Chemical Hygiene Plan

Prepared by

Process Development Center
Jenness Hall

The University of Maine
Orono, Maine 04469

Version: January 2006
Revised 1/26/17

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Process Development Center – Jenness Hall

Chemical Hygiene Plan

1. Purpose

The primary goal of the Chemical Hygiene Plan (CHP) is to protect human life and University of Maine property with the application of "real safety" initiatives and practices. This Chemical Hygiene Plan has been prepared to provide guidance in safe laboratory operations for the Department of Chemical and Biological Engineering Administrators, Principal Investigators, Laboratory Managers, and Laboratory Workers (including students). By establishing laboratory operations according to the provisions of this CHP, faculty, staff, students, and visitors can be protected from health and safety hazards presented by chemical usage in this Department. This Plan has been prepared to ensure compliance with the University Chemical Hygiene Plan and the Federal Occupational Safety and Health Administration Regulations (1910.1200 - Hazard Communication, and 1910.1450 - Occupational exposure to hazardous chemicals in laboratories.).

The purpose of this Chemical Hygiene Plan is to educate and protect Chemical & Biological Engineering Department staff from exposures to hazardous chemicals. This will be achieved through:

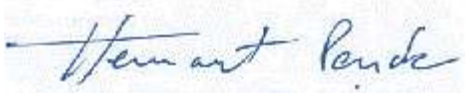
a) Understanding and using prudent safe work practices,

b) Proper handling of chemicals, including appropriate ventilation systems, personal protective equipment, storage and disposal, and

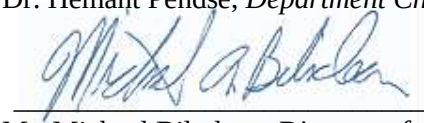
c) Following applicable procedures and guidelines described in this Plan.

Responsibility:

The Director of Safety & Environmental Management is **Wayne Maines**. The Safety & Environmental Management staff is responsible for giving technical guidance and support in the implementation of the provisions of the Plan. It is the responsibility of the Chemical & Biological Engineering Department to implement the Plan, but it is the responsibility of each employee to adhere to the Plan. The Chemical & Biological Engineering Department can amend this Chemical Hygiene Plan.

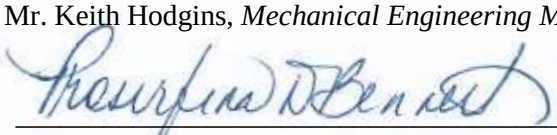


Dr. Hemant Pendse, *Department Chairman*



Mr. Michael Bilodeau, *Director of the Process Development Center*

Mr. Keith Hodgins, *Mechanical Engineering Manager*



Ms. Proserfina Bennett, *Managing Director, Process Development Center*

2. Background

The University of Maine has implemented policies and programs to keep exposures to hazardous chemicals in laboratories at the lowest practical levels and below the Permissible Exposure Limits (29 CFR 1910.1000, Subpart Z) established by the Occupational Safety and Health Administration (OSHA). The control of laboratory exposures to hazardous chemicals will be accomplished by implementing a chemical hygiene plan containing work practices, procedures, and policies that provide a safe and healthy environment.

The OSHA Laboratory Standard (29 CFR 1910.1450) was established to protect laboratory workers from harmful exposures to hazardous chemicals. All laboratories in which chemicals are used are covered by this Standard. In Maine, the Standard is enforced by the Maine Department of Labor (MeDOL). Our Department's Safety Committee has coordinated the development of a Compliance Program to ensure compliance with this Standard. One element of the compliance program is the development of this Chemical Hygiene Plan.

3. Training and Information

All faculty, staff, undergraduate, and graduate students of the University of Maine who work in any laboratory where hazardous chemicals are stored or used must complete the required safety awareness programs appropriate for the operations conducted in that laboratory. As a minimum, all personnel must complete the Chemical Hygiene training program offered through SEM. Other safety awareness training may include Hazardous Waste, Radiation Safety, and Biological Safety. The principal investigator of the laboratory is responsible to ensure that all laboratory personnel complete the required training. In addition, principal investigators must ensure that co-op students, undergraduate students, high school students, and visitors are sufficiently informed and aware of potential hazards in the lab and receive appropriate safety awareness training.

All training must be documented and maintained. The training records for those working in the Process Development Center are located in the PDC Office, 107 Jenness Hall.

The training program at the Pulp and Paper Process Development Center for all laboratory workers consists of two parts: 1) introduction to the standard and to information not specific to the individual worksite, and 2) area site specific training. The training and information will be provided when an employee is initially assigned to a laboratory where hazardous chemicals are present, and also prior to assignments involving new hazardous chemicals and/or new laboratory work procedures.

3.1 Training and Information

The training and information program will describe the:

1. The location and availability of the Departmental and/or Laboratory Chemical Hygiene Plan – **Safety cabinet in the pilot plant, main office (Room 117) or PDC office (Room 107)**;
2. The location and availability of known reference materials on the physical and health hazards of various classes of laboratory chemicals handled, methods/procedures for safely handling and detecting the presence or release of hazardous chemicals present in the laboratory, including, but not limited to, Material Safety Data Sheets received from the chemical supplier – **SDS are located in the safety cabinet in the pilot plant and in an electronic copy**;
3. The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard – **see SDS**;
4. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and,
5. The location and proper use of available protective apparel and equipment (PPE).
6. The appropriate response in the event of a chemical emergency (spill, overexposure, etc.);

When an employee is to perform a non-routine task presenting hazards for which he or she has not already been trained, the employee's supervisor will be responsible for discussing with the employee the hazards of the task and any special measures (e.g., personal protective equipment or engineering controls) that should be used to protect the employee.

Every laboratory worker should know the location and proper use of needed or necessary protective clothing and equipment, and emergency equipment/procedures.

3.2 Additional training

Additional training topics beyond those listed above may or may not be required, based on the work to be done and the hazards associated with the execution of that work. Training which is provided should be appropriate to the tasks and the hazards of the job.

Training topics, which should be addressed, include:

- **First Aid and Cardiopulmonary Resuscitation (CPR)** – Recommended but not required of faculty and staff at the Chemical & Biological Engineering Department. CPR is renewed annually, First Aid every three years.
- **Fire Extinguisher Hands-on Training** - Required every three years for individuals who work with open flame and highly flammable chemicals, at remote sites, as a first responder, as an emergency evacuation coordinator or in welding activities.
- **Computer Terminal Training** - Required annually for persons who work on computers for an average of at least four hours per day.
- **Lock Out/ Tag Out Training** – Required annually for individuals who work with, or are affected by, Lock Out/ Tag Out programs for energized equipment.
- **Radiation Protection Training** – Required for individuals who work with ionizing radioactive materials or sources or non-ionizing radiation. Further information can be obtained from the Radiation Safety Officer.
- **Hearing Conservation Training** – Required annually for individuals who are exposed to noise levels above the OSHA defined permissible exposure limits. Currently, no process in Jenness Hall exceeds the PEL for noise level.
- **Electrical Safety** – Required for individuals who work with high voltage, high amperage or live electrical wires while on the job. Recommended for individuals of all levels and electrical exposures.

3.3 Training frequency

Training shall be provided at the time of an individual's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations, such as; a change in job description, job location, or chemical hygiene plan.

The frequency of refresher information and training is to be determined by the individual department or laboratory, in most instances. Individuals exhibiting a lack of knowledge or understanding of health and safety practices (i.e.; through improper or unsafe work practices, etc.) shall be re-trained immediately. Certain training requirements need to be met on an annual basis; such as Emergency Action Plans, Personal Protective Equipment and can be provided informally within the department as long as appropriate records of the training activity are kept. Other training requirements; such as respirator fit-testing and respiratory training, must be conducted annually by Safety and Environmental Health Management. Contact SEM with questions or for additional clarification.

3.4 Underage Personnel

Any person under the age of 16 will generally not be allowed to work in a laboratory where hazardous chemicals are stored or used. The UM Chemical Hygiene Officer must approve any exceptions to this requirement. For laboratories that utilize radioactive materials, no one under the age of 18 is allowed to work in the laboratory. Underage personnel, including high school students or visitors, must be directly supervised by faculty, staff or graduate students at all times.

3.5 Visitors to the Department

Visitors to the University of Maine Department of Chemical and Biological Engineering are required to comply with various health and safety/security protocols. A "Visitor Safety" presentation must be viewed and a "Visitor Form" signed acknowledging that visitors will comply with UMaine policy regarding safety before visitors are permitted in laboratories, in particular the pilot plant area. Visitors

need to check with their host for personal protective equipment requirements and precautions required for entry in hazardous areas.

3.6 Chemical Safety Information Sources

There are numerous sources of chemical safety information. These sources include:

1. Special health and safety reference literature available from Department of Safety and Environmental Management;
2. The labels found on containers of hazardous chemicals;
3. The substance's Safety Data Sheet; and
4. Laboratory signs.

4. Monitoring

Employee health and area exposure monitoring may be required for a particular laboratory or process. Requirements for exposure monitoring in each laboratory will be determined by the University of Maine Industrial Hygienist and the Department of Human Resources based on the following:

4.1 Permissible exposure limits

For laboratory uses of OSHA regulated substances, the University of Maine Industrial Hygienist will assess and perform monitoring as determined to be appropriate to evaluate if individual exposures to such substances exceed the Permissible Exposure Limits (PELs) specified in 29 CFR 1910, subpart Z. If test results indicate that the PEL has been, or has the potential to be, exceeded, corrective measures will be taken to reduce worker exposures.

4.2 Initial monitoring.

The university shall measure the individual exposure to any substance regulated by a standard, which requires monitoring, after the process has been evaluated and if there is reason to believe that exposure levels for that substance routinely exceed the action level or the PEL.

Use of appropriate engineering controls may eliminate the need for monitoring in certain circumstances. Monitoring or sampling may also be determined to be necessary for certain processes, prior to or during laboratory renovation or redesign activities or at the discretion of the university industrial hygienist. All monitoring evaluations will be conducted in conjunction with Safety and Environmental Health Management.

4.3 Periodic monitoring

If the initial evaluation discloses individual exposures over the action level or the PEL, additional monitoring at appropriate time intervals will be conducted.

4.4 Exposure

Information regarding exposure route(s) of chemicals can be obtained from an SDS or technical document. The SDS will also contain symptoms of overexposure to chemicals or chemical classes.

See the tables below for a quick reference. The following definitions apply to the categories of chemicals in the following tables.

a. *Pyrophoric substances* ignite spontaneously in air at room temperature, either by oxidation or by reaction with atmospheric moisture. Phosphorus is a pyrophoric solid, tributylaluminum is an example of a pyrophoric liquid, and phosphine is a pyrophoric gas.

b. *Corrosive chemicals* cause visible destruction or permanent changes in human skin tissue at the site of contact. Strong acids (*e.g.*, H_2SO_4), strong bases (e.g., NaOH), and dehydrating agents such as P_2O_5 are the major corrosives.

c. *Compressed gases* are gases or mixtures of gases having an absolute pressure exceeding 40 psi at 70 ° F; or an absolute pressure exceeding 104 psi at 130 °F, regardless of the pressure at 70 °F; or liquids having a vapor pressure exceeding 40 psi at 100 °F.

d. *Acutely toxic chemicals* are immediately dangerous to life or health at concentrations in the ppm range. Cyanide salts are an example of an acutely toxic substance.

e. *Reproductive hazards* are substances known to affect human reproductive capabilities, including chromosomal damage (mutagens) and fetal damage (teratogens).

f. *Water Sensitive* chemicals react vigorously with water. The most common ones are the alkali metals, metal hydrides, alkyl lithiums, and alkyl aluminums.

g. *Flammable Liquids* are chemicals that have a flash point below 38.7 °C (100 °F), and a vapor pressure that does not exceed 40 psi at 100 °F.

h. *Oxidizing Substances* are either substances that promote combustion, or substances that spontaneously release oxygen at room temperature or upon slight warming. They include peroxides, chlorates, perchlorates, nitrates, and permanganates. *Strong Oxidizers* are capable of forming explosive mixtures with combustible or easily oxidized compounds, including most organics. Examples of strong oxidizers: ammonium perchlorate, ammonium permanganate, barium peroxide, bromine, calcium chlorate, chlorine trifluoride, chromic anhydride, chromic acid, benzoyl peroxide, fluorine, hydrogen peroxide (> 3%), magnesium peroxide, perchloric acid, potassium bromate, potassium chlorate, potassium peroxide, propyl nitrate, sodium perchlorate, ozone, nitric acid.

i. *Reactive Liquids* are liquid chemicals that react vigorously with moisture or oxygen. Acetyl chloride is a reactive liquid.

j. *Reactive Solids* are solid chemicals that react vigorously with moisture or oxygen. The alkali metals and lithium aluminum hydride are examples of reactive solids.

k. *Carcinogens* are substances that can initiate or speed the development of malignant or potentially malignant tumors, or malignant neoplastic proliferations of cells. Aromatic amines are examples of carcinogens.

l. *Acutely toxic gases* are substances that are immediately dangerous to life or health at concentrations in air in the low ppm (parts per million), and have an absolute pressure exceeding 40 psi at 70 °F or 104 psi at 130 °F. Liquids having vapor pressures exceeding 40 psi at 100 °F also are classified as acutely toxic gases. Examples of acutely toxic gases are hydrogen cyanide (HCN) and phosgene ($COCl_2$).

	Category of Substance					
	Pyrophoric	**Corrosive**	**Compressed Gases**	**Acutely Toxic**	**Reproductive Hazards**	**Water Sensitive**
Hazard Assessment	Fire safety, spill response, special fire extinguisher	As in hygiene plan	Proper regulators, pressure shielding, secure hose connections	Be aware of health risk; any special handling	Be aware of health risk; any special handling	Fire safety, spill response, special fire extinguisher
SEM Notification	NA	NA	NA	Prior to first use, or if procedures or quantity change	Prior to first use, or if procedures or quantity change	NA
PPE	Gloves, goggles, lab coat required	Gloves, goggles, lab coat required	Thermal gloves for liquefied gases	Gloves, goggles, lab coat required	Consult MSDS; Gloves, goggles, lab coat required	Gloves, goggles, lab coat required
Safety Equipment	Eyewash, safety shower, shielding, required	Eyewash, safety shower, required	Shielding required; exposure monitors for toxics	Eyewash, safety shower, shielding, required	Eyewash, safety shower, required	Eyewash, safety shower, required
Ventilation	Hood or glove box required	Hood required if vapor production is expected	Hood required if gas otherwise hazardous	Hood or glove box required; biological safety cabinet?	Hood or glove box required; biological safety cabinet?	Hood or glove box recommended
Emergency Procedures	Special spill controls, special first aid measures	Standard, as in hygiene plan	Special first aid for toxics	Standard; plus special first aid	Do not attempt to clean up spill; call EH&S	Standard; consult MSDS
Gas Cylinders	NA	NA	Secured by straps, etc., transport with safety cart	NA	NA	NA
Signs and Labels	Chemicals must be labeled as pyrophoric	Chemicals must be labeled as corrosive	Label full or empty, as well as chemical identity	Sign on room door noting designated area for toxics	Sign on room door noting designated area for reproductive hazards	Label with chemical identity
Designated Area	NA	NA	NA	Caution tape or signs to demarcate designated area	Caution tape or signs to demarcate designated area	NA
Special Storage	Inert atmosphere, away from flammables	As in hygiene plan	Upright, secured; cylinder cap or regulator at all time; away from heat sources	Store in area designated for acutely toxic substances	Store in area designated for reproductive hazards	Store in cool, dry location
Vacuum Protection	Pump must be rated for pyrophorics	NA	NA	Shielding required if used under vacuum	Shielding required if used under vacuum	NA
Waste Disposal	EH&S must be notified	May be neutralized if not otherwise toxic	Return to supplier	Minimize waste when possible; dispose of as hazardous waste	Minimize waste when possible; dispose of as hazardous waste	Minimize waste when possible; dispose of as hazardous waste

	Category of Substance					
	Flammable Liquids	**Oxidizing Agents**	**Reactive Liquid**	**Reactive Solid**	**Carcinogens**	**Acutely Toxic Gases**
Hazard Assessment	Fire safety measures	Fire safety assessment	Fire safety and specific reactivity assessment	Fire safety assessment; possible peroxide formation	Be aware of health risk; any special handling	Be aware of health risk; any special handling
SEM Notification	NA	Required for $HClO_4$	NA	NA	Prior to first use, or if procedures or quantity change	Prior to first use, or if procedures or quantity change
PPE	Consult MSDS	Consult MSDS	Consult MSDS	Consult MSDS	Consult MSDS	Consult MSDS
Safety Equipment	Eyewash, safety shower, required	Eyewash, safety shower, shielding, required	Eyewash, safety shower, required	Eyewash, safety shower, shielding, required	Eyewash, safety shower, required	Eyewash, safety shower, required
Ventilation	Use hood if > 500 mL	HClO4 requires hood with washdown facility	Fume hood or glove box required	Fume hood or glove box required	Fume hood or glove box required	Fume hood or glove box required
Emergency Procedures	If spilled, turn off ignition sources	Standard; possible special first aid	Standard; possible special first aid	Standard; possible special first aid	Standard	Standard; possible special first aid
Gas Cylinders	NA	NA	NA	NA	NA	Upright, secured; cylinder cap or regulator at all time; away from heat sources
Signs and Labels	Must be correctly labeled	Must be correctly labeled	Must be correctly labeled	Must be correctly labeled	Sign on room door noting designated area for carcinogens; containers must carry carcinogen label	Sign on room door noting designated area for toxics
Designated Area	NA	NA	NA	NA	Caution tape or signs to demarcate designated area	Caution tape or signs to demarcate designated area
Special Storage	Flammables cabinet required for > 5 L outside safety cans	Store below 30 °C; in dry location; minimize quantity stored	Store below 30 °C; in dry location; minimize quantity stored; date containers	Store below 30 °C; in dry location; minimize quantity stored; date containers	Must be stored in designated area	Must be stored in designated area
Vacuum Protection	Fume hood, glove box, or otherwise isolated; use cold trap on vacuum pump	Fume hood, glove box, or otherwise isolated; use cold trap on vacuum pump	NA	NA	Cold trap on vacuum pump; filter if needed to prevent release of particles	NA
Waste Disposal	Standard for hazardous waste	Do not combine with other wastes	Do not combine with other wastes	Do not combine with other wastes	Standard for hazardous waste	Empty/partially filled cylinders returned to supplier

4.5 Exposure assessments

Exposure assessments may be conducted to determine if:

- An employee could possibly be exposed to a hazardous chemical in a manner that might cause harm. Those research-generated materials that have a potential to exceed a PEL, or an action level, will be evaluated for measurable exposures to known chemical families.
- There was an exposure that might have caused harm to occupationally exposed individuals and to determine the chemical(s) involved. These exposure assessments are only to determine the facts of a particular incident, as such; they do not make recommendations for on-going or future corrective actions or medical evaluations.

4.6 Overexposure

Any or all of the conditions listed below warrant additional inquiry as to whether a potential overexposure has occurred and whether an exposure assessment should be conducted:

- An individual manifests symptoms such as those listed below and (i) Some or all of the symptoms disappear when the individual is removed from the exposure area, and, (ii) The symptoms reappear soon after the employee returns to work with the same hazardous chemicals.
- When multiple persons in the same laboratory work area have similar complaints
- A hazardous chemical leaked, spilled or was otherwise rapidly released in an uncontrolled manner; or,
- An individual had direct contact with a hazardous chemical.

Symptoms of Over Exposure

The symptoms of overexposure to a chemical will be listed on the substance's material safety data sheet, MSDS. Common signs and symptoms of exposure to chemicals include:

- Skin rashes or dermatitis
- Irritation to the eyes, nose, throat, upper respiratory tract, or skin
- Burns to the skin or eyes
- Fatigue, dizziness, headaches, lightheadedness, loss of coordination, insomnia, muscle or joint pain
- Persistent cough, wheezing, tightness of the chest, chest pain, difficulty breathing, shortness of breath
- Nausea, vomiting, abdominal pain

4.7 Employee notification of monitoring results.

Within 15 working days after the receipt of any monitoring results, the Department of Human Resources will notify the individual of monitoring results in writing either individually or by posting results in an appropriate location that is accessible to affected individuals. Interpretation of monitoring results shall be provided to the individual as part of the notification process.

4.8 Medical consultation and medical examinations.

The purpose of a medical consultation is to determine whether a medical examination is warranted. When assessment results indicate that an employee may have been exposed to a hazardous chemical, the employee shall have the opportunity (and is encouraged to) obtain a medical consultation

under the direct supervision of a licensed physician. If the consultation indicates that a medical examination is needed, the employee shall be provided an opportunity to see a licensed physician who has experience in treating victims of chemical overexposure. Details of the consultation, examination, as well as any tests and follow-up are determined by the physician and are considered confidential. Examinations must be under the direct supervision of a licensed physician and must be at no cost to the employee.

The university will consult with the Principal Investigator or other person thoroughly familiar with the conditions of employee exposure before medical consultations or examinations are scheduled. Information for baseline evaluations will be based on the job descriptions, chemical exposures, chemical inventories and any other relevant information that is available to all parties. Once a baseline determination has been made, the physician will work with the Office of Human Resources to establish medical baseline requirements.

In the event of a potential overexposure, the Principal Investigator or other responsible party must provide the physician with the following information:

- The known or identifiable components of the hazardous chemical(s) to which the individual may have been exposed;
- A description of the condition under which the exposure occurred including quantitative exposure data, if available; and
- A description of the signs and symptoms of exposure that the employee is experiencing, if any.

The university shall provide all individuals who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

- Whenever an individual develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory;
- Where exposure monitoring reveals an exposure level routinely above the action level or the PEL for an OSHA regulated substance; or,
- Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure.

Baseline medical evaluations shall be provided to all individuals determined to have a potential for exposure to specific hazardous materials. The determination for testing will be based upon review of the job description, information provided by the primary investigator and evaluation of the specific task by the university industrial hygienist as well as consultation with an occupational physician.

All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

4.9 Physician's written opinion

For examination or consultation required under this standard, the Office of Human Resources shall obtain a written opinion from the examining physician that includes the following:

- Any recommendation for further medical follow-up;
- The results of the medical examination and any associated tests;
- Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

- A statement that the employee has been informed, by the physician, of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

Results of medical examinations or consultation shall be considered confidential information. This written physician's opinion will not reveal specific findings of diagnoses unrelated to occupational exposure.

5. Standard Operating Procedures/Guidelines

Standard Operating Procedures (SOPs) or Standard Operating Guidelines (SOGs) include safety and health considerations to be followed when laboratory work involves the use materials or processes that present chemical or physical hazards. SOPs or SOGs shall be written for general laboratory processes, whether research or classroom activities. These documents shall be updated annually or as needed to ensure that any major process or chemical changes are noted appropriately.

Standard Operating Procedures/Guidelines for procedures that deal with the Process Development Center (PDC) are located in the PDC office, 107 Jenness Hall. Standard Operating Procedures/Guidelines for all procedures that deal with the Chemical & Biological Engineering Department are located in the departmental office, 117 Jenness Hall, or with the Principal Investigator of the Research Program.

Literally thousands of different compounds are involved in the research being conducted in campus laboratories. Consequently, it is impossible in this Chemical Hygiene Plan to provide standard operating procedures for each specific hazardous substances. This Section outlines general procedures that should be employed in the use of all hazardous substances.

5.1 Steps and Procedures

All work involving chemicals in laboratories must be conducted using the "Standard Operating Procedures" outlined below. In addition, laboratory workers must determine whether any of the chemicals to be handled in the planned experiment meet the definition of a particularly hazardous substance due to high acute toxicity, carcinogenicity, and/or reproductive toxicity. If so, consider the total amount of the substance that will be used, the expected frequency of use, the chemical's routes of exposure, and the circumstances of its use in the proposed experiment. For very toxic or hazardous substances, or specialized practices, consideration must be given to whether additional consultation with safety professionals and development of specialized SOPs is warranted or required.

DO NOT CONDUCT AN EXPERIMENT OR PROCEDURE IF YOU DO NOT FEEL COMFORTABLE WITH THE PROCESS. Consult your supervisor for additional training.

STEP 1: Determine the toxicity and warning properties of the chemicals to be used in your experiment.

- Identify the chemicals involved in the proposed experiment and determine the amounts that will be used.
- Use an up-to-date SDS to determine the exposure limit, type of toxicity, warning properties (smell, irritation, etc.) and symptoms of exposure for each chemical involved in the planned experiment.
- If a new chemical substance(s) will be produced during the experiment and the toxicity is unknown, assume it is a particularly hazardous substance and follow the procedures in Section 7.
- Assume that any mixture of chemicals will be more toxic than its most toxic component.
- Consider substituting less toxic chemicals.

STEP 2: Determine most likely routes of exposure based on how chemicals will be used and their physical/chemical properties.

- ***Inhalation*** – Inhalation risks are highest when volatile liquids, gases, dusts, or mists are used or generated. Heating will increase the volatility of liquids. Pay particular attention to chemicals with low exposure limits. Potential for inhalation is highest when chemicals are used on an open lab bench. Use in enclosed apparatus or chemical laboratory hoods decreases inhalation exposure potential.

- ***Skin Exposure*** – Chances for skin exposure exist for most laboratory chemical procedures. When the "skin" notation is listed in the exposure limit section of the SDS, the chemical can be absorbed through the intact skin.
- ***Injection or ingestion*** – Not normally a major route of exposure if proper handling procedures are used. Determine whether the experiment involves a significant risk of inadvertent ingestion or injection of chemicals.

STEP 3: Determine required control measures, personal protective equipment, and proper work practices to minimize exposure.

A. Inhalation Control Measures

Determine When to Use Laboratory Chemical Hoods (Fume Hoods)

Procedures involving volatile toxic substances and those operations involving solid or liquid toxic substances that may result in the generation of vapors or aerosols should be conducted in a laboratory hood or other type of local exhaust ventilation. See Section 6 for a more detailed discussion of laboratory hoods. Other types of control devices include glove boxes, custom designed hoods, shut-off valves, and monitoring equipment linked to alarms and shut-off valves.

Determine Whether Respirators Might Be Required

Generally, hazards should be controlled by use of ventilation and it should not be necessary to use respirators. Contact Safety & Environmental Management for help in evaluating the need for a respirator. If one is needed and you are medically qualified to wear a respirator, obtain one of the correct type and size from SEM. Do not use a lab mate's respirator.

B. Personal Protective Equipment For Eyes and Skin

Select and wear appropriate eye and face protection.

Wearing eye protection is required by OSHA regulation whenever and wherever potential eye hazards exist. Hazards requiring eye and/or face protection include flying particles; molten metal; liquids including acids and caustic materials, biological or radioactive materials; chemical gases or vapors; and potentially injurious light radiation. Eye protection is required at all times in labs and shops. Use safety glasses with side shields as basic eye protection for handling chemicals where there is a low risk of splash or splatter. When pouring large amounts of chemicals, observing processes that are under heat or pressure, making adjustments to chemical containing apparatus, or performing other operations or tasks with a moderate to high potential splash risk or severe consequences in the event of a splash, chemical goggles should be used. A face shield can be used with the goggles to protect the face under these circumstances.

Wear appropriate clothing in the laboratory when working with hazardous substances.

Wear laboratory coats with long sleeves. Wear long pants (trousers) or long skirt that cover your legs and shoes that cover your feet. Do not wear sandals or open-toed shoes or shoes made of woven material when working with hazardous substances. Confine long hair and loose clothing.

Avoid skin contact and ingestion of hazardous substances by using appropriate hand protection, protective clothing, and proper work practices.

Contact with the skin is a frequent mode of chemical injury. A common result of skin contact is localized irritation, but an appreciable number of hazardous substances are absorbed through the skin with sufficient rapidity to produce systemic poisoning. Ingestion of substances is rarely deliberate, but may occur because of contamination of hands handling food, contamination of common work surfaces in the lab, and incidental contamination of food or materials that come in contact with the mouth, and through poor work practices. Avoid contact with, and ingestion of, hazardous substances by taking the following precautions:

- Select and wear appropriate hand protection, generally gloves, to prevent injury to hands or exposure by absorption of chemicals through the skin of the hands. Gloves for work with

chemicals must be selected based on the potential contact hazard, and the permeability of the glove material. For incidental skin contact with small amounts of chemicals on a surface, or work with most powders, disposable nitrile gloves are usually adequate. For work involving materials that are readily absorbed through the skin, the glove must be carefully selected using glove impermeability charts. Silver Shield brand gloves work well for many common laboratory chemicals that can be absorbed through the skin, but you should verify their effectiveness for your application. You should also evaluate need for hand protection from physical hazards such as extreme heat or cold, and make sure you use appropriate gloves.

- Never use mouth suction to pipette chemicals or to start a siphon; a pipette bulb or aspirator should instead be used to provide vacuum.
- Never taste laboratory chemicals.
- Wash your hands with soap and water immediately after working with hazardous chemicals.
- Eating, drinking, smoking, gum-chewing, and applying cosmetics in laboratories where hazardous substances are in use is prohibited. Do not store food, beverages, cups, or other drinking and eating utensils in areas where hazardous chemicals are used or stored.
- Immediately clean up small spills on work benches or in laboratory hoods.

Properly use and maintain personal protective equipment (PPE).

Personal protective equipment should be kept clean and stored in an area where it will not become contaminated. Personal protective equipment should be inspected prior to use to be sure it is in good condition. It should fit properly and be worn properly. If it becomes contaminated or damaged, it should be cleaned or fixed or, in the case of disposable equipment, discarded and replaced.

STEP 4: Be Prepared for Emergencies

Before beginning an experiment, know what specific action you will take in the event of the accidental release of any hazardous substances involved. Know the location and how to operate all safety equipment including fire blankets, eye washes, safety showers, spill carts and spill control materials. Be familiar with the location of the nearest fire alarm and telephone, and know what telephone numbers to call in the event of an emergency. Know the location of the circuit breakers for your laboratory. See Section 12 for further details.

6. Control Measures to Reduce Exposure

6.1 Engineering controls

Prior approval

Approval by the immediate supervisor is required to proceed with a laboratory task when there is a new procedure, process, or test, with no existing method, and/or where there is potential for exposure to hazardous substances.

Barrier devices

Guards and/or other barrier devices will be installed on equipment wherever possible.

Hoods and local ventilation devices

A hood or local ventilation device such as a snorkel tube will be used for all operations that might release hazardous vapors or dusts. Before using a hood, confirm that it is operating correctly. Do not store chemicals in hoods. Do not place equipment in hoods that interfere with effective hood operation. Leave hoods on at all times. Building air lows are established with the hoods on. Hood sashes should be closed when not in use.

Testing of hoods: Evaluation of the quality and performance of the hoods will be done annually by Facilities Management to ensure that:

- Airflow entering the hood and within the hood is not excessively turbulent;
- Average face velocities will be in the range of 60 to 120 ft/min. (excessively high air flow velocities should be avoided since turbulence and ineffective capture of chemical vapors may result);
- Each hood will have a method of determining that it is operating;
- Hood face velocities will be checked regularly (at least annually) using appropriate flow measuring devices by taking a traverse at severally equally spaced points across the hood opening
- Re-evaluation of hood velocities will be performed whenever changes in the ventilation systems hood design or equipment setup are made.

Use of Hoods:

- Stand in the center of hood a minimum of 4" away from the lip.
- Locate apparatus a minimum of 6" into the hood, and raised approximately 2" off bench top.
- The sash should be open only when installing apparatus. Close the sash as much as possible while working. Close the sash completely when leaving hood or not working actively inside the hood.
- Keep all doors in the lab closed as much as possible. Open doors cause air currents to vary creating the possibility of back drafting chemical vapors.
- Direct traffic patterns away from hoods where work is being performed. Set up barricades if necessary.
- Do not change position of the louvers.
- Hoods are NOT storage areas.

Glassware, tubing, and equipment

Handle and store glassware with care to avoid damage. Do not use damaged containers. Never put broken glassware into general waste containers. All glassware must be rinsed prior to disposal.

- Use extra care with evacuated glass apparatus. Shield or wrap them to contain chemicals and fragments should implosion occur.
- Secure tubing used to transfer chemicals with clamps. Inspect this tubing periodically for deterioration.
- When transferring hazardous chemicals, use funnels, tubing, or other means to prevent spills or release of vapors. Do this transfer in an area where an accidental spill will be contained (e.g., hood, plastic tub, etc.).

6.2 Personal protective equipment

Personnel working in a laboratory setting shall comply with policies set forth in the University's Health & Safety manual. These policies include requirements for appropriate attire and Personal Protective Equipment (PPE).

The need for specific PPE shall be evaluated on a case-by-case basis. Consult the SDS information for appropriate PPE to use for chemicals in the experiments you are conducting. The determination of need for PPE for tasks shall be based upon a hazard assessment, with required PPE noted in writing. All safety equipment shall comply with current ANSI standards and be maintained in good condition.

Where engineering and administrative controls are not feasible and the use of respirators is necessary to maintain exposure below permissible exposure limits, the department shall provide, at no cost to the employee, the proper respiratory equipment. Individuals which have been identified for respirator use will be required to follow the University of Maine Human Resources and health requirements appropriate to the type of respiratory protection required. All respirators shall be or approved by Safety and Environmental Health Management. Use of respirators will comply with the University of Maine Respiratory Protection Program.

Protective apparel

Lab coats, aprons, and gloves will be provided whenever the potential for contact with hazardous chemicals exists. The material, construction, and degree of protection will depend on the chemical hazard.

Eye protection

At a minimum, safety glasses must be worn whenever working in designated areas. Goggles and face shields will be added depending on the hazards of the chemicals and the work being done.

- Safety glasses meeting ANSI standards will be worn in labs, shops, and pilot spaces where designated. Safety glasses with side shields are recommended.
- Where there is a risk of splashing hazardous chemicals, safety shields must be worn in addition to safety glasses or goggles can be worn in addition to prescription glasses.
- Contact lenses are not recommended for use in the lab. If used, the lab supervisor must be informed so appropriate precautions can be taken.

Skin protection

Gloves will be made available in the laboratories and shops.

- Chemical resistant gloves will be worn when handling hazardous chemicals. The glove type will be selected to protect from specific chemical types.
- Care should be taken to clean and remove gloves to prevent the spread of hazardous chemicals to common use areas (e.g., doorknobs, telephones, etc.).
- Barrier creams can be used to protect skin from exposure to alcohol and some solvents.

Other safety equipment

Safety equipment is provided as a part of the laboratory facilities:

- An easily accessible drench-type shower;
- Eye wash fountain or station;
- Flammable liquid storage cabinet (vented and electrically grounded);
- Fire extinguishers;
- Emergency phone;

6.3 Hygiene practices

Personal hygiene

Personal hygiene is an important factor in chemical hygiene. To react with a person, a chemical must contact that person. The four routes of entry (inhalation, ingestion, and eye or skin contact) limit the chemicals' ability to contact us. If we properly protect ourselves we can eliminate the chemicals' ability to do harm. Personal hygiene practices include:

- Wash promptly if skin contact is made with any chemical, regardless of corrosivity.
- Avoid inhalation of chemicals; do not "sniff: test chemicals.
- Wash well before leaving the laboratory; do not wash with solvents, use soap and water.
- Remove lab coats or protective clothing before leaving the laboratory area. Do not store used protective clothing in the office area.

Footwear

Bare feet, open-toed shoes and sandals will not be allowed in labs, shops, or pilot area.

Housekeeping

Common housekeeping practices contribute greatly towards chemical hygiene and safety. A clean work area is much safer that a dirty or cluttered one. Some appropriate housekeeping measures include:

- Keep all aisles, hallways, and stair clear of all chemicals or other "storage" items.
- Working surfaces and floors should be cleaned regularly.
- Keep all work areas and especially workbenches clear of clutter and obstruction.
- Access to emergency equipment, showers, eyewashes, fire extinguishers, and exits should never be blocked.
- Wastes should be kept in the proper containers and labeled properly.
- Any unlabeled containers are considered wastes by the end of each workday.

Unattended and off-hours operations

If equipment or experiments must operate after hours and unattended, inform the Dept. of Public Safety of the location, nature of the work, potential hazards, who to call if a problem occurs and what action is to be taken in this case.

- Place signs on doors and the equipment, notifying others of the operation and a contact person.
- Leave lights on.
- Provide a means to contain hazardous substances should an equipment failure or leak occur.

7. Additional Protection (Carcinogens and other PHS)

Additional protection for work with particularly hazardous substances (PHS) is required. These substances include "select carcinogens," reproductive toxins and substances that have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate

7.1 Regulated and controlled work areas

Areas for the storage of carcinogens will have controlled access. Only personnel with special instructions on the hazards and safe handling of carcinogens will be permitted use of the carcinogens. The rooms where carcinogens are used and stored should be kept at a slightly negative pressure when compared to the rest of the rooms. These locations shall be clearly labeled.

7.2 Closed system protection

All work involving carcinogens must be done in a containment device to reduce the risk of employee exposure to the vapors. Containment devices include fume hoods, glove boxes, or similar apparatus.

7.3 Handling of contaminated waste

Carcinogenic wastes are to be collected and labeled for disposal. Specific procedures for disposal will be followed by the hazardous waste disposal facility and will be consistent with the RCRA.

7.4 Personal hygiene

Laboratory personnel using carcinogens shall take extra precautions in maintaining good personal hygiene.

7.5 Protection of vacuum system

To protect the vacuum lines and pumps, HEPA filters or high efficiency scrubber systems should be used.

7.6 Protective apparel

Persons working in restricted areas should not wear any personal items such as jewelry that might become lost if decontamination is not possible. When possible, disposable clothing should be used. Gloves and long sleeves should be worn at all times to prevent skin contact with the carcinogen.

7.6 Additional precautions

Working with carcinogens should be done in the smallest amounts possible. Purchases of the chemicals should be restricted to minimal amounts necessary to prevent uninterrupted work.

8. Prior Approval Procedures

All new and updated laboratory operation, procedure or activity shall require prior approval from the department level health and safety committee or the Department of Safety and Environmental Health Management, before implementation. Training for affected personnel must be conducted prior to execution.

9. Chemical procurement, distribution and storage

9.1 Procurement

Individuals should become familiar with the general characteristics of the materials to be used in the laboratory prior to procurement. This shall include proper handling, storage and disposal procedures and any unique hazards, which might be associated with the chemical. This information is available on Safety Data Sheets or directly from the chemical manufacturer.

Determination of appropriate quantities of chemicals required to conduct a procedure should be evaluated prior to purchase as an effort to reduce waste and unused product. Amounts or concentrations procured should be as small as practical. Chemical storage begins with buying the minimum amount of chemical necessary. The true cost of storing chemicals includes not only the purchase price but also the cost of storage cabinets and secondary containment. Minimizing purchases minimizes costs. Minimized inventories provide a safer workplace, minimize the risk from spills, reduce disposal costs, and protect the environment.

9.2 Receiving of chemicals.

No container should be accepted without and adequate identifying label. Containers should be intact, in good condition, properly labeled and a current SDS shall be readily accessible.

Upon receipt of a new chemical it should be labeled with the chemical name, the date received, the name of the person who obtained it, and color coded if necessary. (some chemicals become unstable over time and also need a disposal date posted)

9.3 Safety Data Sheets

Safety Data Sheets (SDS) must be included with incoming chemicals and added to the SDS files. **A file of SDS sheets is located in the safety cabinet in the pilot plant or electronically**. SDS files will be reviewed and updated annually when chemical inventories are conducted. They must be readily available for employee review at all times the employee is in the work place.

The Safety Data Sheet (SDS) is a detailed information bulletin prepared by the manufacturer or importer of a chemical that describes the physical and chemical properties, physical and health hazards, routes of exposure, precautions for safe handling and use, emergency and first-aid procedures, and control measures. Information on an MDS aids in the selection of safe products and helps prepare employers and employees to respond effectively to daily exposure situations as well as to emergency situations.

Sections of an SDS and Their Significance

OSHA specifies the information to be included on an SDS, but does not prescribe the precise format for an MSDS. The SDS must be in English and must include at least the following information.

Section 1: Identification of the substance/mixture and of the company/undertaking

- Product identifier
- Relevant identified uses of the substance or mixture and uses advised against
- Details of the supplier of the safety data sheet
- Emergency telephone number

Section 2: Hazards identification

- Classification of the substance or mixture

- Label elements
- Other hazards

Section 3: Composition/information on ingredients

- Substances
- Mixtures

Section 4: First aid measures

- Description of first aid measures
- Most important symptoms and effects, both acute and delayed
- Indication of any immediate medical attention and special treatment needed

Section 5: Firefighting measures

- Extinguishing media
- Special hazards arising from the substance or mixture
- Advice for firefighters

Section 6: Accidental release measures

- Personal precautions, protective equipment and emergency procedures
- Environmental precautions
- Methods and material for containment and cleaning up
- Reference to other sections

Section 7: Handling and storage

- Precautions for safe handling
- Conditions for safe storage, including any incompatibilities
- Specific end use(s)

Section 8: Exposure controls/personal protection

- Control parameters
- Exposure controls

Section 9: Physical and chemical properties

- Information on basic physical and chemical properties
- Other information

Section 10: Stability and reactivity

- Reactivity

- Chemical stability
- Possibility of hazardous reactions
- Conditions to avoid
- Incompatible materials
- Hazardous decomposition products

Section 11: Toxicological information

- Information on toxicological effects

Section 12: Ecological information

- Toxicity
- Persistence and degradability
- Bioaccumulative potential
- Mobility in soil
- Results of PBT and vPvB assessment
- Other adverse effects

Section 13: Disposal considerations

- Waste treatment methods

Section 14: Transport information

- UN number
- UN proper shipping name
- Transport hazard class(es)
- Packing group
- Environmental hazards
- Special precautions for user
- Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

Section 15: Regulatory information

- Safety, health and environmental regulations/legislation specific for the substance or mixture
- Chemical safety assessment

Section 16: Other information

9.4 Laboratory storage

Storage area

- Storage should be away from exits, heat, and direct sunlight.
- Nothing should be stored over shoulder height of an employee without special provisions, such as a proper step stool.
- No chemicals should be stored above the height of six (6) feet.
- Chemical storage areas need general ventilation. Specific chemicals may require special ventilation.
- Flammables require an approved storage cabinet if more than 10 gallons are present at any one time. (Cabinets are recommended for all flammable liquids.)
- Restricted access is recommended for highly toxic chemicals to prevent unauthorized use.
- Bench tops should not be used as chemical storage areas.
- Chemicals should not be stored on the floor (exception: properly secured gas cylinders).
- Gas cylinders must be segregated according to compatibility, stored away from heat sources, upright, and secured so that they will not fall over.

Compatibility

Chemicals must be stored only with compatible substances. The BAKER color coding system is recommend. Once segregated into compatible groups the chemicals can be put in alphabetic order.

Baker Storage Color Coding System

Color	Hazard
Red	Flammability (Store in a flammable liquid storage area.)
Yellow	Reactivity (Store separately and away from flammable or combustible materials.)
White	Corrosive or contact hazard (Store in corrosion-proof area)
Blue	Toxic or poison (may need to be in secured area)
Orange	General can be stored together
Striped Labels	Incompatible materials of the same color class have striped labels. (Proper storage needs to be individually assessed)
(Exceptions to the Baker System) Yellow and White Striped Label	Strong Oxidizing Acids; Perchloric acid, Nitric acid, Sulfuric acid, and Chromic acid solutions, (These may be stored together but separate from all other chemicals.)

The following table is a guide to assist in the storage of common chemicals.

CHEMICAL COMPATIBILITY

Do not store this	with this
Acetic acid	Oxidizers: chromic acid, nitric acid, sulfuric acid, permanganates, peroxides
Acetic anhydride	Oxidizers, as above; alcohols, glycols, water
Acetone	Oxidizers, as above; hydrogen peroxide; strong base
Acetylene	Halogens; metals or metal ions, such as copper, silver, mercury
Alkali metals	Carbon dioxide; chlorinated compounds like CCl4; water
Ammonia (anhydrous)	Mercury; halogens; oxidizing agents as above
Ammonium nitrate	Acids; metal powders; reducing agents, including flammables and combustibles; sulfur
Aniline	Oxidizing agents, as above
Arsenates	Reducing agents
Azides	Acids
Bromine	Ammonia, acetylene; alkenes and polyenes; powdered metals;
Carbon, activated	Oxidizing agents
Chlorates	Acids, metal powders; reducing agents, including flammables and combustibles
Chromic acid; chromium trioxide	All reducing agents, including flammables and combustibles; organic solvents
Chlorine	See Bromine
Chlorine dioxide	Ammonia; all reducing agents, including flammables and combustibles
Copper	Acetylene; hydrogen peroxide, other peroxides
Cyanides	Acids
Flammable liquids	All strong oxidizing agents, halogens
Fluorine	Storage not permitted
Hydrazine	All strong oxidizers, esp. hydrogen peroxide
Hydrocarbons, flammable	All strong oxidizers; halogens
Hydrofluoric acid	Storage not permitted
Hydrogen peroxide	Metals and metal salts; flammables and combustibles; aromatic amines; discard after three months
Hydrogen sulfide	All strong oxidizers
Hypochlorites	Acids, activated carbon; strong reducing agents
Iodine	Acetylene; ammonia, anhydrous or aqueous
Mercury	Acetylene; nitric acid; ammonia
Nitrates	Acids; all reducing agents and flammables

Nitric acid (concentrated)	All organics; all flammables; chromic acid; hydrohalic acids; hydrogen sulfide
Nitrites	Acids; strong oxidizers; strong reducing agents
Nitroalkanes	Strong base; amines
Oxalic acid	Silver and silver salts; mercury and mercury salts; strong oxidizing agents
Oxygen	All flammable and combustible organics, including oil and grease
Perchloric acid	All organics; all metals except stainless steel
Peroxides (organic)	Acids; heat; friction and shock
Phosphorus (white)	Air; oxygen
Potassium	Organic halides; water; alcohols of three carbons or fewer; CO_2
Potassium perchlorate	See Perchloric acid
Potassium permanganate	Glycerol, other polyols; low MW aldehydes; sulfuric acid
Selenides	Reducing agents (produce H_2Se)
Silver, silver salts	Acetylene; dicarboxylic acids; ammonium salts
Sodium	See potassium
Sodium peroxide	All oxidizable organics
Sulfuric acid	Easily oxidizable organics; hydrohalic acids; chlorates and perchlorates; permanganates

Containers

- Must be constructed from a proper material that is compatible with the chemical that it will contain and be physically sound. (no rust or bulging)
- Have tight fitting lids that prevent a spill when the container is tipped.
- All containers must be labeled with contents and hazards. (including gas cylinders)
- Gas cylinders must have cap installed when not in use.
- It is recommended that upon receipt of a new chemical it should be labeled with the date received, the name of the person who obtained it, and color coded.

Segregation and containment

- Sufficient space should be provided so that incompatible chemicals can be segregated.
- Do not store incompatible chemicals in the same cabinet.
- The only exception to the above segregation guidelines is for laboratories where very small quantities are stored. All exceptions require a consultation with the Safety Coordinator and approval by Environmental Health and Safety.
- Polypropylene or polyethylene plastic containers should be used to provide both segregation and secondary containment.
- Secondary containment should be provided for liquids that are flammable, corrosive, highly toxic, or highly volatile. (Solids do not require secondary containment.)

Secondary containment is defined as a chemically resistant container that will hold 110% of the volume stored within that container. A closed container is not required for secondary containment

Procedures

- The chemicals then need to be placed upright, in a proper storage area with compatible chemicals.
- Storage area should be inspected regularly for leaking or defective containers and chemicals that have been put in the wrong place.
- Only have the quantities on hand that you can reasonably expect to use in the next year or less.
- A chemical inventory must be maintained and MSDS kept current.

9.5 Transportation & distribution

Chemicals should be placed in a secondary carrying container or bucket. Transportation methods will be evaluated for potential risks (i.e.: asphyxiation in elevators due to spills or evaporation).

9.6 Chemical substances developed in the laboratory

Some laboratories may synthesize or develop new chemical substances on occasion. If the composition of the substance is known and will be used exclusively in the laboratory, the laboratory worker must label the substance and determine, to the best of his/her abilities, the hazardous properties (e.g., corrosive, flammable, reactive, toxic, etc.) of the substance. This can often be done by comparing the structure of the new substance with the structure of similar materials with known hazardous properties. If the chemical produced is of unknown composition, it must be assumed to be hazardous, and appropriate precautions taken.

9.7 Chemical waste disposal

All chemical wastes must be disposed of properly. Waste falls into two categories: hazardous and non-hazardous. Non-hazardous wastes must be disposed of in compliance with appropriate laws. This section will only deal with hazardous wastes.

Storage and collection - Satellite Accumulation Area (SAA)

A Hazardous Waste Satellite Accumulation Area (SAA) is a location where hazardous wastes are initially generated and tend to accumulate. These areas are regulated by the Maine Department of Environmental Protection (DEP) and must be managed accordingly. SAA regulations are designed to ensure that hazardous wastes are handled and stored in a manner that minimizes the hazards to human health or the environment from fires, explosions, or releases of hazardous waste. In order to prevent hazardous wastes from being inadvertently discarded with the regular trash or to the sewer system, all hazardous materials must be evaluated before disposal by Department of Safety & Environmental Management (SEM).

All hazardous wastes must be collected in compatible containers that are clearly labeled with a "HAZARDOUS WASTE" label.

Waste Determinations

All hazardous materials must be considered hazardous wastes unless determined otherwise. Waste determinations are initiated by contacting SEM or by filing a Request for Chemical Pickup Form with SEM.

When a waste determination is made, SEM provides storage/disposal instructions. Additional information may be required in some cases.

Containers and Compatibility

Waste chemicals must be stored in containers that are chemically compatible with the contents. Incompatible wastes must not be mixed together.

Containers must be kept tightly closed when waste is not being added to or removed from the container. (The only exception is when it is unsafe to seal the container: as when a reaction is not yet complete and evolving gasses would cause a pressure buildup and explosion).

Accumulation Limits

Only one container of each type of waste may be stored in a SAA. Full containers must not be stored in accumulation areas because SAA's are not designed to meet the alarm and containment requirements for Waste Storage Areas.

Each Acutely Hazardous Waste may be accumulated in any size container of up to 1-quart in volume. Wastes other than Acutely Hazardous Wastes may be accumulated in any size container of up to 5 gallons.

Inspection Requirements

All SAA's must be inspected each regular business day. A *Satellite Accumulation Area Inspection Log* must be maintained daily and must be readily accessible for inspection within the area. Copies of the daily inspection log should be sent to SEM on the last working day of every month.

Labeling Requirements

Each hazardous waste container in a SAA must be properly labeled. Fill in all information that applies, being sure to include all hazardous chemical constituents and the approximate concentration of each.


HAZARDOUS WASTE

Federal Law Prohibits Improper Disposal

GENERATOR INFORMATION:

Name: _____

Address: _____

CHEMICAL CONSTITUENTS & CONCENTRATION:

_____ _____

_____ _____

_____ _____

_____ _____

_____ Date waste was first added to container.

_____ Container full date. Call EH&S IMMEDIATELY.

_____ Date transferred to Waste Storage Site.

CAUTION HANDLE WITH CARE

Contains Hazardous or Toxic Wastes

Disposal Procedures

Complete a *Request for Chemical Pickup Form* and contact SEM (581-4055) or fax the form to (581-4085) before the container is filled. This will prevent having more than one container of a single type of waste in a SAA and will allow for timely removal of the wastes. Once a container is full, it must be removed from the area and transferred to a Waste Storage Area within 72 hours.

Training:

Standard Satellite Accumulation Area Training is conducted by the Department of Safety & Environmental Management. Training must be updated annually to ensure that employees are familiar with waste handling procedures, storage requirements, and emergency procedures.

Disposal

All unwanted hazardous materials must be evaluated before disposal. These hazardous waste determinations are performed by specially trained Department of SEM staff to ensure that the University properly disposes of hazardous wastes.

An employee with a hazardous material for disposal must complete a Request for Chemical Pickup Form and send or fax the form to SEM. If the material is determined to be a hazardous waste, SEM will arrange for a pickup or disposal services. If the material is determined not to be a hazardous waste, information on proper disposal will be provided.

Waste chemicals cannot be accepted from off campus. It is illegal to transport or accept hazardous waste without a license and the University does not have a license. If you have a legitimate use for chemicals which someone would like to donate, contact SEM for assistance in processing the required authorization.

Hazardous Chemicals

Disposal of hazardous chemicals should be accomplished by completing a *Request for Chemical Pickup Form*. The form includes the room number, location within the room, the chemical name(s), and concentration of each constituent, the approximate quantity, any known hazards, and the name of a contact person. Hazardous chemicals should be handled as chemical inventory until removed by SEM.

The contents of each container should be identified and clearly labeled. Each container should be numbered with the number from the upper right hand corner of the pickup form. Research samples or other materials for which detailed analysis is not available should be listed with the most specific information available (e.g. *Whatchamacallita extract* in 60% Methanol 40% Chloroform). If more information is needed, SEM will contact the person listed on the form.

Used chemicals should be stored in compatible containers and the containers should be closed when not in use (the only exception is when it is unsafe to seal the container due to the characteristics of the chemical being stored). Containers must not be left open simply for convenience. When hazardous wastes are accumulated in containers (i.e. some waste today and some tomorrow) the Satellite Accumulation Area guidelines must be followed.

When waste chemicals are collected in containers, compatibility must be considered. Additionally, certain types of waste chemicals are very expensive to dispose of and must not be mixed with other waste. Mercury, pesticides, PCB, Dioxin, biohazard, and radioactive materials must be segregated from other wastes. In general, only materials of the same chemical family should be combined in a single container.

Non-Hazardous Chemicals

Non-hazardous chemical wastes should be clearly labeled with the words "Non-Hazardous Waste," the name of the person generating the waste, and the department where they work, prior to disposal.

Once labeled, non-hazardous chemical wastes may be placed in the regular trash. If unsure whether or not a material may be placed in the regular trash, call SEM. It is better to call and be certain than to inadvertently place a hazardous material in the trash where it may harm someone or the environment.

Empty Chemical Containers

Empty containers should be drained, rinsed, and allowed to dry before disposal as ordinary trash. Caps should be removed. If the containers held an acutely toxic material, they should either be disposed of as hazardous waste or rinsed three times with an appropriate solvent capable of removing the hazardous residues. Empty containers should be clearly labeled with the words "Non-Hazardous Waste," the name of the person placing the container in the trash, and the department where they work.

Empty glass containers, laboratory glassware, or broken glass should be collected in a heavy-duty waste bag or strong cardboard box to prevent injuries from sharp edges. When full, the collection container should be sealed and labeled with the words "Non-Hazardous Waste", and the names of both the person and department generating the waste. All discarded lab glass should be placed in the regular trash and should not be recycled.

9.8 Waste water discharge

It is the goal of the University of Maine to minimize the release of toxics into the environment. This may be accomplished through a variety of means: waste minimization, recycling, toxics use reduction, and substitution using less toxic alternatives.

Chemicals may be discharged to the sewer under certain, controlled circumstances. It is the position of the University of Maine, that in-lab neutralization of corrosive waste, as a final experimental or research step, is preferable to reliance on an external neutralization system or catch basin. Control of laboratory processes has always been the best, and first, line of defense in addressing chemical waste concerns.

Prior to sewer disposal, a hazardous waste determination must be made. By state and federal law, it is ILLEGAL to dump hazardous wastes down the drain. Additionally, it is against University policy to dump significant quantities of heavy metals or other recognized environmental pollutants down the drain.

De minimus quantities of chemicals, as defined by the Environmental Protection Agency (EPA), include quantities found in table 40 CFR 268.43. These chemicals may be discharged to the sewer system provided they are not otherwise classified as hazardous wastes.

9.9 Re-use program

The Redistribution/Reuse program works in concert and conjunction with the waste minimization program. Using these programs concurrently will be the most efficient use of time and space. Chemicals that are not wanted by one part of the University can be used elsewhere through the reuse program.

Any unused chemical, including but not limited to Acids, Bases, Salts, Organic solvents (no mixtures), and Organic and Inorganic chemicals, is acceptable for the chemical reuse program.

To put an unwanted chemical into the Reuse program:

• Complete a *Chemical Reuse Form* or *Request for Chemical Pickup Form* for each chemical you wish to have evaluated. In the comments section of the Chemical Pickup form indicate that the chemical may be reused.

• Send or fax a copy of the completed form to SEM and attach the original to the container. The information on the chemical pickup form will enable someone who has a question about the age, origin, or purity of the material to question about the age, origin, or purity of the material to contact the originator of the chemical.

• The chemical must be in the original container with the original label attached and intact. Do NOT label as "hazardous waste".

• The chemical must NOT be CONTAMINATED. Unopened containers have the best potential for reuse.

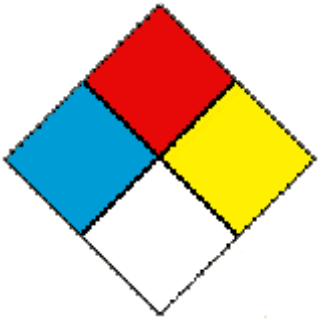
Chemicals that the originator has identified for reuse will be picked up along with the chemicals for hazardous waste disposal. SEM personnel will affix a green tag to the reuse chemicals, assuring easy identification, date, and documentation. SEM stores reusable chemicals for at least 90 days. All materials submitted for chemical exchange will be placed on the reuse inventory. At the end of 90 days unwanted chemicals are evaluated and if unwanted will be placed in storage awaiting disposal as hazardous waste for a maximum of 90 days as part of the hazardous waste inventory.

If the chemicals are reused, there is no disposal charge to the University and no chemical purchase cost for the department or individual project. The chemical reuse program also lists chemicals that researchers have indicated they are willing to share with others at little or no cost. Often, only a small quantity of chemical is needed but is not available from the manufacturer. To participate in this program, send a list of the chemicals you are willing to share with other researchers to Safety & Environmental Management.

10. Signs and Labels

10.1 Hazard rating

A uniform system of chemical hazard ratings has been adopted. It explains to any emergency response personnel, at a glance, what the potential hazards are within the marked area. This label system is used by the National Fire Protection Association (NFPA) and uses a diamond-shaped label containing four differently colored squares. A number (0 - 4) or an abbreviation is added to each square indicating the order of hazard severity. The higher the number, the greater the hazard.



Red Background
Flammability

- 4 - flash point < 73 ^{o}F
- 3 - flash point < 100 ^{o}F
- 2 - flash point > 100 ^{o}F < 200 ^{o}F
- 1 - flash point > 200 ^{o}F
- 0 - will not burn

Yellow Background
Reactivity

- 4 - explosive at room temp
- 3 - shock and heat may detonate
- 2 - violent reaction with water
- 1 - unstable if heated, not violent
- 0 - not reactive with water

Blue Background
Health Hazard

- 4 - deadly
- 3 - extreme danger
- 2 - hazardous
- 1 - slightly hazardous
- 0 - normal material

White Background
Specific Hazard

- oxidizer OX
- acid ACID
- alkali ALK
- corrosive CORR
- use NO WATER

10.2 Chemical containers

All chemical containers must have the original or a secondary label affixed which identifies the common name (if available) and any associated hazards, which are known. NFPA ratings of 0-4 should be used to indicate severity levels.

Labels on incoming containers of hazardous chemicals shall not be removed or defaced until the container has been emptied. Damaged or illegible labels shall be replaced immediately.

10.3 Special hazards

Warnings of special hazards, equipment or requirements (i.e.: hot surfaces, pinch points or" safety glasses required" shall be posted in the vicinity of the hazard and clearly visible).

10.4 Laboratory signs

- Emergency telephone numbers (**911**) must be affixed to every telephone)

- Appropriate emergency numbers and names (i.e.; "laboratory responsibility" signs) must be posted on the outside of the laboratory;
- Safety equipment and exit signs must be posted.

11. Spills and Accidents

All users of a laboratory need to be trained on the location and use/activation of the following emergency equipment:

1. Emergency Eyewash.
2. Emergency Shower.
3. Fire Alarm System.
4. Spill Kit.
5. Telephone.

11.1 Reporting procedure

All accidents, spills and "near-misses" must be reported immediately to the supervisor. These incidents will be carefully analyzed and documented with results distributed to all individuals.

11.2 Chemical spill guidelines

Chemical Spills are separated into two classes emergency and non-emergency. Upon the discovery of a spill, the determination must be made if an emergency exists. Emergency spills should be immediately reported to Public Safety, and no clean up should be attempted. An emergency is a spill that is beyond your capability, or training, or cannot be cleaned up safely. Non-emergency spills may be cleaned up by the laboratory workers providing they are trained and can do so safely.

Factors to be considered

1. Injuries resulting from the spill.
2. Area impacted by the spill
3. Identity of chemical spilled, quantity, and the degree of hazard.
4. Availability of proper PPE and Spill kit.
5. Level of training of individual who will perform clean-up.

Emergency chemical spill guidelines

1. If you have been contaminated by the hazardous material, take immediate action.
    - Most likely, this will be the use of the Emergency Shower or Eyewash. Rinse for a full fifteen (15) minutes.
    - While taking action, shout for help and let others know of the danger.
    - Seek medical attention.
    - Administer first aid *only if you have been trained and are using the proper personal protective equipment.*
    - If you have not been contaminated, leave the room, secure the door, and warn others to stay away.
2. Activate the Evacuation/Fire Alarm and **call 911 (cell phone users must call 581-4040)** from a safe place.
3. Give the dispatcher the following information:
    - Location of the spill (building, room number and portion of room affected);

- Identify the material spilled;
- Your name and phone number where you can be reached.

4. Meet the Emergency Responders and identify yourself as the person who reported the spill.
5. Remain available until the commander of the HazMat team tells you your help is no longer needed.
6. The Incident Commander of the Fire Department is in charge of the incident, and is required to follow very strict procedures. These procedures can take from one-half hour to five hours or more. Many times these procedures can be shortened by having accurate and timely information from the people involved.
7. Do not re-enter the building until it is declared safe by the authorities.

Non-emergency chemical spill guidelines

1. Determine that you can safely handle the situation with your available resources.
2. Alert others in the area to the problem.
3. Prevent others from coming into contact with the hazardous material, by barricading, locking doors, establishing warning signs, or having some-one stand at the entrance to direct traffic.
4. Perform the cleanup in accordance with your area-specific protocols
5. Call Safety and Environmental Management to report the spill, **581-4055**, and report the following information:
   - Where and when the spill occurred;
   - Who was involved (both name and phone number);
   - What chemical was spilled;
   - The quantity spilled;
   - How the clean up was accomplished.
6. Safely dispose of the material resulting from the spill by placing it in a compatible, sealed container and label it as "Spill Cleanup Material". This label must also contain a list of the chemical contents of the spill including amounts and concentrations. Complete and send a request for chemical pickup form to Environmental Health and Safety.

Spill kits

Spill Kits can either be purchased or be assembled in the laboratory. **A spill kit must be readily accessible. Each spill kit must have a label stating the types and quantities of chemicals it can clean up.**

Example of label:

This Spill Kit is capable of absorbing all chemicals except:

Hydrofluoric acid _____ _____ _____

This kit will absorb up to _____***Four liters***_____ of spilled chemicals

Example of a general spill kit

1. Five-gallon plastic pail with tight fitting lid. (To hold spill kit and waste)
2. Absorbent such as cat litter, sand or, Speedi-Dri. (These react with very few chemicals.) Clearly mark on the container its capabilities, in terms of chemicals and quantity. Plastic scoop and scraper for dispensing and picking up absorbent material.
3. Proper gloves resistant to chemicals used in the laboratory.
4. Splash resistant Chemical Goggles
5. Chemical resistant apron or lab coat.
6. Other PPE as needed per assessment of chemicals in Laboratory.
7. Heavy-duty plastic bag(s) to contain hazardous waste generated by clean-up.
8. Neutralization materials such as sodium bicarbonate for acids or powdered citric acid for bases.
9. Decontamination supplies, many times just soap and water.
10. A copy of the area-specific protocol for spill clean-up should be placed on top of all of the other supplies.

Spill kits are located in each of the laboratories in the pilot plant. These kits contain the most commonly needed supplies and are pre-rated for clean up capacity. The contents should be reviewed to ensure that they are adequate for the spill. A copy of the area-specific protocol for spill clean-up should be placed on top of all of the other supplies.

12. Emergency Action Plan

This section outlines the Emergency Action Plan for the Department of Chemical & Biological Engineering, Jenness Hall.

12.1 Evacuation

Emergency procedures

In the event that you discover a fire or chemical spill, smell smoke or the odor of burning or abnormally hot material, or the alarm is sounded, you shall:

- Verbally warn others in the area.
- Immediately sound the alarm, if not already done.
- If your workspace is not currently involved and you can so safely, shut windows and close the door tightly behind you as you leave.
- Evacuate the building; do not use an elevator, conducting a minimal sweep for visitors and students on the way out.
- Notify University Public Safety at **911 (cell phone users must call 581-4040)** from a safe place and inform them of what has happened. Tell the dispatcher what you are reporting, give them the location and your name.
- Assemble at the rally point and account for all employees, students and guests.
- Brief the Fire Department or other appropriate personnel of concerns upon their arrival.
- Remain at the scene outside the building to direct rescue/emergency personnel when they arrive. When evacuating the building, the stairwells must always be used. **Do not allow anyone except emergency personnel to use the elevators. Do not reenter the building until firefighters have announced that it is safe to do so.**

Procedure for Paper Machine Operation during Fire Alarms

It has been determined that Keith Hodgins and/or Mark Paradis will be authorized to remain in the Pilot Plant to operate the paper machine system during fire alarms. If the situation that caused the alarm is not affecting the Pilot Plant area and if he determines that an experiment is at a stage that continued operation is needed, he will proceed as follows:

1. Determine that two routes of escape are not involved in the current emergency. These routes are through the NE Pilot Plant exit and the NW Pilot Plant exit.
2. The cell phone (356-1753) is present and operating.
3. Call is made to UMPD 581-4040 informing them he (Keith Hodgins and/or Mark Paradis) will be staying behind.
4. Photo ID is present.
5. The machine will be operated using the operator workstations in the center of the Pilot Plant. Steady state operation will be maintained. This may take up to one hour.
6. If any hazard or unsafe condition is perceived, an emergency shut down will implemented. *Some examples of unsafe conditions are: visible smoke or vapor, physical effects such as tearing, coughing, difficulty breathing, unusual taste or observing other people having difficulty.* Keith Hodgins and/or Mark Paradis will exit the building using the nearest safe exit and report to the assembly point at Neville Hall and call UMPD to inform them that he has left the building.

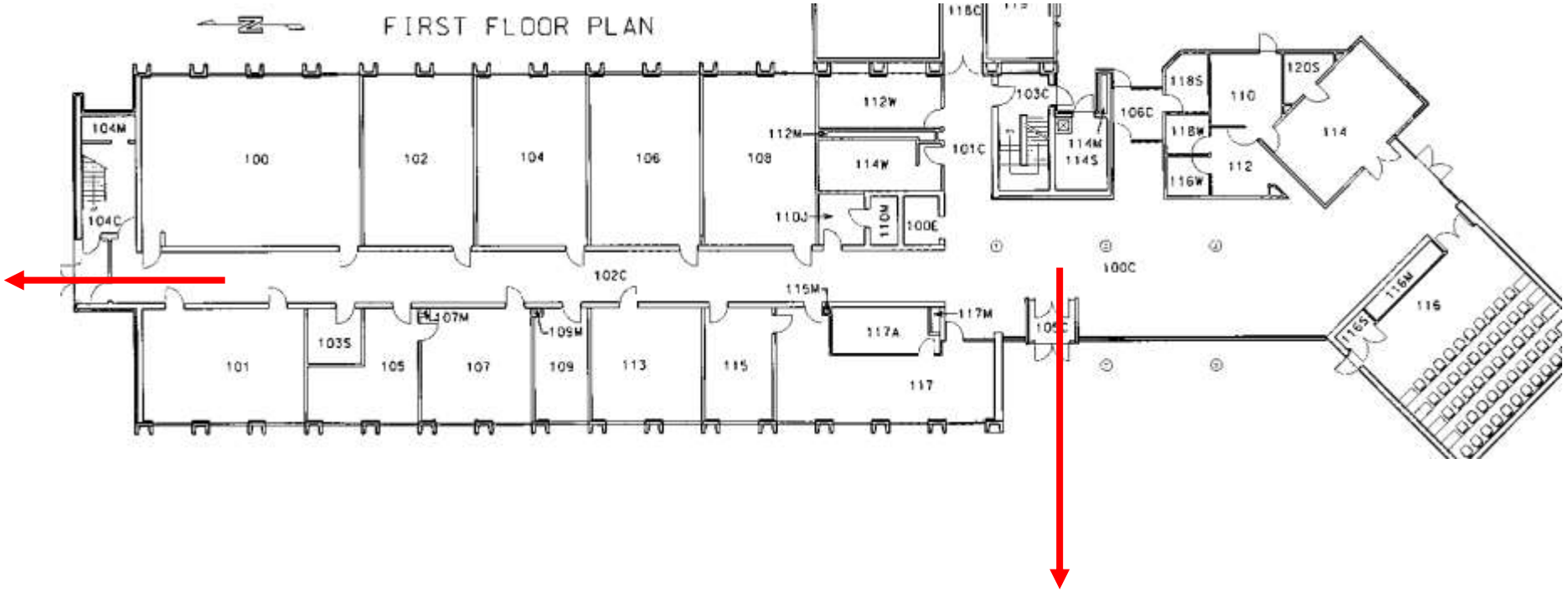
7. This plan will be on file with SEM, UMPD, and ORFD. The Project Leader of the paper machine experiment will be responsible for notifying the Evacuation Coordinator that this plan is in action. The Evacuation Coordinator will relay this information to the responding Fire personnel.
8. This plan will be reviewed and training provided annually.
9. Attached building plan shows location of operator and escape routes.
10. This plan will be reviewed annually, when any change is made, or any time it is found deficient.

Exit Pathways

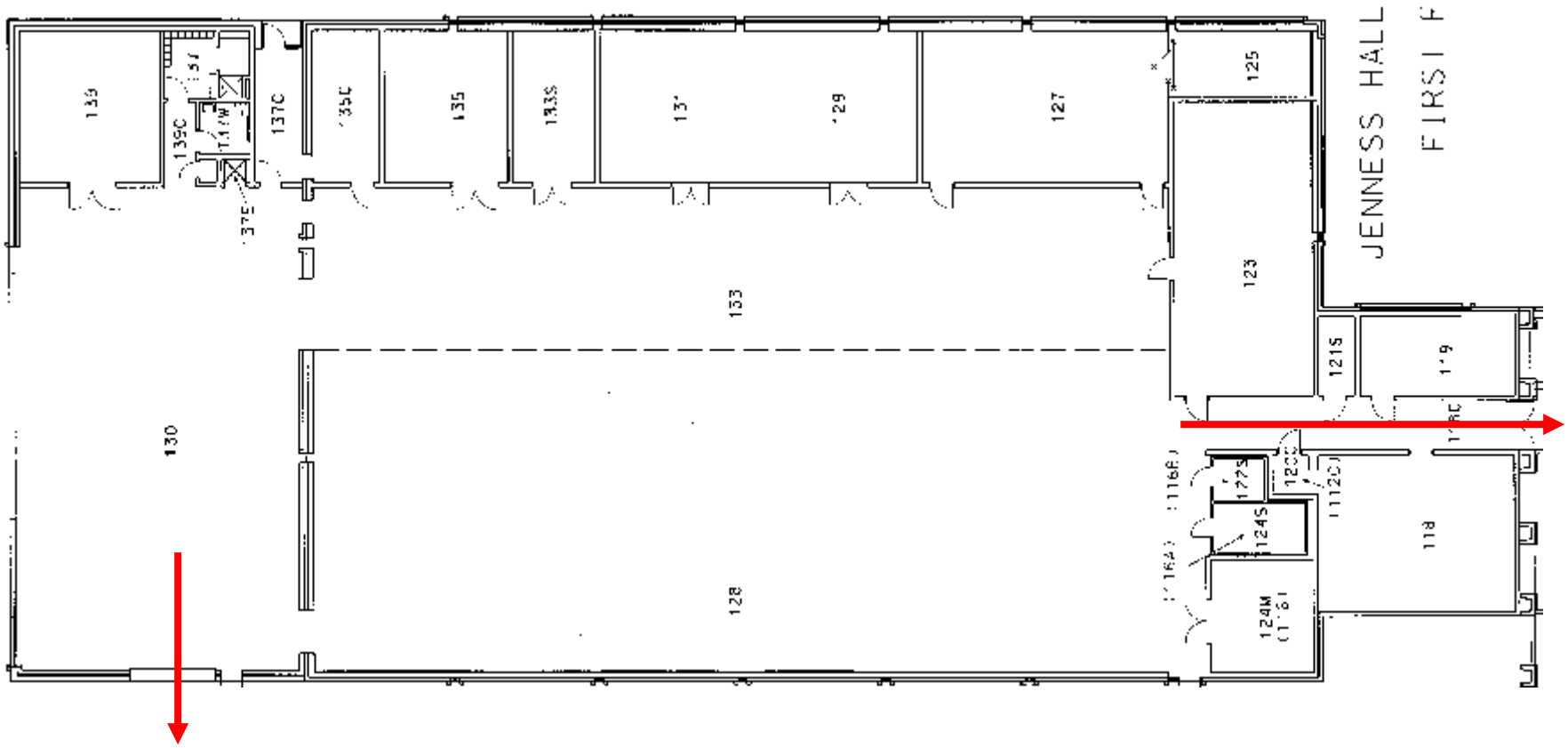
See following diagrams

First Floor – Main Building

Classrooms, offices, lobby, auditorium

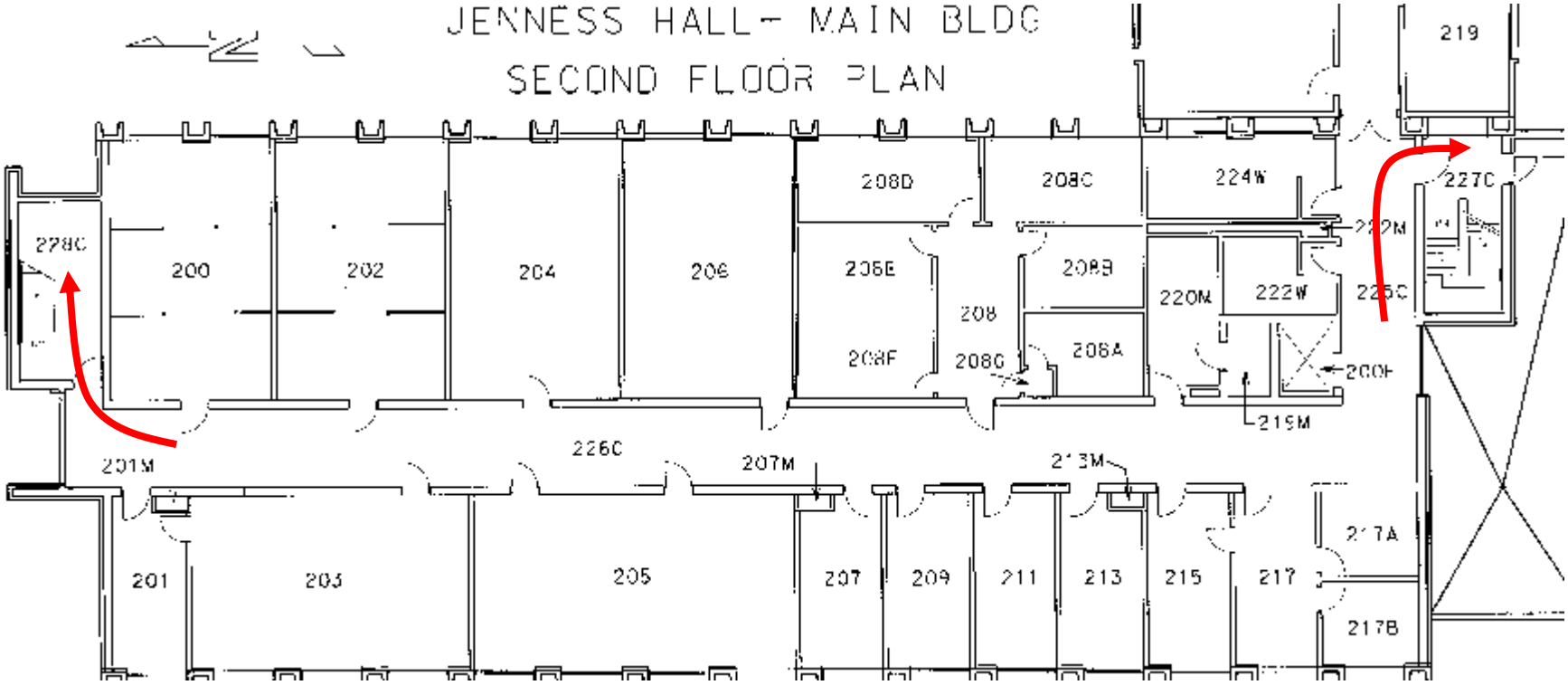


First Floor – Pilot Plant



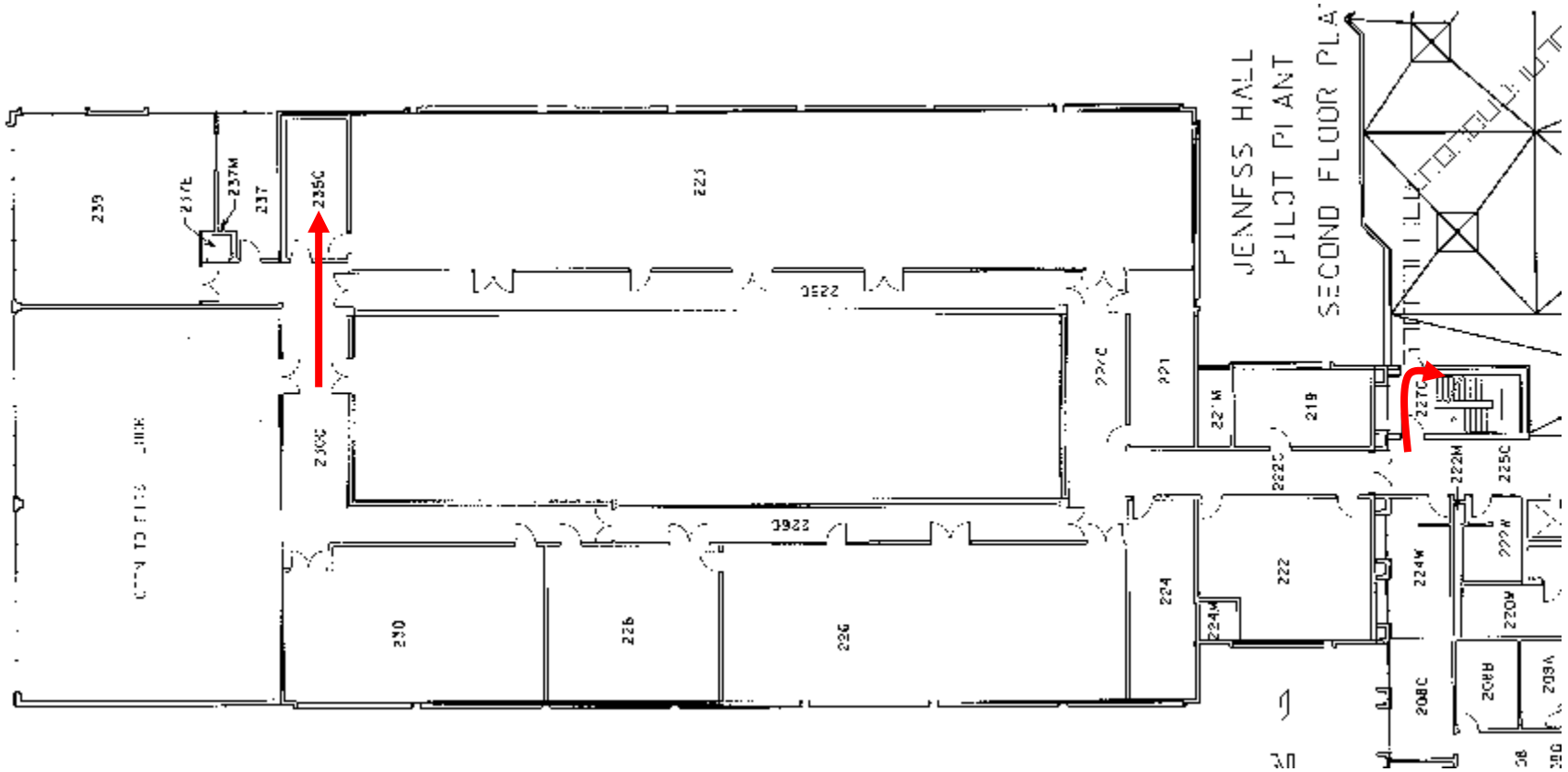
Second Floor – Main Building

Labs and Offices



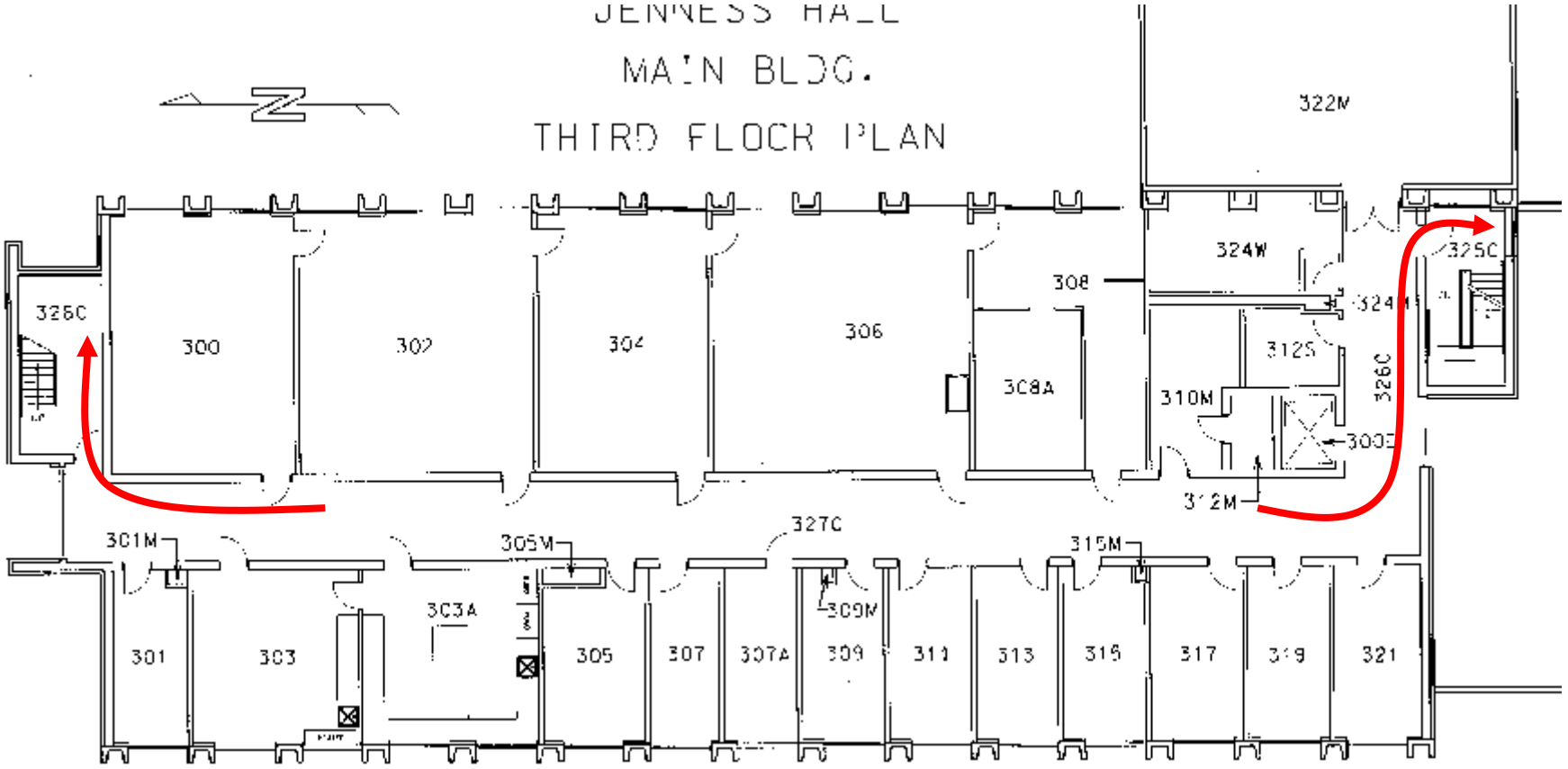
Second Floor – Pilot Plant

Labs and Offices



Third Floor – Main Building

Offices and Labs



Rally points

The CHB rally points are: South East lawn in front of Neville Hall in good weather and lobby of Neville in inclement weather.

At the Rally Point an accounting of employees will be taken by Keith Hodgins, Cathy Dunn, or the most senior of the staff available. **Evacuation coordinators for the PDC clients will be Pros Bennett and the Principal Investigator of the client project** (Mark Paradis, Donna Johnson, and/or Jonathan Spender). If people cannot be accounted for, inform the Emergency Responders.

Use of emergency equipment

Although it is policy to evacuate in case of a fire, circumstances may dictate that a fire extinguisher is needed. DO NOT use a fire extinguisher unless:

1. You have been trained in the **hands-on** use of an extinguisher within the last year.
2. You are able to put out the fire without endangering yourself or others.
3. You have an open path of escape at all times

12.2 Medical care

Personal Injury Emergency Procedures

In the event that you are injured, come upon an injured person, or encounter what you suspect to be blood or other bodily fluids, you shall:

- Call **911 (cell phone users must call 581-4040)** and inform them what has happened.
- If the victim is other than yourself administer first aid only if you have been trained and are using the proper personal protective equipment.
- If the situation involves suspected blood or other bodily fluids and no victim, still call **911 (cell phone users must call 581-4040)** and inform the dispatcher. (**DO NOT attempt a clean-up on your own.**)

Blood-borne pathogens awareness

Bloodborne pathogens are disease causing microorganisms present in human blood and certain other body fluids. The two most commonly encountered bloodborne pathogens are hepatitis B virus (HBV) and human immunodeficiency virus (HIV). Bloodborne diseases are transmitted when pathogens from infectious body fluids enter the bloodstream through breaks in the skin or through mucous membranes. Bloodborne pathogens are not transmitted by casual contact.

The OSHA Bloodborne Pathogen Standard requires the University to establish an Exposure Control Plan that will minimize or eliminate all reasonably anticipated skin, eye, mucous membrane or parenteral (piercing the skin) contact with human blood or other potentially infectious materials (OPIM) in the performance of an employee's duties. The Exposure Control Plan includes an Exposure Determination, categorizing employees according to their risk of exposure (high, medium, and low). Due to the nature of the work in the building, Jenness Hall falls in the "low risk" category. Employees in the "low risk" category would be expected to encounter exposure situations only rarely. Guidelines for handling these situations are provided during every employee's annual hazard communication training.

Biohazard warning signs are used to signify the presence of biological hazards and may also indicate precautions to be taken. Biohazard labels or tags are used on equipment or containers that are or may become contaminated with blood or OPIM. Signs and labels must not be used where no hazard exists. Untrained employees should avoid contact with biohazard labeled equipment or containers and should not enter biohazard areas.

Following an exposure incident, employees should immediately proceed to their designated workplace injury management facility to receive a confidential medical evaluation including baseline blood tests and post exposure prophylaxis (e.g. hepatitis B vaccination). Exposure incidents must be reported to the Office of Human Resources Rehabilitation Specialist within 24 hours using the Supervisor's Injury Report form. The report should include a description of the route of exposure and the name of the source individual, if available.

Emergency medical attention

- **Call 911** for ambulance to transport employee to St. Joseph Hospital or EMMC for medical treatment.

Non-emergency medical attention

- For injuries/illnesses that require non-emergency medical attention, Cutler Health Center can be called at 581-4000 to set up a medical appointment. Generally your supervisor should make this call. An immediate appointment will generally be made available for those injuries requiring immediate medical attention. When Cutler Health Center is not open and you have a workplace injury/illness requiring immediate attention such as a cut finger requiring stitches, you should go to the Emergency Department at Eastern Maine Medical Center.

Overnight admission to a hospital or fatality

- Immediately contact University of Maine Public Safety at **581-4040** to initiate further response.

12.3 Reporting

Reporting work related accidents or illnesses

All work related injuries/illnesses (whether they result in medical attention or not) are reported to the Claims Coordinator in the System Risk Management Office, who will ensure that the claim is reported to the workers' compensation/employee injuries insurance company.

Supervisors should refer to the UMS Risk Management and Insurance website for specific procedures at the website link below.

- http://www.maine.edu/about-the-system/system-office/risk-management-and-insurance/incident-reporting/

Supervisors will utilize the incident report under the subcategory Injuries to Employees-Workers Compensation and follow the instruction on the form.

Injuries and property damage sustained by visitors, students, or the general public

Please complete the Incident Report Form to report injuries or property damages sustained by visitors, students, or the general public alleged to have been caused by the University or occurring on University property or during a University activity or event. Do not use this form for auto accidents or employee injuries.

When you have completed the form, please fax the form to the UMaine Campus Risk Management Administrator at 581.2673.

An accident is an unplanned event (or sequence of events) that causes injury, illness, or property damage. A "near miss" is an unplanned event or sequence of events that have the potential to cause injury, illness, or property damage. A near miss is equally important to investigate because it indicates that something went wrong. It may only be sheer luck that someone wasn't injured - this time.

The supervisor and/or SEM will investigate the who, what, when, where, and how. The focus of any accident investigation is fact-finding, not fault-finding. The goal of an accident investigation is to find the root cause so that the supervisor can determine why it happened to help develop solutions to prevent recurrence.

Returning injured employees to work

Studies show that the first 10 days after a workplace injury are critical to getting a worker well and back on the job in a timely manner. The supervisor has an important responsibility that can both aid in the timely recover of the employee and reduce costs. Stay involved and help identify return to work options.

The Safety and Environmental Management Department provides training and work-site evaluations on request.

Prevention/follow-up

Periodic safety audits will be conducted by the employees and safety coordinator reducing the risks of hazards within the work spaces.

Once the emergency situation has been mitigated, an incident investigation will be completed, and corrective measures will be implemented to prevent future recurrence of the problem.

If an injury is involved then file a first report of injury with Human Resources.

12.4 Fire prevention

List of major work place fire hazards

Flammable chemicals: found in laboratories, shops, maintenance activities (painting, cleaning, repair), engines, boilers and other heating appliances.

Processes involving open flame: Welding, brazing and similar operations, and some lab operations.

Heat producing devices: Drying, cooking, heat producing devices such as hot plates and space heaters.

Use and disposal of chemicals: Experiments in labs, hazardous waste handling, and shops.

Electrical equipment: Short circuits and malfunctioning equipment.

Flammable chemical proper handling and storage procedures

Chemicals use and storage are either covered under the specific Chemical Hygiene Plan in each or laboratory or under the Hazard Communications Policy. These plans and policy define safe storage and handling of chemicals. Basically we follow the manufactures recommendation or industry standards and guidelines.

Types of fire protection equipment and systems to control fires

Many systems are in place including the following; Fire suppression equipment (sprinklers and fire extinguishers); Proper storage areas (flammable storage rooms and cabinets); Fire alarms and detectors; Building systems such as doors, walls, ceilings, and floors.

Training

All employees are required to receive Basic Safety and Area Specific training upon beginning at the University and annually thereafter, included in this training are fire prevention and emergency action plan training.

Maintenance

The maintenance of heat producing equipment is the responsibility of the department and employees using the equipment. In the case of area specific equipment, it is the responsibility of the department using the workspace. In the case of building systems it would be the responsibility of Facilities Management. In all cases employees would follow the manufacturer's instructions and practices or industry standards as appropriate.

12.5 Specific laboratory hazards

Specific hazards in the laboratories will be posted next to each hazard.

12.6 Training and record keeping

Implementation and maintenance

The Department's Emergency Action Plan will be reviewed and exercised whenever a new employee is hired, when changes necessitate, or at least once a year. The training will consist of providing a copy of the Emergency Action Plan and evacuation map to the employee, explaining procedures, walking through an evacuation, and answering any questions.

13. Record Keeping

The university has established and maintains for each individual an accurate record of any measurements taken to monitor individual exposures and any medical consultation and examinations including tests or written opinions required by this standard. At the University of Maine, the Department of Human Resources (HR) in accordance with 29 CFR 1910.1020 shall maintain these records. Records for medical evaluations shall be kept for a period of 30 years following the last date of employment for each individual. Records for exposure evaluations shall be kept for a period of 30 years.

The Pulp & Paper Process Development Center shall maintain training records unless otherwise specified by associated regulations. Training records shall include the name and signature of the attendee; the name of the training course, the name of the instructor and the date the course was administered.

PPE Hazard Assessments shall be maintained for the duration of the assessed activity. Current Safety Data Sheets (SDSs) shall be accessible, in or near the individual laboratories, during normal working hours.

14. General Laboratory and Safety Recommendations

The Laboratory shall meet the regulatory requirements required in other parts of the OSHA regulations, National Fire Protection Agency (NFPA) recommendations, the Environmental Protection Agency (EPA) requirements, the Maine Department of Environmental Protection (MeDEP), State Fire Codes and other applicable federal, state and local governing bodies.

14.1 Housekeeping

1. Maintain general cleanliness and housekeeping.

2. Aisles and walkways should be kept clear of storage.

3. Stairwells and hallways must be kept clear of combustible materials or items that may be easily moved into an exit path.

4. A minimum egress of 28 inches must be maintained at all times.

5. Work surfaces should be reasonably clear and should allow work to be conducted in an efficient and safe manner.

6. Work surfaces should be clear of chemical spills and contamination.

7. Equipment and Chemicals in hoods

   - Only equipment which is absolutely necessary, and must be vented, or operated in a ventilated area, to provide an adequate measure of worker protection, should be maintained in a fume hood.

   - Fume hood sashes shall not be placed above the maximum operating height, as indicated on the annual inspection sticker located on the face of the fume hood. Sashes should be used at the lowest position possible to allow for comfortable manipulation of materials inside the fume hood.

   - Equipment in fume hoods should not be operated if the airflow is below the minimum acceptable levels.

   - Chemicals may only be stored in properly labeled "Chemical Storage Fume Hoods". Fume hoods which are used for processing or manipulations may not to store chemicals or hazardous waste.

8. Equipment in low-use storage areas.

   - Old equipment, no longer in use, should be recycled, sold or given to an appropriate party if there is no likelihood of use in the next ten years. Areas should be purged regularly to provide adequate storage for those items that can and should be stored for future use.

   - Equipment and computer cardboard boxes should be broken down and recycled; Styrofoam inserts should be thrown in the trash. Boxes for new equipment should be kept no longer than three months, as new boxes can be obtained for the return of standard computer equipment should the need arise.

- Heavy items should be stored below waist height.

- All equipment and boxes shall be labeled with the owner's name and the date the items were placed in storage.

- Old, expired or unwanted chemicals shall not be stored in standard storage areas. If their value or purpose has expired, they must be disposed of as hazardous waste.

9. Storage in laboratories

   - Chemicals shall be stored according to compatibility, properly labeled and stored below eye level (but off the floor).

   - Chemical storage shelves should be equipped with ½ inch "lips" to prevent containers from falling.

   - Compressed gas bottles shall be secured with a strap or chain that is securely fastened to a permanent object (such as a wall or fixed workbench). This strap must be located between the neck of the bottle and the top 1/3 of the container.

   - Storage shall not block access to emergency eyewashes, fire extinguishers or drench showers.

   - Materials shall not be stored in front of electrical panels or service panels. A minimum of 36 inches of space shall be maintained in front of existing panels.

10. Broken glassware shall be kept in a solid container with a lid, marked appropriately and securely sealed before discarding in the regular trash.

11. Pets and children are not allowed inside the laboratory.

14.2 Inspection checklists

1. Laboratories should be inspected regularly to eliminate unsafe conditions and prevent unsafe acts from occurring.

2. Inspections may be formal or informal, random or announced; but all inspections should be documented and maintained for future reference by the individual(s) conducting the inspection. It is advisable to have different individuals inspect laboratories as each person has a different background and perspective.

3. Follow-up inspections should be conducted to ensure that corrective actions have been taken. Corrective actions should be documented with the date of correction and action taken. This should be filed with the original inspection report.

14.3 General rules for all laboratory work with chemicals

1. Food, drink, cosmetics and smoking materials are not to be used, consumed or stored in chemical storage or chemical use areas.

2. For accidents and spills, the following procedures should be taken for essentially all laboratory chemicals:

- Eye Contact: Promptly flush eyes with water for at least 15 minutes and seek medical attention.

- Ingestion: Seek medical attention immediately.

- Skin Contact: Promptly flush the affected area with water for 15 minutes, remove any contaminated clothing and seek medical attention if symptoms persist.

- Promptly clean up all spills using the appropriate personal protective equipment and spill kits. Neutralize the area, if necessary, and wash down surfaces with soap and water. All spill cleanup materials need to be disposed of as a hazardous waste, if the chemical is classified as a regulated "hazardous waste".

3. Develop and encourage safe work habits.

4. Avoid unnecessary exposures to any chemical, by any route.

5. Do not smell or taste chemicals.

6. Do not use mouth suction for pipeting or starting a siphon.

7. Vent apparatus, which may discharge hazardous chemicals, into local exhaust ventilation devices.

8. Wash exposed skin with soap and water before leaving the laboratory.

9. Do not wear potentially contaminated personal protective equipment (such as gloves) outside of the laboratory area. Be careful when handling equipment inside the laboratory (such as phones) with contaminated PPE that might also be handled under non-work conditions.

10. Confine long hair and loose clothing. Do not wear sandals or shorts inside of a chemical use or storage area

11. Wear prescribed Personal Protective Equipment (PPE).

- Safety Glasses: ANSI approved impact resistant glasses must be worn by any individual who works inside, or enters, a laboratory area.

- Chemical Splash-Resistant Safety Goggles: ANSI approved Chemical Splash-Resistant Safety goggles shall be worn when handling, manipulating or transferring corrosive or extremely hazardous chemicals; or when indicated as necessary by the laboratory supervisor.

- Gloves: Wear appropriate gloves for the chemicals being handled when there is a potential of contact with toxic materials. Glove/chemical compatibility information is available from SEM, from suppliers and glove manufacturers. Inspect gloves before every use, wash thoroughly before removal and replace periodically.

- Respiratory Equipment: Dust masks should only be used for protection from nuisance dust exposures. Respirators; whether paper, half- or full-face units must be approved, issued and monitored by the University of Maine Industrial Hygienist. Depending on circumstances, medical evaluations may be required before a respirator can be issued.

12. Use a fume hood for operations that might result in the release of hazardous chemical vapors or dust. In general, when working with a chemical that has a TLV or PEL of 50 ppm or lower, a hood or local exhaust ventilation device should be used. Ideally, exposures should be kept as low as reasonably achievable. When using a fume hood it is important to always confirm the hood performance before beginning work.

13. Laboratories, which accumulate hazardous waste for disposal, are subject to the Satellite Accumulation Area requirements. These wastes must be stored in a compatible container with a closed lid; labeled correctly, stored such a way that it cannot access sewer or storm drains (secondary containment works best) and inspected every working day.

14. In general, chemical wastes that have a pH greater than 9.0, less than 5.5, that contain a toxic or heavy metal component, are flammable or are radioactive may not be disposed to the sanitary sewer or storm drain. Questions and exemptions need to be directed to the Hazardous Waste Manager in SEM or the Radiation Safety Officer, as appropriate.

15. The use of highly hazardous chemicals should be approved by the appropriate laboratory manager and have a Standard Operating Procedure developed prior to commencing work. Notification of intent to use highly hazardous chemicals should be made to SEM and FM in writing, before chemicals are purchased and/or used in experimental protocols.

14.4 Laboratory layout

1. Ground Fault Circuit Interrupters (GFCIs) should be located in exposed electrical circuits that are within six feet of a flowing water source (i.e.: sinks and emergency showers).

2. An appropriate general ventilation system should be installed and constructed such that air intakes and exhausts are located to avoid the intake of contaminated air. This system should not be relied on for protection from toxic substances.

3. Fume Hoods should be located such that an individual does not need to pass in front of the hood when exiting the laboratory under emergency conditions.

4. Special ventilation devices (Fume hoods, glove boxes, isolation rooms, etc.) shall be provided if individuals work with toxic or highly toxic substances. These devices should be directly vented to the outside and not be part of a re-circulated air ventilation system.

5. Safety equipment such as emergency eyewashes and drench showers shall be readily accessible and maintained in good working order at all times.

14.5 Maintenance of laboratory equipment

1. All departmental-owned laboratory equipment should be maintained as per manufacturer's instructions. Routine maintenance should be performed and noted in a laboratory logbook.

2. If equipment needs to be calibrated, a calibration procedure and log need to be kept with the machine. All external or factory calibration cycles should be maintained.

3. Lock Out/Tag Out (LO/TO) procedures, in accordance with the University of Maine program, shall be written and implemented when a piece of equipment can not be unplugged to perform maintenance activities.

4. LO/TO procedures shall be posted or maintained near the equipment to be serviced.

5. Approved LO/TO devices and tags or labels shall be used in accordance with state and federal requirements.

6. Fume Hoods should always be checked for adequate flow before commencing operations. Non-operational or questionable hoods should be reported to work control (581-4400) immediately. Once a fume hood has been repaired, it must be re-certified before use.

14.6 Unattended operations and working alone

1. For unattended operations, leave laboratory lights on, place an appropriate sign on the door and provide secondary containment for toxic substances in the event of failure of a utility service (such as cooling water).

2. Do NOT work alone in a building.

3. Do NOT work alone in a laboratory if the procedures being conducted are hazardous.

14.7 Laboratory maintenance of safety equipment

1. Flush emergency eyewashes regularly for at least two minutes, verify that the cap will pop off when water pressure is applied (replace if it does not) and log date and initials in a conveniently located log.

2. Verify that access to emergency eyewashes, drench showers and fire extinguishers is not blocked.

3. Check and re-supply any existing first aid kits every six months.

14.8 Minimizing exposures

1. Where possible, remove hazardous chemicals from the laboratory process. Using water as a solvent or using a mechanical device, such as a microwave, instead of a hazardous chemical, can often do this. Laboratory processes should be reassessed often and improved when new technologies become available.

2. Less hazardous chemicals should be substituted whenever possible or feasible. Where possible, reduce quantities of chemicals stored and used in a process.

3. The use of engineered controls is always the first line of defense in minimizing exposures. These include the proper use of fume hoods, installation of machine guards and noise dampening devices, and shutoff valves/buttons for emergency situations.

4. Administrative procedures are used when engineered controls are not adequate or cannot be instituted. These include proper signage, appropriate and adequate training, managerial oversight and documented procedures and guidelines.

5. Personal Protective Equipment should only be used when engineered controls or administrative controls cannot adequately protect the health and safety of the workers in the laboratory. PPE assessments must be completed for each major process and need to be kept as part of the laboratory documentation.

15. Definitions

"Action level": A concentration, designated in 29 CFR 1910 Subpart Z for specific substances, calculated as an eight (8) hour time-weighted average, which initiates certain required activities such as, engineering controls, administrative controls, periodic exposure monitoring and medical surveillance. An Action Level shall not apply to chemicals that do not have a designated valued listed in Subpart Z, or for research generated chemicals or unknowns that do not have established exposure limits. For these chemicals, all procedures where objective data indicates a reasonably anticipated potential for exposure, the previously stated control measures shall be instituted.

"Administrative Controls" are methods of controlling or reducing employee exposure(s), which incorporate, but are not limited to, one or more of the following control options;

1. Standard Operating Procedures;
2. Training and Education;
3. Modified Work Practices;
4. Job Rotation;
5. Air Sampling;
6. Improved Personal Hygiene;
7. Biological Sampling or Medical Surveillance Programs;
8. Maintenance of Laboratory Equipment; and/or
9. Facilities Maintenance of Laboratory Space.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Carcinogen" (see "select carcinogen").

"Chemical Hygiene Officer" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

"Chemical Hygiene Plan" means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (1) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (2) meets the requirements of paragraph (e) of this section.

"Combustible liquid" means any liquid having a flashpoint at or above 100 deg. F. (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"Compressed gas" means:

1. A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or
2. A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg. C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

3. A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 deg C) as determined by ASTM D-323-72.

"Corrosivity" means an aqueous acid solution with a pH less than or equal to 2.0, an aqueous base solution with a pH greater than or equal to 12.5, a chemical capable of causing destruction of human tissue, or liquids which corrode steel or aluminum at a rate of 0.25 inches or more per year at 130° F (55° C) or a solid which may exhibit corrosive properties when mixed with water.

"Designated area" means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute or chronic toxicity, whether a known or a potential hazard. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

"Engineering Controls" are methods of controlling or reducing employee exposure(s), which incorporate, but are not limited to, one or more of the following control options:

1. Process change, such as paint dipping instead of paint spraying;
2. Source Substitution or Modification, e.g., histologists may substitute limonene-based tissue fixative for xylene;
3. Process or Source Isolation, such as control rooms to physically separate the worker from the hazard; or
4. Mechanical Ventilation, such as dilution or local exhaust designed to draw source vapors, gases, or particulates away from the breathing zone of the worker.

"Emergency" is a situation, actual or imminent, including incidents, accidents or conditions, which, if left uncorrected may result in injury, loss of life, damage to buildings, or situations which present an immediate safety hazard or security risk**. Note:** A situation is not an emergency if corrective employees in the immediate area can take measures; it does not pose an increased health and safety risk beyond those normally associated with the laboratory; and, employees have the proper equipment and training to deal with the situation.

"Employee" (see "Occupational Exposed Individuals" or " Potentially Exposed Individuals")

"Explosive" means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

"Field Laboratory" is a remote site, vessel, vehicle or station where chemical, and possible physical, hazards are present. This includes, but is not limited to motorized and non-motorized boats, field stations, transportation vehicles and aircraft, field trips and on-site sampling.

"Flammable" means a chemical that falls into one of the following categories:

1. Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
2. "Gas, flammable" means (A) a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or (B) a gas that, at ambient temperature and pressure, forms a range of flammable mixtures in air greater than 12 percent by volume, regardless of the lower limit.
3. "Liquid, flammable" means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

4. "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 1910.109 (a), that is liable to cause fire through friction, absorption or moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

"Flashpoint" means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

1. Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or
2. Pensky-Martens Closed Tester (See American National Standard method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (378 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or
3. Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278 -78)).

NOTE: Organic peroxides, which undergo auto-accelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

"Hazardous Chemical" is a known substance or mixture of substances which, under certain circumstances, poses a significant risk to laboratory workers owing to acute or chronic toxicity, flammability, corrosivity or explosivity; or which exhibits health or physical hazard properties as defined in 1910.1200, subpart A. Exemption: a hazardous chemical does not include substances which provide no potential for employee exposure such as procedures using chemically impregnated test media and commercially prepared test kits, nor does this apply to uses of hazardous chemicals which do not meet the definition of laboratory scale, even if that use occurs in a laboratory.

"Highly Hazardous Chemical" is a hazardous chemical that has the potential for causing lethal or crippling injuries under normal conditions within a university or laboratory setting.

"Laboratory" is a facility in which one or more of the following definitions are met:

1. Any building or a room inside a building where the use of chemicals defined as hazardous occurs. These include, but are not limited to, teaching facilities, darkrooms, art studios and research facilities.
2. Any permanent remote site where the use of chemicals defined as hazardous occurs. Examples are farms, permanent field stations and permanent experiment stations.
3. Any building or room inside a building where physical hazards, associated with the use of hazardous chemicals, are present. This includes teaching and research facilities, but excludes sites such as; machine shops, print shops, janitorial closets and laboratories (where only physical hazards and no chemical hazards are present in the judgment of EH&S), live animal research facilities, offices and lecture classrooms.

"Laboratory scale" Laboratory scale manipulations shall be considered those processes where the minimum required quantity of a hazardous chemical are used to perform a planned chemical manipulation. This process shall follow guidelines for research protocols and be designed for analysis or research. Processes in which a product is generated for uses other than analytical or

research needs (e.g. for sale or distribution to other laboratories or industries) shall not be considered "laboratory scale";

"Laboratory-type hood" is a device located in a laboratory, enclosed on five sides, with a movable sash or fixed partial enclosure on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Laboratory-type hoods may include the following:

1. Conventional or Standard Chemical Fume Hood which controls the pattern of air movement through the hood and sash across the hood entrance to an exhaust in the top or the back;
2. By-pass Chemical Fume Hood which operates as a conventional hood except when closed and then allows air to enter through a bypass grille located above the sash;
3. Auxiliary Air Chemical Fume Hood which supplies an air plenum outside the hood at the top of the face opening; or,
4. Variable Air Volume (VAV) Chemical Fume Hood, which allows the exhaust volume to be varied by changing the speed of the exhaust blower in the ductwork.
5. BioSafety Cabinets (BSCs) for use with biological agents and pathogenic microorganisms; where the unit is exhausted to the outside

"Laboratory Ventilation Devices" may exist in addition to, or instead of, a Laboratory-type hood. These include, but are not limited to:

1. BioSafety Cabinets (BSCs) for use with biological agents and pathogenic microorganisms;
2. Canopy Hoods used for non-hazardous exhaust operations;
3. Elephant Trunks or Snorkels used for capturing emissions from gas chromatographs, spectrophotometric equipment or other specific laboratory devices;
4. Glove Boxes with tight-closing doors or air locks in arm holes with impervious gloves at negative pressure;
5. Laminar Flow Cabinets that incorporate directional flow of air to capture and carry away airborne particles;
6. Slot Hoods designed to capture contaminants in industrial applications; and,
7. Table top hoods with small, spot ventilation that is normally vented downward through the tabletop.
8. California Hoods with moveable sashes on more than one side;
9. Distillation Hoods for use with distillation apparatus;
10. A Ductless Hood that filters the exhaust air and returns it directly to the laboratory space;
11. Perchloric Acid Hoods with a by-pass type of hood constructed with a water wash system so it is safe for use with Perchloric acid or other reagents that might form flammable or explosive compounds in contact with organic construction materials;
12. Radioisotope Hood that provides interior work surfaces that are impervious and easy to decontaminate; or,
13. Walk-in Hood designed to be floor-mounted with sash and/or doors for closing the open face.

"Laboratory use of hazardous chemicals" refers to the handling or use of hazardous or potentially hazardous chemical in which the following conditions are met:

1. Chemical manipulations are carried out on a "laboratory scale".
2. Multiple chemical procedures or chemicals are used;
3. The procedures involved are not part of a "production process". A production process shall be defined as a process in which the resultant or desired end product is produced in a quantity greater than that needed to sufficiently test or analyze the process in question. Simulation of actual manufacturing procedures for the sole purpose of developing, testing or evaluation a specific process or procedure, regardless of scale, shall not be considered as a "production process";
4. A hazard assessment has been performed for the specific process and a detailed Standard Operating Procedure (SOP) has been developed for the process. Based upon the assessment, protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

"Medical Consultation" is a consultation, which takes place between an employee and a licensed physician for the purpose of determining what medical examination, or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place. If an over exposure is suspected, an exposure assessment is necessary. If an assessment indicates that an employee could reasonably have been exposed to a hazardous chemical in a manner that might have caused harm, the victim is entitled to a medical consultation and, if determined in the consultation, to a medical examination at no cost to the employee.

"Occupational Exposed Individuals" are those individuals or students who, during the course of performing tasks related to their occupation or education are, or potentially may be, subject to exposure to hazardous or potentially hazardous chemical or physical hazards which may negatively impact an individual's health or well-being.

"Organic peroxide" means an organic compound which contains the bivalent -O-O structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic group, or substituent.

"Oxidizer" means a chemical other than a blasting agent or explosive as defined in 1910.109 (a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

"Research-Generated Sample" includes a substance or mixture of substances generated for purposes of laboratory research or testing by: (1) extraction from plants, animals, or environmental sources; or (2) a chemical reaction or sequence of reactions performed on other substances. The exact composition of the sample and the potential hazards associated with it may or may not be known, and indeed, may be the object of the research to be carried out with the sample.

"Physical Hazard" means any existing or potential condition in the laboratory that by itself, or by interacting with other variables, can result in deaths, injuries, property damage or other losses. These conditions include, but are not limited to:

1. A chemical for which there is a reasonable expectation that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, shock sensitive, ignition hazard, or water-reactive;
2. Compressed gases, under positive pressure, which could lead to a rupture of the tank or valve;
3. Thermal hazards, which can cause contact tissue damage from extreme heat or cold, or high-pressure reactions when warmed in a sealed vessel. These may include cryogenic sources from super conducting magnets, vacuum lines or technical research equipment, or burns from heat sources, furnaces and autoclaves.

4. Pressure hazards from hydraulic, pneumatic or chemical sources, which operate at elevated, pressures above one atmosphere or under a vacuum and have the potential of implosion or explosion.
5. Glass and other laboratory equipment which can easily be broken; and other relevant housekeeping or fire safety concerns.

"Potentially Exposed Individuals" are persons who do not directly work with hazardous, or potentially hazardous, chemicals or physical agents but may be exposed indirectly (e.g.: working in an adjacent office, custodial/maintenance workers, etc.) during the performance of their occupation or education. Visitors, students, or other people not specifically employed by the University shall also be considered indirectly exposed if their activities result in the potential contact with hazardous or potentially hazardous chemical or physical agents.

"Protective laboratory practices and equipment" means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

"Reactive" means a chemical having low activation energy for combination with some other chemical substance. This reaction requires two separate substances for a reaction to take place.

"Reproductive hazard" means chemicals that affect the reproductive chemicals, which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

"Select carcinogen" means any substance, which meets one of the following criteria:

1. It is regulated by OSHA as a carcinogen; or,
2. It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or,
3. It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC) (latest editions); or,
4. It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

    - 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.

"Significant Exposure" means an acute or chronic exposure to hazardous, or potentially hazardous, chemicals or physical agents at or above the conservative limits established by OSHA or the American Conference of Governmental Industrial Hygienists (ACGIH). Where there is a potential to cause health impairments or where symptoms of ill health are exhibited at concentrations below established limits, an evaluation shall be made of the nature and physical characteristics of the agent(s) and the sensitivity of the individual and the potential to cause health impacts. Based upon this evaluation and comparisons of TLVs of similar (chemically and physically) acting agents, similar classes of chemicals, the known properties of the chemical and the circumstances of exposure, a threshold value shall be established and implemented.

“Toxicity” means a substance which can have an adverse effect on a plant, animal or human based on the dose, length of exposure, route of entry and reactive properties. Toxicity may be determined by the type of exposure: acute (single exposure) or chronic (multiple exposures); or the mutagenic (capable of causing genetic mutations or chromosomal damage), teratogenic (capable of causing anatomical or biochemical effects on a developing fetus) or carcinogenic (capable of causing cancer in animals or humans) effects.

"Unstable" means a chemical which has high energy relative to the elements from which it is formed *and* requiring a low activation energy to decompose toward these elements.

"Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.