hazards of chemicals in the work area;
- Handling of hazardous materials - acquisition to disposal;
- The use of 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 Lab Safety Manual

w/Chemical Hygiene Plan; and,
- Signs and symptoms associated with exposure associated to hazardous chemicals used in the laboratory.

7.1.6 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 and/or department.

7.2 Training Needs Assessment/Training Matrix

7.2.1 The PI or designee shall develop a Training Needs Assessment (TNA) for each lab member. See Appendix D for a Sample Training Needs Assessment/Training Matrix.

7.2.2 A current TNA shall be maintained for each lab member, or lab member position, by the PI or designee.

7.2.3 The Training Needs Assessment shall be reviewed and updated by the PI or designee as research and/or lab activities change and include different hazards.

7.3 Training Records

7.3.1 Lab Specific training records shall be maintained per the University Record Management and Archive Policy.
- These records may be retained electronically or in hard copy format.
- Records must be readily available upon request during RMS lab assessments.

8.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

8.1 Purpose

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

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

8.2 Default PPE when personnel are in Notre Dame laboratories with hazards includes the following:

8.2.1 Eye protection – This includes safety glasses or goggles, 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 Shirt with the equivalent or greater coverage of a T-shirt.

8.2.4 Closed-toe shoes with substantial soles. Shoes must enclose the entire foot and preferably be made with liquid-resistant materials. Examples of closed-toed shoes that are not acceptable include but are not limited to ballet flats and crocs.

8.2.5 These requirements apply to all individuals when inside a laboratory. This

includes laboratory personnel, visitors, students, service personnel, etc.

8.2.6 The PPE requirements may be adjusted as needed to fit individual laboratory circumstances:

- The PPE may be upgraded as designated by the department or PI.
- The Local Department/Unit Safety Committee may also relax the PPE (except the shoe and shirt requirement) when:
  1. All hazards requiring PPE have been eliminated or mitigated via engineering controls and documented on the PPE Hazard Assessment Form (see Section 8.3), and
  2. The PI or designee requests a review of the PPE Hazard Assessment by the Department/Unit Safety Committee for the change. The Department/Unit Safety Committee and RMS will review the PPE Hazard Assessment.
  3. If the change is approved, the PI or designee shall post the modified PPE requirements using the standard door signage.

8.3 General PPE Requirements

8.3.1 PI or designee shall perform a PPE assessment for their laboratory. These assessments shall also be performed as research changes to include new hazards.

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 Form 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 laboratory PPE certification form initially and when changes occur. (See Appendix F for sample PPE certification.)
- Tasks which require additional and/or specialized PPE shall be covered in a task-specific Job Hazard Assessment (JHA) or SOP.

8.3.4 The PPE Assessment and Certification documents shall be maintained by the laboratory PI as per the University Record Management and Archive Policy.

- 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 or goggles shall always be worn when eye hazards are present.

8.4.4 When wearing contact lenses, it is best practice to wear goggles instead of safety glasses to avoid splashes under the safety glasses interacting with the material of the contact lens.

8.4.5 When performing activities such as using a microscope, safety glasses do not

need 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.

8.4.7 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 appropriate 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. This includes any spills on or punctures to the glove.
- Disposable gloves shall not be reused.
- While in the lab, remove gloves prior to handling items that may be handled without gloves such as phones or doorknobs.
- Gloves must be removed prior to leaving the laboratory; gloves on both hands are not to be worn outside the lab space or in the hallway. In instances where gloves are required for sample handling, one hand must remain ungloved in order to interact with doorknobs to avoid contamination.
- Gloves shall not be placed in general recycling.

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 some flammable materials, a fire resistant lab coat is required. See Appendix G for details.

8.6.3 Lab coats/aprons shall be stored away from personal clothing.

8.6.4 Cleaning of lab coats/aprons:
- Lab coats/aprons shall not be taken home or to a non-commercial laundry to clean.
- Labs shall establish a process for proper cleaning through St. Michael's

Laundry or other service.

- For students in undergraduate teaching labs, consult the relevant department's procedure.
- Lab coats shall be cleaned regularly.

8.6.5 Lab coats are not to be worn outside of the lab in common areas, kitchenettes, personal offices, and group spaces. Additionally, lab coats are not to be worn in the hallways unless moving on non-carpeted flooring through hallways where food is neither stored nor consumed. If labs are spread across buildings such that travel requires moving on carpet or past food spaces, one lab coat per space per person should be provided. In instances where labs are BSL-2 rated, lab coats are never to be worn outside of the lab.

8.6.6 Lab coats for common use equipment, such as liquid nitrogen fill stations, should be provided near the equipment. Users should wear lab coats provided and not wear their personal lab coats from the lab.

8.7 Foot Protection

8.7.1 Closed-toe shoes with substantial soles shall be worn at all times in labs where chemical or physical hazards are present. Perforated or mesh shoes, flip-flops, ballerina flats, or sandals shall not be worn. Liquid resistant shoes are not required at this time, but are recommended.

8.7.2 Chemical resistant overshoes or boots may be used to avoid possible exposure to corrosive chemicals 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 need to be discarded if contaminated with a hazardous material.

8.7.3 Protective footwear (steel-toe, dielectric, 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 All personnel who are required or volunteer to wear a respirator shall comply with the OSHA Respiratory Protection Standard at 29 CFR 1910.134. 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:

- When selecting a dust mask 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. Refer to the Hearing Conservation Program.

8.9.2 Contact RMS where there are concerns about the noise level in the area. RMS will help determine if the area qualifies for entry into the Hearing Conservation Program.

8.9.3 When selecting hearing protection for the first time, consult with RMS. Use appropriate protection such as earmuffs or earplugs when exposed to high noise levels.

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 Fire extinguishers may only be used by those who are current with annually required fire extinguisher training.

9.1.5 There are several types of fire extinguishers available. Keep appropriate fire extinguishers available depending on hazards present in the space and communicate their specific purpose/use with lab personnel.

- 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.
- Class K – used in kitchens to combat grease fires; typically not

seen in lab spaces.

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 adequate flow, tepid temperature, eye pieces covered and that eyewash use is not blocked. These inspections shall be documented. Inspection sheets can be found on the RMS website.
  - 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 pipettors 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 > 15 lbs. shall not be stored above 6 ft. Nothing shall be stored on top of refrigerators, freezers, or flammable cabinets.

10.3.4 Storage of material within 18 inches of the ceiling in sprinklered spaces is prohibited.

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

10.3.6 Emergency exits shall be kept unlocked from the inside.

10.3.7 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, chewing tobacco, chewing gum, oral nicotine pouches, and vaping/smoking are prohibited in the laboratory.

10.4.2 Long hair and loose clothing shall be confined. Obtrusive, long, or loose-fitting headwear shall be removed with the exception of religious head coverings, which should be tucked into the lab coat. Jewelry must be restrained or removed.

10.4.3 The application of makeup, including lip balm, shall be prohibited in the laboratory.

11.0 **GENERAL 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. Electrical tape is not an acceptable repair for frayed or exposed wiring. Remove the cord and replace with a new one, work with an electrician to repair the cord, or remove the item from service and dispose.

11.3 Cords should be kept out of work areas. If this situation is unavoidable, cords shall be secured to the floor with tape, cord molding, or protection strips as to not create a trip hazard.

11.4 Wires shall not be stretched across other equipment.

11.5 Personnel should know location of circuit breakers.

11.6 Do not use electrical equipment to perform a task for which it is not designed. Surge protectors shall not be daisy-chained (one surge protector plugged into another surge protector or extension cord).

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

11.7.1 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).

11.7.2 Permanent wiring shall be installed for long-term or repetitive needs. An extension cord may be used while awaiting permanent wiring.

11.7.3 Extension cords may not be daisy-chained (one extension cord plugged into another extension cord).

11.7.4 Damaged extension cords shall be replaced. They shall not be spliced or repaired with electrical tape.

11.7.5 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.

11.7.6 Extension cords are to be unplugged when not in use.

12.0 **UNATTENDED OPERATIONS**

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

12.2 Caution is required when performing unattended operations:

12.2.1 A sign shall be posted on the lab door to communicate appropriate warnings and precautions. An 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.
12.2.4 All experiments shall be designed to failsafe. If this is not possible, the experiment does not qualify for an unattended operation.

13.0 **LABORATORY SECURITY**

13.1 Laboratories shall be closed and locked when no one is present or within eyesight.
13.2 Unknown persons shall not be permitted into a secure area.
13.3 Contact NDPD at 911 or 574-631-5555 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 implosion under vacuum. Defective / broken glassware shall be disposed of in a broken glassware container or removed from service for repair.
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 Hot glass and cold glass look identical. Be cautious when handling glassware that has either come out of an oven or is around heat. Use temperature-appropriate gloves. Do not handle hot glassware without thermal gloves.
14.5 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. Bell jars on vacuum pumps and vacuum desiccators should be shielded in cabinets or behind blast shields.
14.6 Plastic coated glassware should be used where possible when vacuum is present in a system. Glass dewars must be taped solidly around the outside if plastic coatings are not available.
14.7 Exercise care in removing frozen glass stoppers.
14.7.1 First try soaking glass stopper in hot water to expand the glass.
14.7.2 Slowly apply minimal pressure with the thumbs working around the glass stopper.
14.7.3 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 SHARPS

15.1 Sharps include razor blades, syringes, needles, and scalpel blades.
15.2 Eliminate the use of sharps whenever possible.
15.3 Use needles with self-storing sheaths or those designed to protect the user.
15.4 Always keep sharps in view and open only one needle at a time.
15.5 Use appropriate gloves.
15.6 Never bend, shear, or break disposable needles or remove them from disposable syringes.

15.7 Do not recap needles. If absolutely necessary to recap, use the one hand method or a device that aids in sharps recapping. These devices should adhere to the benchtop to prevent movement and hold the cap of the needle, allowing the user to uncap and recap with one hand. Contact RMS if assistance is needed in selecting or procuring a recapping device.

15.8 Sharps Disposal
- 15.8.1 Dispose of the sharps immediately in appropriate sharps containers.
- 15.8.2 Place disposal container close to work area.
- 15.8.3 Do not reach into the sharps disposal container
- 15.8.4 Do not remove the lid from the sharps disposal container.
- 15.8.5 Do not overfill the sharps container.
- 15.8.6 Consult Hazardous Waste Procedure for proper disposal of sharps/sharps containers.

16.0 REFRIGERATORS, FREEZERS, AND COOLERS/COLD ROOMS

16.1 Dry ice shall not be placed in a walk-in cooler or cold room.
16.2 The potential hazards posed by laboratory refrigerators and freezers involve vapors from the contents, the possible presence of incompatible chemicals, and spillage.

16.3 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."

16.4 Only refrigerators and freezers specified for laboratory use shall be utilized for the storage of chemicals requiring reduced temperature storage
- 16.4.1 These refrigerators are 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.
- 16.4.2 Standard refrigerators have electrical fans and motors that make them potential ignition sources for flammable vapors.
- 16.4.3 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 but rather must

be stored in a flammables-rated refrigerator.

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

- Many of them have a drain, 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.

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

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

16.5.1 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 shall be used.

16.5.2 Labels and ink used to identify materials in the refrigerators shall be water-resistant. Using sharpies or other permanent markers directly on glass is not an acceptable method for labeling materials for long term storage (>90 days).

16.6 Container storage

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

16.6.2 Chemicals shall not be stored on their sides.

16.6.3 Cardboard boxes shall not be used as long-term storage in cold rooms to prevent mold formation.

16.7 Loss of electrical power can produce extremely hazardous situations.

16.7.1 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.

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

16.7.3 In the event of power loss, dry ice or alternate power sources can be used to prevent refrigerator and freezer contents from warming.

16.7.4 For equipment that must remain powered in case of a loss of power, such as refrigerators and freezers with hazardous or valuable samples, ensure that they are connected to circuits that are hooked up to back up power sources. Contact the building manager to identify these circuits and outlets.

17.0 **LOCK/TAG/TRY**

17.1 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/Tag/Try Safety training as specified in the Lock/Tag/Try Program.

18.0 CHEMICAL AND HAZARD IDENTIFICATION

18.1 Chemical Manufacturer Safety Information

18.1.1 Includes physical and health hazard information and is provided in the chemical label and the Safety Data Sheet.

18.2 Labels

18.2.1 The manufacturer's label shall be kept intact.

18.2.2 Do not intentionally deface or obscure the label or the hazard warnings until the container has been completely emptied.

18.2.3 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.

18.2.4 Hazard warning labels can be downloaded from the RMS Laboratory Safety website.

18.2.5 Date all chemical containers with the dates they are received and opened. Pay special attention to time-sensitive chemicals, such as peroxide-formers.

18.3 Safety Data Sheets (formerly known as Material Safety Data Sheets – MSDS)

18.3.1 Safety Data Sheets (SDS) shall be maintained by the laboratory, if received. They may be maintained electronically. The University of Notre Dame currently uses MSDSOnline to collect all SDSs for chemicals on campus. Labs should use MSDSOnline as either their main SDS repository or in addition to their other system. MSDSOnline can be accessed through the RMS webpage or at this link: https://msdsmanagement.msdsonline.com/024d970f-4536-4bc3-8ff8-4444c0cda6ed/ebinder/?nas=True

18.3.2 SDSs are sometimes difficult to interpret. For more information about understanding and using a SDS, see OSHA's Quick Card on Hazard Communication Safety Data Sheets, OSHA SDS, and OSHA Labeling and Pictograms.

18.3.3 If a desired 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 at 631-5037 or labsafety@nd.edu for assistance.

19.0 CHEMICAL PROCUREMENT, INVENTORIES, STORAGE, HANDLING AND DISPOSAL

19.1 Procurement

19.1.1 A SDS shall be requested for all hazardous chemicals if the SDS is not available online.

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

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

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

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

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

19.1.6.1 Prior to use, an IBC Hazardous/Infectious Materials Document shall be submitted to the IBC.

19.1.6.2 Proper storage and handling procedures shall be identified.

19.1.6.3 Adequate facilities to safely handle the material and designated area for carcinogen use in the laboratory shall be established.

19.2 Inventory

19.2.1 Each PI shall ensure a chemical inventory is maintained and updated at least annually, preferably as a living document as chemicals are ordered and arrive at the lab. The inventory shall include all chemicals in their laboratory(ies). Specifically, the inventory shall:

19.2.1.1 Note the location of the chemical. Minimally, this shall include the building name and lab room number. Ideally, for labs with larger chemical inventories, this would include the location within the lab (eg. flammable cabinet, refrigerator, corrosive cabinet).

19.2.1.2 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, including the CAS number.

19.2.1.3 The maximum quantity of the chemical container (eg. 4 L, 500 g, etc.).

19.2.1.4 The manufacturer and product/catalog number (if available).

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

19.3 Chemical Storage

19.3.1 Hazardous chemicals and liquids shall be stored at a height not to exceed 6 feet.

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

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

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

19.3.5 Consult SDS for storage recommendations.
19.3.6 Chemicals shall be segregated by hazard class. Consult Appendix H and the list of Common Incompatible Chemicals for storage options. When space is limited and difficulties segregating chemicals are present, consult with RMS to develop a plan to fit the space.
19.3.7 Avoid stockpiling chemicals.
19.3.7.1 Purchase only what is needed.
19.3.7.2 Use older stock first.
19.3.7.3 Discard chemicals that are no longer needed or that have expired.
19.3.7.4 Consult Safe Handling of Time Sensitive Chemicals for additional information on expiration time frames.
19.3.8 Hallways shall not be used as storage areas for chemicals.
19.3.9 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.

19.4 Chemical Handling
19.4.1 Prior to use, laboratory personnel shall review the safety and health hazard data of all the chemicals that will be used by consulting the pertinent SDSs, available on the RMS SDS Webpage.
19.4.2 Close caps securely.
19.4.3 Never use unlabeled chemicals.
19.4.4 Never use expired chemicals.
19.4.5 Never add excess chemicals back to their original bottles. Dispose of the excess appropriately.
19.4.6 Add acid or strong bases to water.
19.4.7 Labels (See Section 7.2):
19.4.7.1 Be sure all labels are securely attached and legible.
19.4.7.2 Keep chemicals in their original container if possible.
19.4.7.3 Label all secondary containers to avoid unknown chemicals and/or inadvertent reaction.

19.5 Transporting Chemicals
19.5.1 Use clean bottle carriers to transport chemicals between labs.
19.5.2 The preferred method to transport multiple chemicals between laboratories is on a clean cart.
19.5.3 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.

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

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

19.5.6 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.

19.6 Flammable Liquids

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

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

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

19.6.4 Information on the properties of a specific liquid can be found in that liquid's SDS, or other reference material.

19.6.5 Review the list of flammables and combustibles by class to assist with storage compliance.

19.6.6 Flammable storage cabinets shall follow the requirements outlined in NFPA 30 and shall be chosen based on both the class of flammable chemical and the quantity intending to be stored. For guidance, contact RMS.

19.6.7 Flammable cabinets must be grounded when flammables are actively dispensed from the cabinet (eg. a pump is used to dispense flammable solvent from a drum that doesn't leave the flammable cabinet) or when storing Class IA flammable materials. See Appendix G for a list of common flammable and combustible liquids organized by class.

19.7 Regulated Chemicals & Particularly Hazardous Substances – Carcinogens, Reproductive Toxins, and Acutely Toxic Materials

19.7.1 A Particularly Hazardous Substance (PHS) is defined by the OSHA Laboratory Standard as a select carcinogen, reproductive toxin, and/or a substance that has a high degree of acute toxicity.

19.7.2 All PHS must have SOPs developed by the laboratory and reviewed by the PI for work involving these materials.

19.7.3 PHS special handling procedures:

19.7.3.1 Avoid or minimize contact with these chemicals by any route of exposure.

19.7.3.2 Use chemicals only in a chemical fume hood or other approved appropriate containment device, such as a glove box.

19.7.3.3 Analytical instruments or other laboratory equipment generating vapors and/or aerosols during their operation should be locally exhausted or vented in a chemical fume hood.

19.7.3.4 Work surfaces should have the ability to be easily decontaminated or protected from contamination with plastic trays or plastic backed paper.

19.7.4 Storing and transporting PHS

19.7.4.1 Particularly hazardous chemicals that are volatile should be stored in a vented storage area in an unbreakable, primary or secondary container, or placed in a chemically resistant tray to contain spills.

19.7.4.2 Nonvolatile hazardous chemicals should be stored securely in cabinets or drawers.

19.7.4.3 Access to all chemicals should be restricted.

19.7.4.4 Cyanide salts and some chemicals listed as chemical warfare agents must be stored in a locked cabinet or locked storage area. If you are unsure whether your material requires these storage conditions, contact RMS.

19.7.4.5 All hazardous chemicals should be transported between laboratories in durable outer containers or chemical carriers. The outside of the containers or carriers should be decontaminated and safe to handle without gloves.

19.7.5 PHS Designated Area Requirements

19.7.5.1 All procedures with PHS must be performed in designated areas. The designated area can be the entire laboratory, an area within a laboratory, or a storage or containment device such as a laboratory fume hood or glove box.

19.7.6 Decontamination and Waste Disposal

19.7.6.1 Decontamination and disposal of waste must be included in the SOP before beginning work.

19.7.6.2 Refer to the SDS or contact RMS for substance-specific decontamination and disposal procedures

19.7.6.3 Chemical waste from procedures using PHS should be placed in containers, tagged, and placed in a designated accumulation area until picked up by RMS. If possible, chemically decontaminate all toxic substances to nontoxic materials as part of the procedure.

19.7.7 Information disclosure prior to beginning work

19.7.7.1 Lab personnel of childbearing age should be informed of any known reproductive toxins used in the laboratory.

19.7.8 Examples of carcinogens and reproductive toxins are listed in **Appendix J**. This is not a comprehensive list, but contains many of the more common PHS that are worked with in laboratories. As previously stated, SOPs are required

for all work involving these chemicals.

19.8 Spill Response

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

19.8.2 Lab personnel shall safely clean up spills within the lab if they have been trained and:

19.8.2.1 Lab personnel know what the chemical is.

19.8.2.2 Spill is small enough for lab personnel to handle.

19.8.2.3 Lab personnel have appropriate PPE.

19.8.3 If laboratory personnel cannot clean up the spill, call 911 or 631-5555 from a cell phone for emergency response assistance.

19.9 Chemical Disposal Procedures

19.9.1 Waste Containers:

19.9.1.1 All waste containers shall be labeled with the chemical name or constituents, percentage of chemicals if mixture, and the words Nonhazardous Waste or Hazardous Waste (e.g., Waste Acetone, Waste mixed acids, Hazardous Waste Mixed Solvents 10% halogenated).

19.9.1.2 Chemical containers shall be covered/closed at all times unless directly adding waste. (Open funnels cannot be left in open bottles.)

19.9.1.3 Waste containers shall not be stored in the sink.

19.9.1.4 Waste containers stored on the floor shall be placed in secondary containment. Waste containers with liquid waste shall be placed in secondary containment regardless of where they are stored. This secondary containment must contain 10% of all combined bottles or 110% the volume of the largest container, whichever volume is larger.

19.9.1.5 Prior to pick up by RMS for disposal, chemical containers shall be labeled with a discard tag properly completed through OnBase.

19.9.2 Waste pickups are conducted as Chemical Discard Tags are submitted and are usually completed within 2 - 3 business days.

19.9.3 For additional information, chemical disposal procedures in the Hazardous Waste Procedure are located on the RMS Hazardous Waste Website.

20.0 COMPRESSED GAS CYLINDERS

20.1 Types of Compressed gases

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

20.1.1.1 Flammable Gases;

20.1.1.2 Oxygen and Oxidizing Gases;

20.1.1.3 Acid and Alkaline Gases;

20.1.1.4 Highly Toxic Gases;
20.1.1.5 Cryogenic Liquefied Gases; and,
20.1.1.6 Inert Gases.

20.2 Handling and Storage Gas Cylinders

20.2.1 See the Laboratory Flammable/Combustible Liquid & Compressed Gas Handling/Storage Procedure for more information.

20.3 Leaking Cylinders

20.3.1 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.

20.3.2 Lab personnel shall not attempt to repair leaking cylinders.

20.3.3 If 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).

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

20.4 Gas Cylinder Hazards

20.4.1 Asphyxiation: The primary hazard associated with inert gases.

20.4.1.1 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.

20.4.1.2 The use of oxygen monitoring equipment is strongly recommended for enclosed areas where inert gases are being used.

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

20.4.2.1 Flammable gases can be ignited by static electricity or by a heat source, such as a flame or a hot object.

20.4.2.2 Oxygen and other oxidizing gases do not burn, but will support combustion of organic materials.

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

20.4.3.1 Some gases are not corrosive in their pure form, but can become extremely destructive if a small amount of moisture is added.

20.4.3.2 Corrosive gases can cause rapid destruction of skin and eye tissue.

20.4.4 Chemical Poisoning: Chemical poisoning is the primary hazard of toxic gases.

20.4.4.1 Even in very small concentrations, brief exposure to these gases can result in serious poisoning injuries.

20.4.4.2 Symptoms of exposure may be delayed.

20.4.5 High Pressure: All compressed gases are potentially hazardous because of the high pressure stored inside the cylinder.

20.4.5.1 A sudden release of pressure can cause injuries and property damage by propelling a cylinder or whipping a line.

20.4.5.2 Consider using a hose safety whip check.

20.5 Empty Cylinders

20.5.1 Remove the regulator and replace the cylinder cap.

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

20.5.3 Do not store full and empty cylinders together.

20.5.4 Do not have full and empty cylinders connected to the same manifold, unless the manifold has been specifically designed for this purpose (e.g., an auto-switch manifold). Reverse flow can occur when an empty cylinder is attached to a pressurized system unless the system is designed to prevent this.

20.5.5 Do not refill empty cylinders. Only the cylinder supplier shall refill cylinders.

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

21.0 DRY ICE

21.1 Dry Ice Description and Hazards

21.1.1 Dry ice is the solid form of carbon dioxide that is available in flakes, pellets, or block form and is non-combustible

21.1.2 Dry ice will sublime (vaporize directly to the gas state) at a temperature of -78.5 °C (-109.3 °F) or higher. Dry ice will sublimate about 5 to 10 pounds every 24 hours (blocks last longer due to decreased surface area) in a typical storage cooler.

21.1.3 Handle dry ice with appropriate insulated gloves. Using bare hands can result in burns/frostbite to the skin in a short period of time.

21.1.4 Use of dry ice in poorly ventilated areas can result in the depletion of the oxygen level, resulting in asphyxiation. Do not store dry ice in a cold room.

21.1.5 Placing dry ice into a tightly sealed container can produce sufficient gas buildup to cause an explosion.

21.2 Shipping Packages with Dry Ice

21.2.1 University personnel responsible for shipping packages containing dry ice shall be properly trained in the Department of Transportation (DOT) and/or International Air Transportation Association (IATA) shipping requirements. Training is available through *eNDeavor*.

21.2.2 General shipping requirements:

21.2.2.1 Dry ice shall be packaged in containers that allow for the release of CO_2 gas. No air-tight containers shall be used.

21.2.2.2 Packages shall be labeled with the MISCELLANEOUS LABEL (see Appendix J for an example label).

21.2.2.3 Packages must be marked next to the miscellaneous label with the UN NUMBER and the PROPER SHIPPING NAME.

21.2.2.4 The NET WEIGHT of dry ice must be marked on the outside of the package.

21.2.2.5 The SHIPPER'S DECLARATION should NOT be COMPLETED UNLESS dry ice is used as a refrigerant for shipment of another dangerous good that requires the completion of the Shipper's Declaration. Do not complete the Shipper's Declaration for shipping diagnostics or biological products on dry ice.

21.3 Dry Ice Storage Controls

21.3.1 Dry ice is to be stored in a well-ventilated location and placed in a Styrofoam chest, insulated cooler, or a special cooler designed for the storage of dry ice.

21.3.2 Because of the thermal expansion of dry ice (one pound of dry ice produces about 250 L of gaseous carbon dioxide), do not store in a tightly sealed or air-tight container.

21.3.3 Do not use or store dry ice in confined areas, walk-in refrigerators, environmental chambers, or rooms without ventilation.

21.3.4 Dry ice baths should be open to the atmosphere to avoid pressure build up.

21.3.5 Storage containers require hazard communication labeling. See Appendix J for an example label.

21.3.6 Personnel handling dry ice shall be trained on the hazards (Section 24.1).

21.4 Dry Ice PPE requirements

21.4.1 Safety goggles, cryogenic gloves, lab coat, and lab apron shall be worn when handling cryogenic liquids and large quantities of dry ice (eg. when filling a smaller container of dry ice from a large bulk area).

21.4.2 When handling small quantities of dry ice (under 5 pounds), a lab apron may be optional, but safety goggles, cryogenic gloves, and a lab coat are all still required.

21.5 Disposal of unneeded dry ice

21.5.1 Let the unused portion sublimate in a well-ventilated area (eg. a fume hood). This may happen over several days if a large volume is being disposed. Solid blocks will take longer to sublimate than pellets or grains.

21.5.2 Never dispose of dry ice in a sink, toilet, or other drain. The extreme cold can damage plumbing and lead to leaks and broken pipes.

21.5.3 Never dispose of dry ice in the trash or garbage.

21.5.4 Never leave surplus dry ice in the corridors or hallways.

22.0 GENERAL PRINCIPLES FOR CONTROLLING CHEMICAL EXPOSURES

22.1 The hierarchy of hazard controls includes:

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

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

22.1.3 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.

22.1.4 Personal protective equipment: worn by individuals to reduce exposure with chemicals.

22.2 Elimination/Substitution

22.2.1 Substitute a less hazardous chemical whenever possible

22.2.2 Experiments should be designed with the lowest volumes and quantities necessary and with the least hazardous chemicals possible for the reaction

22.3 Engineering Controls

22.3.1 After elimination and substitution, the use of engineering controls is the preferred method for reducing exposure to hazardous chemicals. Examples include but are not limited to:

22.3.1.1 Isolation or enclosure of a process or operation.

22.3.1.2 Use of wet methods to reduce generation of dusts or other particulates.

22.3.1.3 General dilution ventilation.

22.3.1.4 Local exhaust, including the use of ventilation hoods and glove boxes.

22.3.2 Evaluation of control measures

22.3.2.1 Air sampling for evaluating exposure to chemical substances as required by regulation.

22.3.2.2 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). OSHA's Annotated Table of PELs Including ACIGH Limits

22.3.2.3 The PEL is a legal limit in the United States for exposure 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/m^3).

22.3.2.4 The University of Notre Dame follows the ACIGH (see Appendix A) or the most restrictive established limit.

22.3.2.5 Results of any air sampling studies shall be communicated with the affected laboratory, unit and/or department and records shall be maintained by RMS.

22.4 Work Practice and Administrative Controls

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

22.4.1.1 Limit access to the lab when hazardous work is being conducted.

22.4.1.2 Train all lab personnel.

22.4.1.3 Incorporate administrative controls such as rotating job assignments and adjusting work schedules so that lab personnel are not overexposed to a chemical.

22.4.1.4 Incorporate administrative controls in conjunction with engineering controls and PPE controls to minimize exposures.

22.4.1.5 Communicate with other lab personnel about what hazards

are present during experiments occurring in the space.

22.5 Personal Protective Equipment (PPE)

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

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

22.5.2.1 After removing gloves.

22.5.2.2 Before leaving the laboratory area as soon as reasonably possible.

22.5.3 Lab coats and gloves shall not be worn outside the lab to reduce contamination except as outlined above in Sections 8.6.5 and 8.6.6.

23.0 VENTILATION HOODS, LABORATORY VENTILTATION, AND OTHER ENGINEERING CONTROLS

23.1 Laboratory ventilation requires a minimum of 6 air changes per hour in the lab space. Lab air must not recirculate into other areas of the building.

23.2 Ventilation Hoods

23.2.1 Best practice determines hood face velocity to be 80-100 linear feet per minute (fpm) for safe operation. If hoods register at ≤ 60 fpm or ≥ 115 fpm, place a sign on the hood restricting use and contact RMS Lab Safety (labsafety@nd.edu) to submit a service request. If the flow is outside of the working range, the protection that the hood typically provides can be inadequate as fumes can either escape due to too little flow or blown back out due to too high a flow.

23.3 Necessity of chemical ventilation hoods.

23.3.1 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.

23.3.2 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.

23.3.3 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.

23.3.4 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.

23.4 Hood Performance Indicators

23.4.1 Each hood has survey information to help determine whether the particular hood is functioning properly and is appropriate for the work to be performed.

- When the hood survey is completed, dated hood survey information is posted on the hood. Each hood should have this information. It is placed at the sash height that provides the maximum face velocity.
- Do not use a hood that has no survey information. 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, or paper or other material drawn into the exhaust slots. Contact RMS at 574-631-5037 to survey hood flow rate.
- If the survey information is out of date, contact RMS to recertify.
- Do not use the hood until recertified by RMS.
- For more information refer to the Hood Evaluation Procedure

23.4.2 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.

23.5 Hood Use Practices

23.5.1 Check the hood survey information to determine where the sash needs to be positioned for optimum containment. This shall be performed whenever feasible.

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

23.5.3 The hood user shall check the magnehelic gauge if available or other hood performance indicator, such as a digital readout, and compare its reading to

the reading indicated on the hood survey information card.

- For magnehelic gauges, 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 on either the digital readout or the magnehelic gauge differs significantly from that on the sticker, the hood may not be operating properly. If the arrow or number 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. However, these should only be temporary gauges of function as these can clog the vents and baffles in the fume hood if they detach. A better alternative is a small segment of tape from a cassette.
- 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.

23.6 To optimize the performance of the ventilation hood, adhere to the required practices below:

23.6.1 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 interfere with airflow at the face of the hood (e.g., air currents from people walking by).

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

23.6.3 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.

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

23.6.5 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.

23.6.6 Keep the hood sash clean and clear.

23.6.7 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.

23.6.8 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.

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

23.6.10 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. Run electrical cords under the airfoil, through cut outs in the airfoil, or through sidewall openings to avoid obstructing the sash or damaging the cord.

23.6.11 Do not use a hood for any function for which it was not intended. Certain chemicals or reactions require specially constructed hoods (e.g., perchloric acid or high pressure reactions).

23.7 Ventilation hood limitations

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

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

23.7.3 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.

23.7.4 Perchloric Acid: A conventional ventilation hood shall not be used for perchloric acid digestions or other reactions that use perchloric acid at elevated temperatures. 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.

23.7.5 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. Users shall work in hoods equipped with horizontal sliding sashes by keeping a pane of glass in front of them and reaching around the sides into the hood to manipulate the equipment or

chemicals inside. Never work with the sash slid fully open directly in front of the user.

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

23.7.7 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.

23.8 Other Laboratory Exhaust Systems

23.8.1 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. In these cases, other exhaust systems should be used.

23.8.2 Such systems shall not be installed without explicit approval of the building facilities manager and/or Utilities and Maintenance.

23.9 Local Exhaust Ventilation (Elephant Trunks or Snorkels)

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

23.9.2 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.

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

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

23.9.5 Be sure to check function and performance according to the manufacturer's instructions.

23.10 Canopy Hoods

23.10.1 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.

23.10.2 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.

23.11 Toxic Gas Cabinets

23.11.1 To prevent highly toxic or odorous gases from contaminating the laboratory, such gases shall be used and stored in gas cabinets.

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

23.12 Glove Boxes

23.12.1 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.

23.12.2 Gloves and seals on glove boxes must be inspected for leaks prior to use. Both a visual inspection and dexterity check must be performed.

- Changing of gloves must be documented and include the date, manufacturer and model of glove, and person performing the change.
- The maximum life for a glove is 10 years from the date of manufacture, which is stamped on the inside surface of each glove.

23.12.3 Pressure checks must be performed every day, before use, and immediately after the gloves are changed. These checks must be documented. The pressure can be checked in several ways, including:

- Visual inspection: positive pressure glove boxes should have gloves extending outside the box.
- Gauges: There may be built-in oxygen, water, and/or pressure sensors.
- Hand-held air flow meter used on all the seams.
- Soap test on the gloves, seals, and fittings for a qualitative test.

23.12.4 Plug ports that are inactive (never or infrequently used). These plugged ports should have a stub glove and a glove port cap installed.

23.12.5 All PPE needed for the hazardous material must be worn when using the glove box. Always wear clean, disposable gloves while using the gloves on a glove box.

23.12.6 Avoid abruptly extending gloves in the glovebox as this can cause a pressure pulse that will result in contamination.

23.12.7 Respond to off-normal indications or alarms with established procedures. Promptly convey problems and abnormal conditions to a supervisor or PI. Stop work until the cause and consequence of an alarm have been identified and safe working conditions have been restored.

23.12.8 Keep sharps in an approved sharps container.

23.12.9 Do not work in the glovebox unless the lighting is working.

23.12.10 Remove waste in a timely manner. Do not allow it to accumulate. Hazardous waste containers in the glovebox must be appropriately labeled with the term "Hazardous Waste," the full names of all chemicals (no abbreviations), and the hazards associated with those waste chemicals.

23.12.11 Hands-on training done by a lab member or PI is required prior to new

users using the glove box. Training must be documented with a signature sheet. It is recommended that this training include the following:

- Physical limitations of components, gloves, and support systems.
- Ventilation and vacuum controls.
- Atmospheric controls.
- Features that prevent over-pressurizations, flooding, and fire.

23.12.12 It is recommended that glove boxes have sign-up sheets to record both user and functioning of the glove box.

23.12.13 In the event of a glove failure, document who was working, the material they were working with and potentially contaminated with, and the tasks that may have contributed to the failure. See Section 26.0 for reporting accidents.

23.12.14 For any further information on glove boxes, visit the American Glove Box Society at gloveboxsociety.org.

24.0 ACCIDENTS INVOLVING HAZARDOUS CHEMICAL EXPOSURES

24.1 Reporting Accidents and Injuries

24.1.1 All accidents, injuries, near-misses, and good catches shall be reported to the supervisor or PI.

24.1.2 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, but rather to determine root causes for accidents to inform preventative measures.
- All employee injuries shall be reported to your departmental office so the appropriate forms can be completed.

24.2 A Supervisor's First Report of Injury shall be sent to RMS within 24 hours of the incident. For questions, call the Claims Specialist at 574-631-7532.

24.3 Medical Providers

Lab Personnel Status	ND Wellness Center	UHS/St. Liam's Hall	After Hours
Students (Grad or Undergrad) enrolled in a class		X	St. Liam's
Undergrad students in a research lab as part of a class		X	St. Liam's
Any paid (Salary or stipend, including paid grad and undergrad students) lab personnel	X		Med Point 24 – 6913 N. Main St. Granger
Non-ND personnel (volunteers/visitors)	Report to their medical provider.		

Note: Please see section 6.3.3 for a list of common scenarios and proper medical provider information.

24.4 Hazardous Chemical Exposures to Skin

- Take immediate first aid action and seek medical attention. If transportation is needed, call NDPD at 911 from a campus phone or 574-631-5555 from a cell phone.
- Explain carefully what chemicals were involved. If able, bring the appropriate SDS.

24.4.1 First Aid Procedure

- Immediately flush with water for no less than 15 minutes using a 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.

24.4.2 Check the SDS to determine if any delayed effects can be expected.

24.4.3 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.

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

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

- This can be purchased through the University Health Center by requesting a special purchase order. For more information, contact University Health Services at 574-631-7479. Additional Calgonate brand calcium gluconate gel can be purchased through Grainger on BuyND (item number 11C643) or directly from the Calgonate website.
- Calcium gluconate gel expires after 2 years, so it is important that the lab supply be checked annually.

24.5 Chemicals in Eyes

24.5.1 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. If necessary, a coworker may need to help hold open the afflicted person's eye due to their pain reflex.

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

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

24.6 Chemical Inhalation

24.6.1 Close containers, open windows or otherwise increase ventilation, and move to fresh air. If possible, nearby fume hoods can also be opened and put into purge mode to increase air flow.

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

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

24.7 Accidental Ingestion of Chemicals

24.7.1 Immediately go to the Wellness Center or University Health Services.

24.7.2 Do not induce vomiting unless directed to do so by a healthcare provider.

24.8 Accidental Injection of Chemicals

24.8.1 Wash the area with soap and water and seek medical attention at the Wellness Center or University Health Services as appropriate.

24.9 Thermal Burns

24.9.1 Immerse the burned area in cold water and seek medical attention at the Wellness Center or University Health Services as appropriate. Do not apply ice to burns as it can damage skin tissue, increase the risk of infection, and decrease blood flow to the burn, which can hinder the healing process.

24.10 Clothing/Hair fires

24.10.1 If your clothing/hair catches fire, drop to the floor and roll to smother the fire.

24.10.2 If a co-worker's clothing/hair catches fire, get the person to the floor and roll them to smother the flames.

24.10.3 A safety shower can be used to put out the flames. If possible, remove burnt clothing.

24.10.4 Call 911 or 574-631-5555 from a cell phone.

24.10.5 NEVER use a fire extinguisher to put out a fire on a person.

25.0 MEDICAL CONSULTATION POLICY

25.1 Laboratory personnel shall seek medical attention by contacting 911 or 574-631-5555 from a cell phone, under the following conditions:

25.1.1 If the individual experiences signs or symptoms associated with a hazardous chemical to that they may have been exposed in the laboratory.

25.1.2 Whenever a spill, leak, explosion or other occurrence results in the likelihood of a hazardous chemical exposure to a laboratory worker.

25.2 Where exposure monitoring reveals an exposure level routinely above the OSHA action level or permissible exposure limit, personnel will be instructed to seek medical attention.

25.3 Medical exams

25.3.1 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.

25.3.2 Personnel have a right to request and view the results of their medical exams and any monitoring that has occurred.

26.0 RECORDKEEPING

26.1 Medical Records

26.1.1 Shall be retained by the appropriate medical facility for employment plus 30 years from the time of separation.

26.2 Safety Data Sheets

26.2.1 SDS shall be retained for 30 years from the time of separation.

26.3 Training Records

26.3.1 Lab Specific training records shall be maintained per the University Record Management and Archive Policy.

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

26.4 Industrial Hygiene Monitoring

26.4.1 Records shall be retained by RMS for 30 years from the time of separation.

REVISION TABLE

History	Effective Date
-Added link to Hazardous Waste Procedure, -Updated link to Training Needs Assessment, -Confirmed all current links, -Changed verbiage in Section 17 from Lock-Out/Tag-Out to Lock/Tag/Try	July 31, 2017
Updated contact information and dead/broken links.	July 31, 2018
Updated broken links.	April 30, 2019
-Revised hazardous waste requirements to reflect compliance changes. -Updated fume hood certification criteria to align with Fume Hood Procedure. -Updated links throughout document. -Added Particular Hazardous Substances, Prior Approval, etc.	February 14, 2020
-Updated template stylings so the whole document is consistently formatted. -Updated Appendix D since the Training Needs Assessment form was moved into Qualtrics. -Updated Appendix E since the PPE Hazards Assessment form was moved into Qualtrics. -Updated Appendix F so the PPE Hazards Assessment form visual shows a screenshot of the actual form.	March 29, 2021
-6.3.3 – clarified medical providers for paid students (graduate and undergraduate) -7.2.3 – added language about updating Training Needs Assessment as “research and/or lab activities change and include different hazards” -8.2.4 – added more information to lab-appropriate footwear including examples of closed-toed shoes that are not acceptable (ballet flats, crocs) -8.3.1 – added “or as research changes to include new hazards” to the frequency of PPE assessments -8.4.4 – new section on the use of eye protection with contact lenses -8.5.3 – clarified language prohibiting gloves on both hands in hallways and prohibiting handling doorknobs and other common areas with gloves	February 21, 2024

-8.6.3 – added recommendation for location of lab coat storage and prohibited storing of lab coats on the backs of lab chairs and on hood knobs -8.6.5 – new section prohibiting wearing lab coats outside of labs with noted exceptions -8.7.1 – new language on recommendations for liquid resistant shoes -9.1.4 – addition of language informing labs to keep appropriate fire extinguishers available depending on the hazards present in the space; also added class K extinguishers -10.4.1 – fully prohibit eating and drinking in lab regardless of whether or not hazardous materials are present -10.4.2 – language about restraining or removing jewelry -11.2 – electrical tape is not an acceptable repair for frayed or exposed wiring -11.6 – addition that surge protectors shall not be daisy-chained -14.4 – additional section about the hazards of hot glassware -15.7 – added information about needle recapping devices -16.5.2 – added clarification that sharpie or other permanent markers directly on glass is not an acceptable method for labeling materials for long term storage (>90 days) -20.2 and the rest of CHP – contact information updated -21.2.5 – section added about dating chemicals as received -21.3.1 - updated to contain information on MSDSOnline -22.4.5 – section added about not adding excess chemicals back to their original bottle -22.6.6 – section added to include NFPA 30 guidelines for flammable storage cabinets -22.6.7 – section added to include outlines for when flammable cabinets must be grounded -25.1 – further hood face velocity values are included as well as contact information for when the hoods are outside of those ranges -25.5.10 – language added to run electrical cords such that they don't block the sash from closing -26.2 – updated the table to reflect the changes made to the table in 6.3.3	

-26.3.5 – added expiration timelines for calcium gluconate and purchase availability/vendors -26.5.1 – added language about putting fume hoods in purge mode if possible to increase air flow in the event of aerosolized chemicals -26.8.1 – added first aid information about never putting ice on burns -26.9.5 – section added explicitly stating never to use a fire extinguisher to put out a fire on a person -30.1.6 – added further water conditions -Appendix A – added more entries to reflect all acronyms used throughout the document -Appendix E - New PPE Hazard Assessment screenshot -Appendix G - full list of flammable materials organized by class added -Entire document – grammar and spelling fixes	
-Link updates and checks -Improved information on chemical inventory data expectations -Incorporation of the Dry Ice Procedure (now section 24.0 with labeling in Appendix J)	August 28, 2025
-Combination of the previous three sections into one -Inclusion of PHS and requirements for use (now section 19.7, including a list of chemicals in what is now Appendix J)	October 15, 2025

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.

CAS Registry Number – Also known as a CAS Number or simply "CAS" or "CAS RN." A number unique to a specific chemical substance. They can contain between five to ten digits, separated by hyphens into three parts, following the general guideline of XXXXXXX-XX-X, where the first series can contain between two and seven digits, the second only two, and the third only one. CAS Numbers are internationally recognized.

CDC Select Agents – As per the Centers for Disease Control and Prevention: "Select agents are biological agents and toxins that have been determined to have the potential to pose a severe threat to public health and safety, to animal and plant health, or to animal or plant products." Also known by the name DHS Select Agents.

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.

Department/Unit Safety Coordinator - Safety Coordinator (SC) - Appointed by the Department Head, or Center/Institute Director, the SC serves as Chair of the Local Safety Committee (LSC). The SC is the main point of contact for the LSC

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.

eNDeavor – Located at https://www.endeavor.nd.edu. Replaced complyND as the safety training platform in June 2023. Contains trainings that are required in addition to trainings that are optional but may be helpful for general knowledge.

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 Personnel - An individual who works or is present in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Laboratory Safety Advisory Committee (LSAC) – A committee tasked to provide ongoing strategic direction and oversight for laboratory safety and health initiatives in partnership with Risk Management and Safety on Notre Dame's campus. This committee is composed of faculty and staff from departments in the College of Science, the College of Engineering, the College of Arts and Letters, RMS, and NDFD.

Laboratory Safety Officer (LSO) – A member of the lab who is designated as the safety representative and point of contact for RMS. The LSO is a type of Principal Lab Contact (PLC).

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) – The individual within a laboratory who has been designated as the point of contact for RMS and personnel working within the laboratory. This definition is not meant to preclude direct interaction between RMS and any personnel; rather, it is meant to define a specific point through which information is expected to flow on an ongoing basis.

Particularly Hazardous Substances (PHS) – Per the OSHA Laboratory Standard, a select carcinogen, reproductive toxin, and/or a substance that has a high degree of acute toxicity. Use of these chemicals requires a Designated Area and SOPs for each substance in addition to restricted storage conditions. See Section 19.7 for more information.

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

Select Agents and Toxins - Biological agents and chemical 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 10 mg/m^3;
    - After repeated skin application of less than 300 mg/kg of body weight per week; or
    - After oral dosages of less than 50 mg/kg of body weight per day

APPENDIX B – REFERENCES

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UNIVERSITY OF NOTRE DAME

LABORATORY RISK ASSESSMENT TOOL (Lab R.A.T.)

The Laboratory Risk Assessment Tool (Lab RAT) provides a framework for risk assessment complimenting the process researchers already use to answer scientific questions.

This tool provides a format for researchers to systematically identify and control hazards to reduce risk of injuries and incidents. Conduct a risk assessment prior to conducting an experiment for the first time and review the **Lab R.A.T. Guidelines** document for further details.

The risk assessment process involves rating the risk of the experiment from "low" to "unacceptable" risk. Consult with your PI / supervisor and RMS if your risk rating is "high" or "unacceptable" to redesign the experiment and / or implement additional controls to reduce risk.

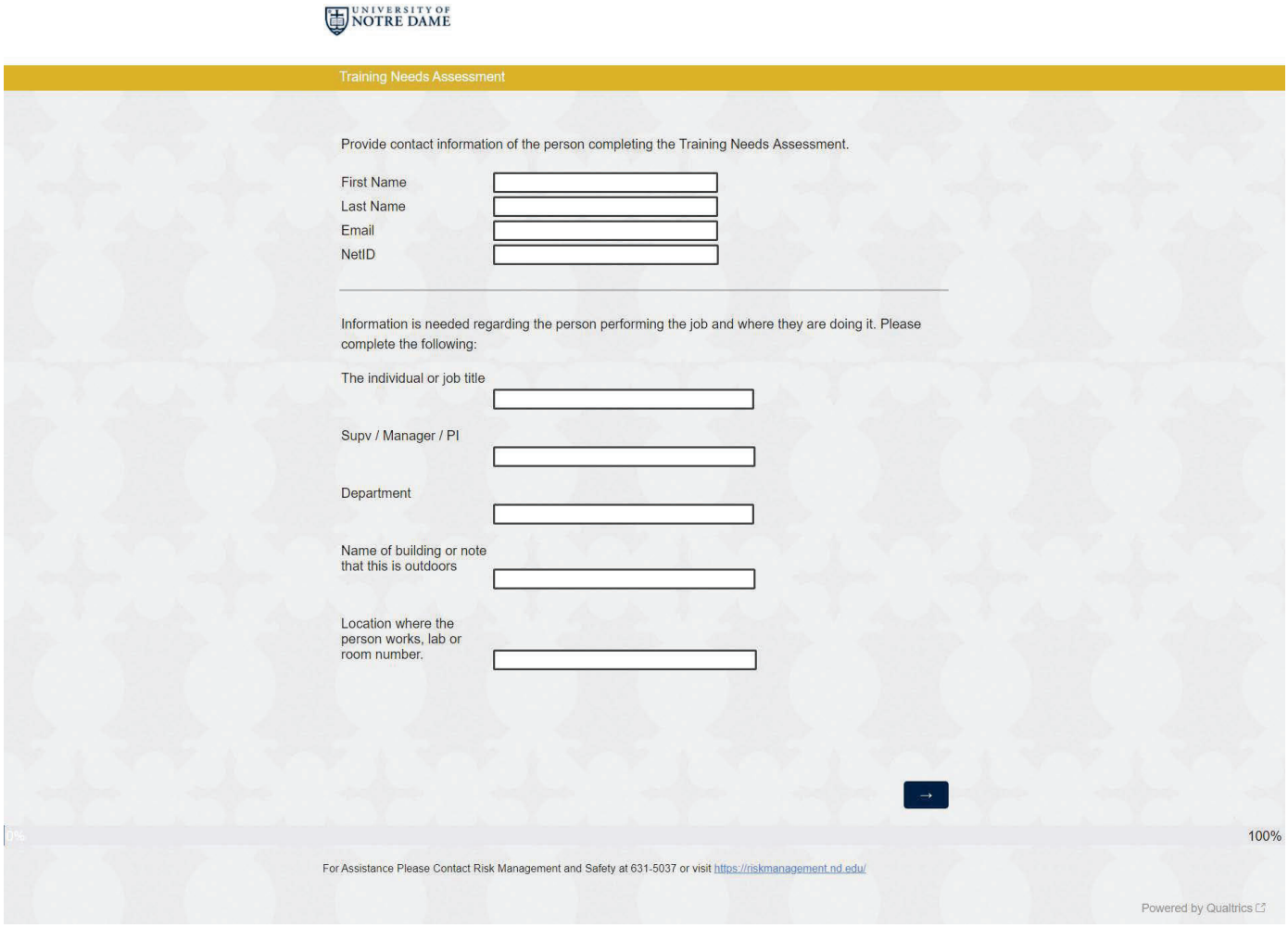


Procedure:	
PI / Lab Group:	
Department:	**Building / Location:**
Form Completed By:	**Start Date:**

PHASE 1: EXPLORE

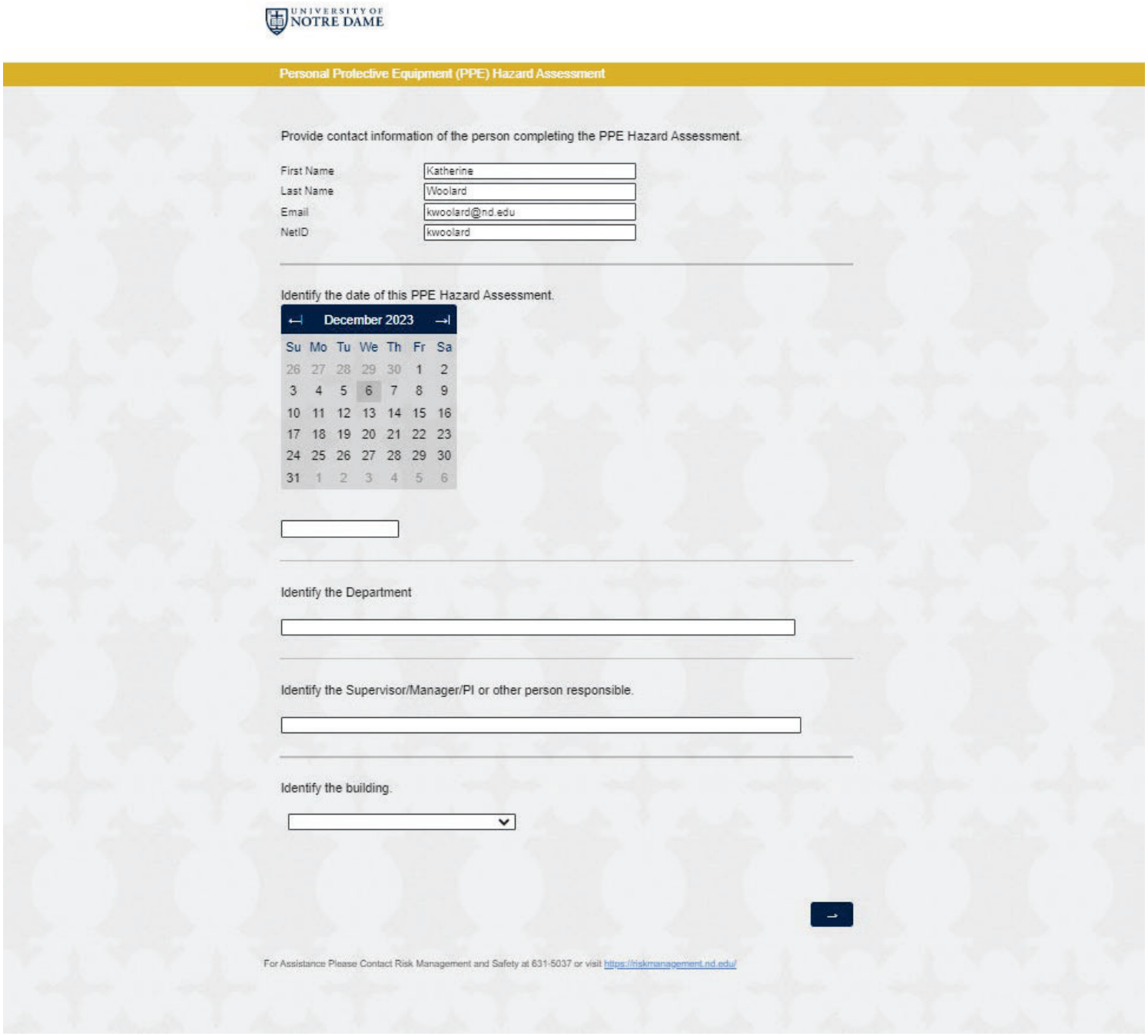
Identify your research question and approach. What question are you trying to answer? What are you trying to measure or learn? What is your hypothesis? What approach or method will you use to answer your question? Are there alternative approaches?

APPENDIX D – SAMPLE TRAINING NEEDS ASSESSMENT / TRAINING MATRIX



(Reviewed as hazards change)

APPENDIX E – PPE HAZARD ASSESSMENT



UNIVERSITY OF NOTRE DAME

Personal Protective Equipment (PPE) Hazard Assessment

Provide contact information of the person completing the PPE Hazard Assessment.

First Name	Katherine
Last Name	Woolard
Email	kwoolard@nd.edu
NetID	kwoolard

Identify the date of this PPE Hazard Assessment.

December 2023

Su	Mo	Tu	We	Th	Fr	Sa
26	27	28	29	30	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

Identify the Department

Identify the Supervisor/Manager/PI or other person responsible.

Identify the building.

For Assistance Please Contact Risk Management and Safety at 631-5037 or visit https://riskmanagement.nd.edu/

APPENDIX F – PPE CERTIFICATION FOR LABS

Minimum PPE required for all laboratories with hazards unless otherwise noted include: Safety Glasses, Fully 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.

University of Notre Dame
Lab Personnel PPE Knowledge Certification

Default PPE required for all laboratories with hazards unless otherwise noted below include:
Safety Glasses, Closed-toe shoes with substantial soles, Pants or Skirt to the Ankles, and Shirt with coverage equal to or greater than a T-Shirt.

Changes in the default PPE_____

_____

By signing below, I certify that I understand the default PPE requirements for the (PI Name) _____ 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 G – 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

**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 for terms used in Appendix G

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).

Flammable and Combustible Liquids Organized by Class

Class 1A

Acetaldehyde	Dimethyl sulphide	Methylamine
Ammonium perchlorate	Ethylamine	Methyl formate
t-Butylamine	Ethyl chloride	Methyl mercaptan
1-Butylene	Ethyl ether	n-Pentane
t-Butyl hydroperoxide	Ethyl mercaptan	Propylene oxide
"Collodion"	Furan	Trimethylamine
Cyanogen	Hydrogen cyanide	Vinylidene chloride
Deuterium	Isopentane	
Dimethylamine	Isopropylamine	

Class 1B

Acetal	Diisopropylamine	Methyl chloroformate
Acetone	1,1-Dimethylhydrazine	Methyl ethyl ketone (MEK)
Acetonitrile	Dioxane	Methyl hydrazine
Acetyl chloride	Ethyl acetate	Methyl isobutyl ketone
Acrolein	Ethyl acrylate	Methyl isocyanate
Acrylonitrile	Ethyl alcohol, > 60%	Methyl methacrylate
Allyl alchohol	Ethyl benzene	Methyl propyl ketone
Allyl chloride	Ethyl bromide	Naphtha, VM & P
Benzene	Ethyl chloroformate	Nickel carbonyl
2-Butanone (MEK)	Ethylene dichloride	Pentaborane
Butylaldehyde	Ethyleneimine	1-Pentanethiol
n-Butyl acetate	Ethyl formate	2-Pentanone
Tert-Butyl alcohol	Gasoline	Piperidine
n-Butylamine	n-Heptane	1-Propanethiol
n-Butyl mercaptan	n-Hexane	Propargyl alcohol
n-Butyronitrile	n-Hexanethiol	Propionitrile
Carbon disulfide	Hexone	n-Propyl acetate
bis-Chloromethyl ether	Iron pentacarbonyl	n-Propyl alcohol
Chloromethyl methyl ether	Isobutyl alcohol	Propylene dichloride
B-Chloroprene	Isobutyronitrile	Propylene imine
Crotonaldehyde	Isopropyl acetate	n-Propyl nitrate
Cyclohexane	Isopropyl alcohol	Pyridine
Cyclohexene	Isopropyl ether	Tetrahydrofuran (THF)
Cyclopentane	Methoxycyclohexane	Toluene
1,1-Dichloroethane	Methyl acetate	Triethylamine (TEA)
1,2-Dichloroethylene	Methyl acrylate	n-Valeraldehyde
1,2-Dichloropropane	Methyl acrylonitrile	Vinyl acetate
Diethylamine	Methylal	o,m,p-Xylene
Diethyl ketone	Methyl alcohol	

Class 1C

Amyl acetate	Cumene	Ethylene diamine
Amyl alcohol	Cyclohexylamine	n-Ethylmorpholine
n-Butyl alcohol (1-Butanol)	Cyclopentadiene	Ethyl silicate
Sec-Butyl alcohol (2-Butanol)	1,3-Dichloropropene	2-Hexanone
n-Butyl acetate	Dicyclopentadiene	Hydrazine
Chlorobenzene	Diethyl carbonate	Isoamyl acetate
Chlorostyrene	Epichlorohydrin	Isoamyl alcohol (secondary)
o-Chlorotoluene	Ethyl alcohol, 20-60%	2-Isopropoxyethanol

Isopropyl glycidyl ether
Mesityl oxide
Methoxyflurane
Methyl butyl ketone
Methyl isoamyl ketone
Morpholine
Nickel tetracarbonyl
Nitroethane
Nitromethane
1-Nitropropane
2-Nitropropane
Nonane
n-Octane
Propylene glycol monomethyl ether
Styrene (Vinyl benzene)
Trimethyl phosphite
Turpentine

Class 2

Acetic acid, glacial
Acetic anhydride
Acrylic acid
Allyl glycidyl ether
Benzenethiol
Butyl acrylate
n-Butyl glycidyl ether
Chlorostyrene
Cyclohexanethiol
Demeton
Diacetone alcohol
Dichloroethyl ether
1,1-Dichloro-1-nitroethane
2-Diethylaminoethanol
1,2-Diethylbenzene
Diisobutyl ketone
Dimethyl formamide
Dipropyl ketone
2-Ethoxyethanol
2-Ethoxyethyl acetate
Ethyl alcohol, 10%
Ethyl butyl ketone
Ethylene chlorohydrin
Ethylglycol acetate
Ethylidene norbornene
Formalin, 37% (Methanol, 15%)
Formic acid
1-Heptanethiol
sec-Hexyl acetate
Isoamyl alcohol (primary)
Kerosene
Methyl (n-amyl) ketone
Methyl "Cellusolve" (EGME)
Methyl "Cellusolve" acetate (EGMEA)
o-Methylcyclohexanone
5-Methyl-3-heptanone
Methyl isobutyl carbinol
Methyl styrene
Naphtha (coal tar)
1-Octanethiol
Propionic acid
Stoddard solvent
Tetramethyl lead
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Vinyl toluene

Class 3A

2-Aminopyridine
Aniline (and homologs)
Benzoyl peroxide
Benzyl chloride
2-Butoxyethanol (EGME)
n-Butyl lactate
p-tert-Butyltoluene
Camphor (synthetic)
Chloroacetaldehyde
1-Chloro-1-nitropropane
m, o, p-Cresol
Cyclohexanol
Cyclohexanone
Decaborane
1,2-Dibromo-3-chloropropane (DBCP)
2-N-Dibutylamiinoethanol
o, p-Dichlorobenzene
Diglycidyl ether
Dimethyl acetamide
Dimethylamino propionitrile
N,N-Dimethylaniline
Dimethyl carbamoyl chloride
Dimethyl sulfate
Dipropylene glycol methyl ether
Divinyl benzene
1-Dodecanethiol
Ethanolamine
Ethyl alcohol, 5%
Formalin, 37% (± Methanol, 7%)
Furfural
Furfuryl alcohol
Glycidol
2-Hydroxypropyl acrylate
Indene
Isooctyl alcohol
Isophorone
N-Isopropylaniline
Methacrylic acid
Methyl-2-cyanoacrylate
Methylcyclohexanol
Monomethyl aniline
Naphthalene
Nitrobenzene
Phenol (Carbolic acid)
Phenylhydrazine
B-Propiolactone
o,m,p-Toluidine
1,2,3-Trichloropropane

Class 3B

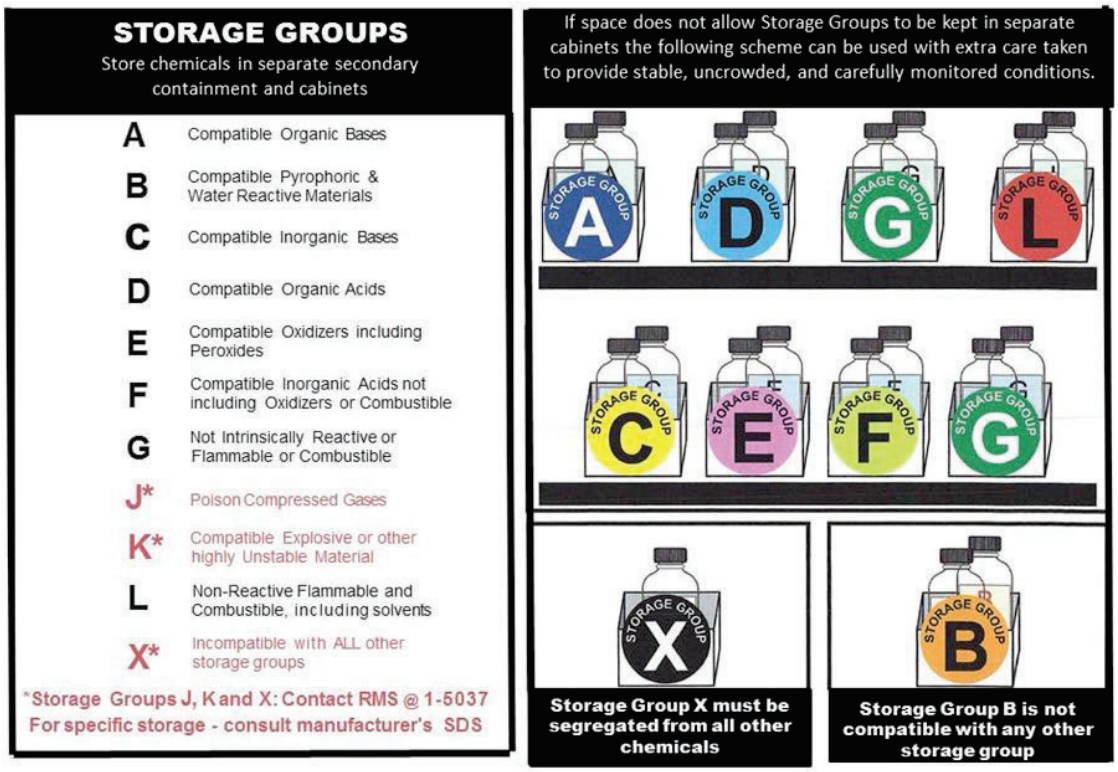
Acrylamide
o-sec-Butylphenol
Caprolactam
Catechol
Chloroacetophenone
Cyanamide
1-Decanethiol
o-Dianisidine
Dibutylphthalate
1,1-Dichloroethylene
1,3-Dichloro-5,5-dimetnylhydantoin
Diethanolamine
Diethylenetriamine
Diethyl phthalate
Dimethylphthalate
o,m-Dinitrobenzene
Dinitrotoluene
Di-sec octyl phthalate
Diphenyl
Diphenylamine
Ethylene glycol
Ethylene thiourea
Formamide
1-Hexadecanethiol
Hexamethylene diisocyanate
Hexamethyl phosphoramide
Hexylene glycol
Hydroquinone
Isoflurane ("Forane")
Isophorone diisocyanate
Maleic anhydride
Malononitrile
4-Methoxyphenol
Methylene bisphenyl isocyanate
Methylene chloride
4,4'-Methylene dianiline
Methyl silicate
Naphthalene diisocyanate
Naphthylamine
Nicotine
p-Nitroaniline
4-Nitrobiphenyl
p-Nitrochlorobenzene
o,m,p-Nitrotoluene
Oil mist (mineral)
Paraffin wax
Phenol/Chloroform
p-Phenylene diamine
Phenyl ether (vapor)
Phthalic anhydride
Propane sultone
Succinonitrile
Sulfur monochloride
o,m,p-Terphenyl
Tetrachloronaphthalene
Tetraethyl lead
Thioglycolic acid
Toluenediamine
Toluene-2,4-diisocyanate
Tributyl phosphate
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
Trichloroethylene
Trichloronaphthalene
Triphenyl phosphate
Vinyl cyclohexene dioxide
Xylidine
Zinc stearate

Noncombustible

Boron tribromide
Bromine
Bromoform
Carbon tetrachloride
Chloracetyl chloride
Chlorobromomethane
Chloroform
Difluorodibromomethane
Enflurane ("Ethrane")
Ethylene dibromide
Fluorotrichloromethane
Formalin, 10%
Glutaraldehyde
Halothane
Hexachlorocyclopentadiene
Methyl iodide
Perchloroethylene (Perk)
Perchloromethyl mercaptan
1,1,2,2-Tetrachloroethane
Tetraethyl pyrophosphate (TEPP)
Thionyl chloride
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-/CFC-113)

APPENDIX H – 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



Adapted with permission from Stanford University

APPENDIX I – BASIC CHEMICAL SEGREGATION TABLE

Class of Chemicals	Examples	Incompatibilities
Oxidizers	Inorganic oxidizers - Sodium hypochlorite, ammonium nitrate Organic peroxides – methyl ethyl ketone peroxide, allyl compounds, haloalkenes, dienes, monomeric vinyl compounds, vinyl acetylenes, unsaturated cyclic hydrocarbons	Separate from reducing agents, flammables and combustibles
Flammable Liquids	Acetone, benzene, diethyl ether, methanol, ethanol, toluene	Separate from acids, bases, oxidizers, and poisons.
Flammable Solids	Phosphorus, lithium, sodium, potassium	Separate from acids and oxidizers.
Corrosives Acids	Oxidizing acids - nitric acid, perchloric acid, chromic acid, picric acid, chromerge Flammable and organic acids – glacial acetic acid, trifloroacetic acid, trichloroacetic acid, triflic acid Mineral acids - Hydrochloric acid, sulfuric acid,	Separate from flammable liquids, flammable solids, bases, oxidizers.
Corrosives Bases	Inorganic bases –sodium hydroxide, potassium hydroxide, ammonium hydroxide Reducing agents – Lithium aluminum hydride, sodium borohydride, lithium borohydride	Separate from oxidizers and acids.
Compressed Gases-Oxidizing	Oxygen, chlorine	Separate from flammable gases.
Compressed Gases-Flammable	Methane, acetylene, propane	Separate from oxidizing and toxic compressed gases, oxidizers.
Compressed Gases-Poisonous	Carbon monoxide, hydrogen sulfide	Flammable and/or oxidizing gases.
Compressed Gases – Inert	Nitrogen, helium, argon	See SDS
General Chemicals (Non-reactive)	Agar, sodium chloride, sodium bicarbonate, and most non- reactive salts	See SDS
Water Reactive Chemicals	Sodium metal, potassium metal, lithium metal, lithium aluminum hydride	Separate from all aqueous solutions and oxidizers.
Poisons (Toxicological Hazard)	Cyanides, heavy metals compounds (e.g., cadmium, mercury, osmium) methyl iodide, dimethyl sulfate, mercury	Flammable liquids, acids, bases, and oxidizers.

APPENDIX J – CARCINOGENS AND REPRODUCTIVE TOXINS

This list is not all inclusive. Consult RMS if you have a question about a substance that is not on this list.

Carcinogens are substances capable of producing cancer in mammals and are regulated by OSHA, listed by the National Toxicology Program (NTP) as a carcinogen (or potential carcinogen) in its most recent Annual Report on Carcinogens, and/or listed by the International Agency for Research on Cancer (IARC) as a Group 1, 2A, or 2B carcinogen. Carcinogens currently in common use at the university include acrylamide, chloroform, dichloromethane, and formaldehyde.

Reproductive toxins are substances that affect either male or female reproductive systems or capabilities and include agents which damage the genetic material (mutagens) or the developing fetus (teratogens). Reproductive toxins currently in common use at the university include ethidium bromide and acrolein.

Chemical	CAS
1,1-dimethylhydrazine (UDMH)	57-14-7
1,2-Dibromo-3-chloropropane	96-12-8
1,2-Dichloroethane	107-06-2
1,3-Butadiene	106-99-0
1,3-Propane sultone	1120-71-4
1,4-Dioxane (p-dioxane)	123-91-1
1,4-Buatanediol dimethanesulfonate (myleran, busulfan)	55-98-1
1-methyl-3-nitro-1-nitrosoguanidine (MNNG)	70-25-7
2-Acetylaminofluorene	53-96-3
2-Ethoxyethanol (ethyl cellosolve)	110-80-5
2-Ethoxyethylacetate (cellosolve acetate)	111-15-9
2-Methoxyethanol (methyl cellosolve)	109-86-4
2-Methoxyethylacetate (methyl cellosolve acetate)	110-49-6
2-Naphthylamine	91-59-8
2-Nitropropane	79-46-9
3-Methylcholanthrene	56-49-5
3,3'-Dichlorobenzidine (and its salts)	91-94-1
3,3'-Dimethylbenzidine (o-tolidine)	119-93-7
4,4'-methylene bis(2-chloroaniline) (MOCA)	101-14-4
4,4-Methylenedianiline	101-14-4

Chemical	CAS
4-Aminodiphenyl	92-67-1
4-Dimethylaminoazobenzene (p-dimethylaminoazobenene)	60-11-7
4-Nitrobiphenyl	92-93-3
7,12-Dimethylbenz[a]anthracene (DMBA)	57-97-6
Acetaldehyde	75-07-0
Acrylamide (solid form)	79-06-1
Acrylonitrile	107-13-1
α-Naphthylamine	134-32-7
Arsenic and arsenic compounds	Varies
Benz[a]anthracene	56-55-3
Benzene	71-43-2
Benzidine	92-87-5
Benzo[a]pyrene	50-32-8
Beryllium	7440-41-7
Beryllium compounds	varies
β-Naphthylamine	91-59-8
β-Propiolactone	57-57-8
Bis-chloromethyl ether	542-88-1
Bromodichloromethane	75-27-4
Cadmium and cadmium compounds	Varies
Carbon tetrachloride	56-23-5
Chemotherapy agents	Varies
Chlornaphazine	494-03-1
Chloroethylene (vinyl chloride)	75-01-4

Chemical	CAS
Chloroform	67-66-3
Chromium (IV) compounds	Varies
Cobalt and cobalt compounds	Varies
Cyclophosphamide	50-18-0
Diazoaminobenzene	136-35-6
Diben[a,h]anthracene	53-70-3
Diepoxybutane	1464-53-5
Diethylstilbestrol (DES)	56-53-1
Diethyl sulfate	64-67-5
Dimethyl sulfate	77-78-1
Ethyl methanesulfonate	62-50-0
Ethyelen dibromide	106-93-4
Ethyleneimine	151-56-4
Ethylene oxide	75-21-8
Formaldehyde (formalin)	50-00-0
Furan	110-00-9
Hexamethylphosphoramide	680-31-9
Hydrazine	302-01-2
Isoprene	78-79-5
Lead and lead compounds	Varies
Methylmercury and other organomercury compounds	Varies
Methyl methanesulfonate	66-27-3
Methylene chloride (dichloromethane)	75-09-2

Chemical	CAS
Methyl chloromethyl ether	107-30-2
Nickel and nickel compounds	Varies
Nitrobenzene	98-95-3
N,N-bis(2-Chloroethyl)-2-naphthylamine (chlornaphazine)	494-03-1
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
N-Nitrosodi-n-butylamine	924-16-3
N-Nitrosodi-n-propylamine	86-30-6
N-Nitroso-N-ethylurea	759-73-9
N-Nitroso-N-methylurea	684-93-5
N-Nitroso-N-methylurethane	615-53-2
NNitrosopiperidine	100-75-4
Polychlorinated biphenyls (PCBs)	Varies
Propylene oxide (epoxypropane)	75-56-9
Propylenimine (2-methylaziridine)	75-55-8
Styrene	100-42-5
Thioacetamide	62-55-5
Toluene diisocyanates (TDI)	26471-62-5
Trichloroethylene (TCE)	76-01-6
Uracil mustard	66-75-1
Urethane (ethyl carbamate)	51-79-6
Vinyl magnesium bromide	1826-67-1

APPENDIX K – DRY ICE LABELING



Miscellaneous Dangers Goods Shipping Label

WARNING
SOLID CARBON DIOXIDE
(DRY ICE)

- Use in accordance with manufacturer's Safety Data Sheet
- Extremely cold (-109F). Avoid contact with skin. Can cause frost bite.
- Store and use with adequate ventilation.
- EYE PROTECTION AND INSULATED GLOVES REQUIRED WHEN HANDLING

Example Hazard Communication Label