

DEPAUL UNIVERSITY

Chemical Hygiene Plan

Environmental Health & Safety

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This Chemical Hygiene Plan was developed by the DePaul University Environmental Health and Safety (EHS) Office using best practice examples from the University of Iowa and Princeton University as well as Federal and State regulations and guidance documents. The manual was reviewed and revised by consultant, Woodard & Curran.

1. INTRODUCTION

1.1 PURPOSE

DePaul University is committed to providing a safe laboratory environment for its faculty, staff, students and visitors. The goal of the Chemical Hygiene Plan (CHP) is to minimize the risk of injury or illness to laboratory workers by ensuring that they have the training, information, support and equipment needed to work safely with hazardous chemicals in the laboratory.

1.2 SCOPE AND APPLICATION

The DePaul University Chemical Hygiene Plan (CHP) applies to all university laboratory functions involving hazardous chemicals. This CHP will apply to DePaul students as well as employees.

It is intended to meet the requirements of the Occupational Safety and Health Administrations (OSHA) standard [29 C.F.R. 1910.1450] titled “Occupational Exposure to Chemicals in Laboratories” (OSHA Lab Standard). This standard regulates the laboratory use of chemicals in order to protect the health and safety of employees.

The OSHA laboratory standard does not cover the disposal or treatment of hazardous waste. Therefore neither does the DePaul University Chemical Hygiene Plan except as it pertains to the general practices for handling of hazardous chemicals to maintain a safe and healthful work and learning environment. Methods of disposal of hazardous waste are covered in the DePaul Waste Disposal Guide.

1.3 MAJOR REQUIREMENTS

The major requirements of the DePaul CHP include:

- **Training.** Employees and students working in a laboratory where chemicals are being handled and/or stored are required to complete the on-line Lab Safety Training once every academic year. This training gives an overview of general laboratory safety principles; each instructor will provide more detailed information about their specific laboratory requirements.
- **Laboratory Plan.** A chemical hygiene plan must be implemented in any laboratory where hazardous materials are used or present. The plan must be capable of protecting employees from health hazards associated with hazardous chemicals in the laboratory, and make adequate provisions for keeping exposures to hazardous chemicals below the occupational exposure limits.
- **Work Practices.** Faculty, staff and students are expected to adhere to the minimum provisions of this Chemical Hygiene Plan and any additional requirements set by the instructor or Principal Investigator (PI). Requirements for working with chemicals are covered in Section 7 of this plan, with safe work practices for handling and storing specific classes of hazardous chemicals included in Appendix B and reviewed during the on-line Lab Safety Training.
- **Laboratory Security.** Safeguarding DePaul University resources from unauthorized access, misuse or removal is a duty of all faculty and staff. In laboratories, this obligation rests primarily with the Principal Investigator or instructor; however, all laboratory personnel have a responsibility to take reasonable precautions against theft or misuse of materials, particularly those that could threaten the public. Any extraordinary laboratory security measures should be commensurate with the potential risks and imposed in a manner that does not unreasonably hamper research.

At a minimum, DePaul University expects all laboratory personnel to comply with the following security procedures:

- Question the presence of unfamiliar individuals in laboratories and report all suspicious activity immediately to Public Safety by calling 773-325-7777.
- After normal business hours, keep all laboratories locked when not in use.
- Laboratory building exterior doors are secured after normal business hours. To minimize the likelihood of unauthorized access, all after-hours building users should:
 - Avoid providing building access to unfamiliar individuals.
 - Secure doors behind them.
 - Immediately report any building security problem to Public Safety at 773-325-7777.

Research or other activities involving the use of laboratory space, materials or equipment without the knowledge and approval of the responsible Principal Investigator (PI) is strictly prohibited. Violation of this prohibition may result in disciplinary action including employee termination or student suspension or expulsion.

1.4 PLAN AVAILABILITY, REVIEW AND UPDATE

The DePaul University Laboratory Chemical Hygiene Plan is available through the EHS Office website, the EHS Office staff, or through department laboratory coordinators.

At least annually, the plan is evaluated by the EHS Office with input from the department chairs/deans, laboratory coordinators, and other appropriate personnel (e.g., Facility Operations, RM, etc.) to determine its continued effectiveness and identify any areas where updates or improvements are needed to the plan, the associated training program, or other aspects of the University's laboratory chemical hygiene program.

For each laboratory where chemicals are used or stored, the PI or instructor must ensure that the plan is reviewed for adequateness based on current laboratory operations whenever the nature of the work changes (e.g. change in chemicals, chemical amounts, facilities, etc.) or at least annually.

2. ROLES AND RESPONSIBILITIES

2.1 UNIVERSITY ADMINISTRATION

The University administration has overall responsibility for instituting policies and programs, establishing systems, and providing resources to help ensure that research and teaching activities involving laboratory chemicals are conducted in a responsible manner and in accordance with all applicable requirements. While the University President has ultimate responsibility for the CHP and shall, with other administrators provide continuing support for DePaul University's Chemical Hygiene Plan, certain responsibilities have been delegated to individual Departments, Principal Investigators (PIs), laboratory instructors, other University employees and students as well as to the Environmental Health and Safety (EHS) Office.

2.2 DEANS AND DEPARTMENT CHAIRS

The Deans and Department Chairs are responsible for providing the resources and leadership necessary to ensure that the CHP is carried out within the department. They carry out the responsibilities of the departmental chemical hygiene officer or otherwise delegate the authority to carry out those tasks to someone within the department (e.g., laboratory coordinator).

2.3 ENVIRONMENTAL HEALTH & SAFETY (EHS) OFFICE

The Environmental Health & Safety (EHS) Office provides training, resources and consultation for a variety of laboratory safety issues, including chemical safety as well as laser safety, biological safety, radiation safety, and other topics. *The EHS Manager serves as the University's Chemical Hygiene Officer.*

Responsibilities of the EHS Office include:

- Work with administrators, faculty and staff to develop, implement, review and update the CHP.
- Facilitate general chemical hygiene training for affected faculty, staff and students. Maintain documentation of this training.
- Assist in selecting and verifying adequacy of protective measures (e.g. PPE selection, etc.). Help ensure that personal protective equipment is available and serviceable.
- Monitor the storage, distribution, use and disposal of hazardous chemicals.
- Perform audits and inspections of facilities, procedures and practices to ensure compliance with the CHP and related regulations.
- Remain knowledgeable to current and future legal requirements and other best business practices related to chemical hygiene.
- Review the CHP with other appropriate personnel and update it as necessary, on at least an annual basis (and as otherwise warranted).

2.4 PRINCIPAL INVESTIGATORS/INSTRUCTORS

Responsibilities for Principal Investigators and laboratory instructors include:

- Implement appropriate safe work practices and procedures for all laboratory activities.
- Seek assistance from the EHS Office where necessary for planned changes in laboratory materials or processes.
- Monitor safe behavior in the laboratory.
- Ensure that students and laboratory staff know and carry out proper practices for complying with the CHP.
- Ensure that any required personal protective equipment is available and serviceable.
- Ensure all incidents that occur in the laboratories are reported to the EHS Office on a written Incident Report.

Teaching assistants (TAs) are responsible for assisting the laboratory instructor in meeting the above responsibilities.

2.5 LABORATORY WORKERS (STAFF AND STUDENTS)

Responsibilities for all individuals working in a laboratory (including staff and students) include:

- Know and observe the safe work practices and procedures outlined in the CHP.
- Observe all safety instructions given by the PI, instructor or TA, and observe all reasonable precautions to ensure that every laboratory operation is performed safely.
- Report unsafe conditions or other safety concerns to the PI, laboratory instructor, or TA. (i.e., faulty hoods, missing or damaged fire prevention equipment, unsafe storage of hazardous chemicals, etc.).
- Follow instructions on warning signs, postings and labels.
- Follow emergency procedures and respond to alarms in an appropriate manner.
- Immediately report any spill, possible exposure, or other laboratory incident to the PI or instructor.

2.6 DEPARTMENT LABORATORY COORDINATORS

Department laboratory coordinators are responsible for coordinating the chemical inventory process within each department, and acting as a liaison between the department and the EHS Office where necessary.

2.7 LABORATORY VISITORS

Visitors and contractors who enter laboratory spaces on campus are responsible for meeting the minimum requirements for entry (e.g., no eating/drinking, proper laboratory attire, etc.) and observing all warning signs and other instructions. Visitors and contractors must immediately report any incident that occurs in the laboratory, and should never attempt to conduct tasks that they are not trained and authorized to perform.

Any minors allowed in the laboratory at the discretion of the PI must be accompanied and supervised at all times. Minors should not be present in the laboratory while hazardous operations are in process. Pets are not permitted in the laboratories, with the exception of service animals.

Where visiting scientists will be conducting work in a laboratory, the “host” PI is responsible for ensuring that the visitor has the appropriate training, is oriented to relevant University and laboratory-specific CHP requirements and emergency procedures, and that the laboratory operation to be conducted does not present an increased risk to the University and laboratory/building occupants. Each “host” PI is encouraged to contact the EHS Office in advance of a visiting scientist’s arrival on campus to ensure that all CHP requirements are met and that safety procedures are adequate for the planned laboratory activities.

3. HAZARD IDENTIFICATION, EVALUATION AND CONTROL

3.1 HAZARD IDENTIFICATION

The hazards of laboratory chemicals can be determined by referring to information provided on the manufacturer's label and Safety Data Sheet (SDS). The ability to recognize the signs and symptoms of chemical exposure is important so that if adverse effects do arise despite the precautions taken to avoid exposure, those effects can be recognized early with the appropriate action taken.

DePaul uses a chemical inventory system to assist in tracking the chemicals onsite (see Section 4). In addition, regular oversight by the PI or instructor and periodic inspections assist in identifying laboratory hazards related to chemicals (see Section 3.6). To minimize the risk of chemical hazards in the laboratory, all employees and students are expected to follow the laboratory work requirements outlined in Section 7 of this plan, and the relevant standard operating procedures and safe work practices included in Appendix B.

3.2 EMPLOYEE EXPOSURE DETERMINATION

DePaul University is required by the OSHA Lab Standard to ensure that employee exposures do not exceed permissible exposure limits (PELs) and to prohibit eye and skin contact where specified by any OSHA health standard. The use of properly operating fume hoods is expected to minimize exposure to airborne chemicals in the laboratory, supplemented with the use of appropriate personal protective equipment. Where necessary, industrial hygiene assessment techniques are used to evaluate potential exposures and control measures.

If the deans/departments chairs, PIs or instructors, or EHS Office receives information that constitutes a reason to believe that exposure to any substance routinely exceeds the action level or exposure limit, the EHS Office will arrange for an evaluation of the employee(s)' (or students') exposures, using qualitative exposure assessment and quantitative monitoring techniques as appropriate. The EHS Office, with input from deans and the OGC, will determine on a case-by-case basis the level of evidence needed to constitute a reason to believe that exposures routinely exceed permissible levels, or otherwise where additional evaluation or control is warranted.

3.2.1 Monitoring

Regular quantitative monitoring of airborne contaminants is *usually* not justified or practical in university laboratory settings. There may be some instances when air monitoring is justified (e.g., routine tasks involving volatile hazardous chemicals must be performed outside of fume hoods) when qualitative hazard assessments indicate the need for such monitoring. The EHS Office will arrange or conduct any exposure assessments and monitoring, in accordance with the following provisions:

- If initial monitoring conducted under this scenario discloses that employee exposure exceeds the OSHA action level (or in the absence of an action level, the established exposure limit), DePaul will investigate and implement appropriate controls to reduce employee exposures to an acceptable level.
- Periodic monitoring will be used to assess the effectiveness of the control measures and evaluate the level of employee exposures until they have reached acceptable levels.

3.2.2 Exposure Records

Within 15 working days after the receipt of any monitoring results, the EHS Office will notify the employee(s) of these results in writing either individually or by posting results in an appropriate location accessible to employees.

For each employee, the EHS Office will establish and maintain an accurate record of any measurements taken to monitor employee exposures. These records will be kept, transferred, and made available in accordance with OSHA requirements for exposure records [29 C.F.R. 1910.1020].

3.3 EXPOSURE CONTROL METHODS

A critical method for control of hazardous chemicals in the laboratory is through facility design and the use of engineering controls such as chemical fume hoods. Other exposure control methods may include safe work practices, training, and use of personal protective equipment (PPE). The following hierarchy of controls will be applied to the extent feasible or practical:

- Elimination of material/process or substitution of less hazardous chemical.
- Engineering.
- Administrative.
- PPE.

Selection of the necessary exposure control methods will be based on: knowledge of the material properties and conditions of use (e.g., quantity and physical form, area of use, potential for vapors or aerosols); results from any industrial hygiene exposure assessments conducted, as well as laboratory inspections and audits; and specific measures specified within this plan, within other University policies or procedures, or by the instructor or PI.

General standard operating procedures for chemical handling and storage have been established and are included in Appendix B of this CHP.

For any laboratory work involving *particularly hazardous substances*, such as select carcinogens, reproductive toxins and/or substances with high acute toxicity, additional protection may also be necessary, such as:

- Specification of a posted designated area(s);
- Use of containment equipment such as fume hoods;
- Procedures for safe removal of contaminated waste; and
- Decontamination procedures.

3.3.1 Laboratory Facilities

- **Design.** Planning committees must take prudent measures in designing for safety and health controls when planning future laboratory facilities or the renovation of existing facilities.
- **Maintenance.** Routine maintenance is essential to maintaining a safe laboratory facility. All maintenance functions both routine and non-routine are handled by Facilities Operations.

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- **Usage.** All laboratory facilities have limitations and no one laboratory can meet the requirements of all research or instructional work. Laboratory facilities at DePaul University are generally intended for educational and smaller scale research type operations and may not be suitable for some processes. Whenever there is a doubt to the suitability of a laboratory for a specific procedure, consult with Facilities Operations and the EHS Office.
 - **Ventilation.** A properly functioning ventilation system is critical in protecting laboratory occupants' health and safety, as well as maintaining general comfort. Laboratory ventilation systems should meet or exceed ANSI/AIHA Z9.5 standards.
 - The laboratory should be maintained under negative pressure in relation to adjoining non-laboratory areas. All air from laboratories should be exhausted outdoors. It should not be re-circulated in the ventilation system. The general ventilation system should provide adequate make up air for fume hood exhaust. General air flow should not be turbulent, as this may negatively affect the capture efficacy of the fume hoods.
 - The **chemical fume hoods** are designed to remove toxic or potentially harmful vapors, mists and fumes away from personnel breathing zones and out of the laboratory/building.
 - A minimum of one lab hood with 2.5 linear feet of hood space for every 2 persons must be provided.
 - Each hood should have a continual flow monitoring device.
 - Fume hoods should be inspected for adequate face velocity and capture efficacy at least annually (ANSI/AIHA Z9.5).
 - New fume hoods should be tested and certified for compliance with ANSI/ASHRAE 110.

Chemical fume hoods (and any similar local exhaust ventilation systems in the laboratory) must be inspected, tested, and maintained as part of a regular certification program. DePaul's Facilities Operations conducts an annual check of fume hood performance. Fume hoods passing the evaluation will be labeled with a fume hood certification sticker indicating the date of evaluation and/or the date the next evaluation is due.

The effectiveness of a laboratory fume hood is evaluated using face velocity measurements and alternate testing protocols. Since face velocity alone may not be an adequate measure of fume hood performance, an evaluation of the hood's ability to capture airborne contaminants should be qualitatively assessed using non-irritant smoke. Tracer gas studies to more rigorously assess fume hood performance will be conducted on an as needed basis as determined by the EHS Office (e.g., upon commissioning; existing hoods as appropriate based on risk level, etc.).

Laboratory personnel should immediately report broken or malfunctioning fume hoods to Facilities Operations, and should remove the hood from service until repaired and properly functioning.

3.3.2 Housekeeping and Maintenance in the Laboratory

Maintaining a neat and orderly laboratory is essential to the safety of those who work and learn in the laboratory. Poor housekeeping is found to be the cause or contributing factor in many laboratory accidents. General practices for maintaining good housekeeping in the laboratory include:

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- Maintain clear access ways to exits and emergency equipment (e.g., eye wash stations, safety showers, etc.) at all times.
 - Keep floors clean, dry and free of clutter.
 - Wipe down lab benches frequently.
 - Maintain individual work spaces and clean regularly.
 - Store chemical containers in the appropriate locations.
 - Keep chemical containers capped and away from the edge of the lab tables.
 - Properly store compressed gas cylinders.

The Office of Facilities Operations will handle all maintenance issues and requests. Equipment that is out of service shall be labeled as such and if necessary “locked out.” Out of service equipment will be repaired as quickly as possible. Equipment with safety/health implications should receive priority.

3.3.3 General Housekeeping and Chemical Hygiene Inspections

Formal housekeeping and chemical hygiene inspections should be held quarterly but not less frequently than semiannually. Informal inspections should be carried out continually in order to correct any deficiencies as quickly as possible. Eyewash stations/showers and fire extinguishers shall be inspected monthly by Facilities Operations.

4. CHEMICAL INVENTORY, PROCUREMENT AND DISTRIBUTION

4.1 CHEMICAL INVENTORY SYSTEM

The Vertere chemical inventory system is used to inventory, track, share, and account for the thousands of chemicals used on campus. Upon initial receipt, chemicals are logged and entered into the departments' chemical inventory systems by the department Laboratory Coordinator. The chemical inventory system includes:

- The name, amount and date the chemical was received.
- Location where the chemical is stored.
- Amounts used should be recorded as the chemical is used.

All departments may perform searches of chemicals in order to track their location and current use. Faculty can choose whether to make their chemicals available for sharing or not. This functionality is encouraged as a way to reduce waste and use our chemical inventory most efficiently.

The frequency of chemical use and specific inventory procedures vary by department:

- **Chemistry.** The Chemistry department has the largest volume of chemicals and most frequent use of the Vertere system. Initial inventory of the stockroom and all labs/classrooms has been completed.
 - All new chemical deliveries go through the Laboratory Coordinator.
 - When a chemical has been used up or become unusable for some reason, faculty should e-mail the Laboratory Coordinator with the chemical name/barcode so the appropriate change can be made in the inventory system.
 - Chemistry department faculty also has the option of placing the chemical in a "Used/Old" bin located in the chemistry stockroom at 110 McGowan South.
 - Chemistry has also developed a barcode system for frequently used chemicals in order to track their remaining levels and ensure new chemicals are ordered as needed.
- **Biology.** The Biology department follows similar procedures to the Chemistry department but with reduced volume and smaller numbers of laboratories and instructors. An initial inventory of Biology research labs and teaching classrooms has been completed.
 - To order new chemicals, faculty and staff members contact the Laboratory Coordinator via email or phone with their ordering information. The Laboratory Coordinator inputs the new data into Vertere, prints out a barcode, and leaves it in the faculty/staff member's mailbox.
 - For old/depleted chemicals, faculty and staff members are to contact the Laboratory Coordinator with the used chemical barcode number or general information so the necessary changes can be made in Vertere.
- **Environmental Science.** The Environmental Science department has a relatively small quantity of chemicals. Inventory will be completed in the near future; however, discussions are underway to determine whether the functionality of the Vertere system is necessary for this department due to the reduced numbers and quantities of chemicals.

4.2 CHEMICAL PROCUREMENT

It is the responsibility of the department ordering a chemical or substance to ensure that no substance is ordered without first having a plan in place for the safe storage, use and disposal of that substance. Chemicals should be ordered on a “just-in-time” basis, meaning chemicals should be ordered only in the amounts that are needed and only when they are needed. Smaller containers are preferable to larger containers even when multiple smaller containers may be required. Ordering “bulk” or wholesale quantities of chemicals is prohibited as any savings from “bulk” orders are quickly spent in multiple by the increased cost of handling, storing and disposing of the chemicals as well as the immeasurable costs of increased risk to staff, students and the environment by having unnecessarily large quantities of hazardous chemicals present at DePaul.

Procurement of new chemicals that are highly hazardous requires prior approval from the EHS Office and Department Chair to ensure adequate safety provisions are in place to control risks to laboratory workers and/or the University community, as well as to comply with any additional regulatory requirements (see Section 7.1.1). This includes:

- Procurement of particularly hazardous substances (carcinogens, reproductive toxins, highly acute toxins); and
- Procurement of highly reactive or flammable chemicals that present a physical safety hazard to the user or other laboratory/building occupants.

4.3 CHEMICAL DISTRIBUTION

Chemicals should be received only in the proper area that is designated and properly equipped (e.g. spill kit) to handle shipments of chemical substances. Only designated and trained personnel shall be authorized to receive shipments. Basic guidance on chemical distribution includes:

- Personal vehicles should never be used to move hazardous materials.
- Chemicals distributed from the stockroom should be moved on designated carts.
- Chemicals should be distributed using break-resistant secondary containers made of materials that are compatible with the chemicals, particularly for corrosives and solvents.
- Secondary containers must have adequate volume to contain primary container volume.
- Compressed gas cylinders must be properly secured and strapped to the cart during distribution.

Refer to Appendices B-E for guidance on chemical storage and use.

5. TRAINING AND INFORMATION

Departments are responsible for ensuring that all individuals working in their laboratories have been adequately trained. Training must be provided prior to the time when individuals begin their duties involving chemicals and as needed whenever there is a significant change in the types or quantities of chemicals used.

The EHS Office provides on-line Lab Safety training for the university community. The Lab Safety training that is offered is designed to cover, in a general way, many of the topics required by the OSHA Lab Standard. This training, however, is not intended to be the sole means of training laboratory personnel and must be supplemented by additional safety instruction from the PI, instructor and/or Laboratory Coordinator on the potential hazards associated with an individual's specific duties. This individualized training should include a review of the laboratory's safety features and equipment.

Topics that are to be covered in training include:

- Content of the OSHA Lab Standard.
- Location and availability of the laboratory chemical hygiene plan.
- Exposure limits for hazardous chemicals.
- Signs and symptoms associated with chemical exposure.
- Location and availability of known reference material on the hazards, safe handling, storage, and disposal of chemicals. This includes, but is not limited to, Safety Data Sheets (SDSs).
- How to read and interpret SDS sheets.
- Methods to detect the presence or release of chemicals.
- Physical properties and health hazards of chemicals.
- Measures that laboratory personnel can take to protect themselves from chemical hazards.

6. HAZARD COMMUNICATION

6.1 SIGNS

Various signs are posted throughout the laboratories and chemical storage areas indicating potential hazards, policies, etc. Signs are intended to serve as a reminder or to indicate a specific regulated area. Signs should, under no circumstance, be used as a substitute for properly disseminating information to personnel. Training, access to the chemical hygiene plan and other safety related resources and safety briefs should be the primary source by which effected persons are informed of issues related to chemical hygiene.

6.2 LABELS

All chemical containers shall be properly labeled as to their contents. Containers that are in immediate use and under constant supervision (e.g., a beaker during a laboratory experiment) should be labeled with the name(s) of the chemical(s). Containers not in immediate use should comply with the full labeling requirements:

- Labels on incoming containers must not be removed or defaced.
- The full chemical name(s) should be typed or clearly printed with permanent non-smearing ink.
- Any pertinent warnings, hazards, or preventative safety measures that should be taken must be made clear on the label (e.g., reactive with water).
- The chemical should be labeled as to the date it was received.
- The CAS registry number(s) should be included on the label whenever possible, especially when the chemical may be known by multiple names.
- Labels should be resistant to fading, smudging, tearing, etc.

The use of a hazard rating labeling system similar to that of the National Fire Protection Association (NFPA) 704 or the National Paints & Coatings Association (NFCA) Hazard Materials Identification System (HMIS) may be useful for this purpose.

6.3 SAFETY DATA SHEETS (SDS)

All chemical manufacturers or distributors are required to conduct a hazard evaluation of their products and include the information on a safety data sheet (SDS). The manufacturer or distributor is required to provide an SDS with the initial shipment of their products. Any SDSs received by the laboratory must be maintained in a central location in the laboratory or the department. If the SDS cannot be found, contact the manufacturer or distributor at the number listed on the container label and request an SDS.

Note: If a chemical substance is produced in the laboratory for another user outside of the laboratory, then the requirements of the OSHA Hazard Communication Standard [29 CFR 1910.1200] must be met including the requirements for preparation of SDSs and labeling. Contact the EHS Office for assistance.

7. LABORATORY WORK REQUIREMENTS

7.1 PREPARATION AND PLANNING FOR LABORATORY EXPERIMENTS

Proper preparation and planning is essential for safe laboratory work with hazardous chemicals. Before beginning work involving hazardous chemicals, the PI or instructor must consider and plan for the chemicals, equipment and other materials needed, the proper sequence of steps to be followed, and the necessary protective measures and other safety considerations.

Preparation for work with laboratory chemicals typically includes the following:

- **Chemicals.** Make sure all employees and students are familiar with the hazards of the chemical(s) before beginning work (e.g., flammability, reactivity, volatility). Review SDSs and/or contact the EHS Office for assistance as appropriate. Where feasible, consider how the procedure could be conducted using a less hazardous substitute, or using smaller quantities.
- **Equipment.** Check that that equipment is assembled and/or functioning properly before use, and that employees and students understand procedures for safe use. Review specific information in the equipment operations & maintenance manual as necessary. Use equipment only for its intended use.
- **Written Protocol.** Develop and/or follow written experimental protocols wherever feasible. Step-by-step instructions help to minimize the possibility of errors and identify steps where special precautions may be necessary.
- **Set-up.** Check that equipment and supplies are in place before actual work begins, including the necessary protective equipment. Ensure there is sufficient working space and that the work area is uncluttered and orderly. Remove unnecessary materials, equipment and supplies. Avoid placement of chemicals and equipment on the floor of working areas where they may be knocked over or may create a tripping hazard.
- **Clean-up.** Consider ahead of time the necessary steps and materials for proper clean-up, including as appropriate: hazardous waste to be collected in satellite accumulation areas; surfaces to be decontaminated; glassware to be washed; other disposables to be generated; and similar considerations.

7.1.1 Prior Approval Requirements

Certain laboratory use of hazardous materials, equipment or operations requires prior approval because of the hazards they present, the waste materials and byproducts they generate, the additional regulatory requirements that may apply, or for other health and safety concerns. Examples of materials, chemicals, equipment or operations that may require prior approval include:

1. Procurement of particularly hazardous substances (e.g., select carcinogens, reproductive toxins, highly acute toxins) Refer to the definitions provided in Appendix A and safe work practices in Appendix B.
2. Procurement of highly reactive or flammable chemicals that present a physical safety hazard to the user or other occupants.
3. New or modified procedures presenting a potentially serious risk to the laboratory worker or other occupants due to the materials, quantity, equipment, or nature of the operation.

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4. Procedures where exposures exceed or are reasonably likely to exceed the PELs or other established exposure limits.
 5. Procedures where a failure of any of the equipment did or could have resulted in injury, illness or exposure of a laboratory worker to a hazardous chemical before the procedure may be conducted again.
 6. Procedures where laboratory workers become ill injured or suspect that others have been exposed to a hazardous chemical due to an experimental procedure.

It is anticipated that the use of materials and procedures as described in 1-4 above will not be permitted in teaching laboratories and will be restricted to laboratory research activities involving properly trained personnel.

As part of the preparation and planning process for laboratory operations, a PI who wishes to engage in any of the activities described above should seek guidance and prior approval from the EHS Office and Department Chair, and should also notify the Laboratory Coordinator. To facilitate this process, the PI should email the EHS Office and Department Chair, with a copy to the Laboratory Coordinator, with the following information:

- Brief description of the project including the chemical name, procedural steps, the exposure controls that will be used (e.g., fume hood, PPE, employee training, etc.), and waste handling practices;
- Safety Data Sheet(s);
- Date requested for initiation of the new chemical or new/modified procedures;
- Personnel that will be involved in using the chemical or conducting the procedure; and
- Any other pertinent details.

7.2 PERSONAL BEHAVIOR

All persons working in the laboratory must maintain a professional decorum at all times while in the laboratory. This includes:

- Avoid distracting or startling others. Practical jokes or horseplay are prohibited.
- Use laboratory equipment only for its intended purpose.
- Wear appropriate safety eyewear at all times in the laboratory.
- Do not eat, drink, chew gum, smoke, apply cosmetics or take medication in the laboratory. These activities are prohibited in areas where hazardous materials are stored or used.
- Use pipe bulbs or other appropriate equipment to pipette chemicals. Pipetting of chemicals by mouth is prohibited.
- Wash hands after working with chemicals, even when gloves have been worn.
- Never taste or smell laboratory chemicals.
- Do not use laboratory refrigerators or other chemical storage areas to store food or beverages.

7.3 FUME HOODS

Experiments and chemical reactions should be carried out in the laboratory fume hoods whenever feasible (see also Section 3.1.1 regarding fume hood design and maintenance considerations). Laboratory requirements related to fume hoods use include

- Use only fume hoods that have been evaluated for adequate face velocity and operation.
- Position reaction apparatus at least six inches from the front of the fume hood.
- Never put your head inside the fume hood.
- Keep the fume hood sash closed when not working in the hood.
- Keep the fume hood sash as low as possible while conducting reactions. This will increase the face velocity protecting against inhalation as well as provide a shield to protect against any splashes or violent reactions that may occur.
- Keep fume hoods free of debris and excessive equipment. Having excessive bottles and equipment inside the hood can disrupt the air flow and make the hood less effective.
- Keep all containers closed when not in use and never dispose of chemicals by letting them volatilize in (or out of) the fume hood.
- Notify Facilities Operations of any suspected malfunctioning hoods. Remove malfunctioning hoods from service until they are repaired and properly functioning.

7.4 WORK PRACTICES

General standard operating procedures and guidelines for safe handling and storage of hazardous chemicals are provided in Appendix B, with additional guidance on peroxide-forming chemicals in Appendix C, on storing incompatible materials in Appendix D, and storing flammable and combustible liquids in Appendix E.

Faculty, staff and students must also follow any additional requirements set by the department, PI or instructor (e.g., experimental protocol, personal protective equipment requirements, other safe work practices, etc.).

7.5 PERSONAL PROTECTIVE EQUIPMENT AND ATTIRE

7.5.1 Personal Attire

- Arms and legs should be covered at all times while handling chemicals in the laboratory. Lab coats or long sleeve shirts should be worn.
- Shoes should be appropriate for laboratory work and cover the entire foot. Open toed shoes, sandals, clogs, crocs, etc. are not appropriate for the lab.
- Loose clothing such as neckties and baggy clothing are inappropriate for the lab. Long hair should be confined.
- Jewelry such as rings, bracelets and watches should be avoided as they may trap or react to chemicals close to the skin or cause shocks when contacted with electrical sources.
- Clothing made of cotton material is preferable to synthetic fibers such as polyester or nylon, and should be worn during potentially flammable lab experiments or procedures.

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- Lab coats should not be worn outside of the laboratory areas to reduce the risk of contaminating other spaces.

7.5.2 Personal Protective Equipment (PPE)

Engineering and administrative controls are the primary methods for reducing the risks of chemical exposures in the laboratory. PPE is used to offer an additional layer of protection if engineering and administrative controls fail or where they are not fully sufficient.

The degree of PPE required in DePaul laboratories may vary greatly depending on the specific type of lab work that is being conducted and the materials involved. Experimental protocols developed by the departments should have written procedures dictating specific PPE requirements.

Some basic requirements for PPE include:

- Safety eyewear conforming to ANSI Z87.1 must be worn by all persons in the laboratory whenever the potential for splash, impact, or other contact exists. Safety eyewear must provide for impact as well as splash protection. Regular prescription eyewear does not meet this requirement.
- Specialized eye protection may be required in certain circumstances such as when a potential exposure to lasers or ultraviolet light may occur.
- Full face shields must be worn in addition to goggles when conducting procedures that may result in splashes to the face (e.g., a violent reaction), and may also be necessary when working with extremely hazardous substances such as highly corrosive chemicals.
- Gloves must be worn whenever the potential for contact with hazardous or toxic substances exist. Gloves must be of a material that is compatible with the chemicals/hazards present. (Refer to the Personal Protective Equipment Program or specific glove manufacturer data).
- PPE for use with hot or extremely cold (e.g., cryogenic) items shall have adequate thermal protection.
- Splash aprons and other additional PPE such as chemical protective suits and shoe coverings may be required when working with highly hazardous chemicals. Care should be taken to ensure that the PPE material is suitable to the chemical(s) that they are guarding against.

7.5.3 Respiratory Protection

A respirator may be used when engineering controls, such as general ventilation or a fume hood, are not feasible or do not reduce the exposure of a chemical to acceptable levels. Since the use of a respirator is regulated by the [OSHA Respiratory Protection Standard](#), respirator use at DePaul University is subject to prior review by the EHS Office.

Any PI or other laboratory worker who believes that respiratory protection is needed must notify the EHS Office to request an evaluation of the hazard and enrollment in the DePaul Respiratory Protection Program. This program involves procedures for hazard evaluation, respirator selection, medical clearance, employee training, proper fitting, respirator inspection and maintenance, and recordkeeping. Medical evaluations and fit testing are offered every fall. Contact Jenny Graham at jgraham5@depaul.edu to request respirator training and enrollment in the Respiratory Protection Program.

Voluntary use of a paper or cloth dust mask (“filtering face piece”) is allowed without enrolling in the Respiratory Protection Program, provided that the use doesn’t in itself create a hazard and that employees are provided with a copy of Appendix D (“[Information for Employees Using Respirators When Not Required Under the Standard](#)”) of the OSHA Respiratory Protection standard [29 C.F.R. 1910.134]. Contact the EHS Office if you believe you need to upgrade to a tight-fitting respirator (e.g., typically made of silicone or rubber with cartridges).

7.6 UNATTENDED EXPERIMENTS

While unattended experiments should be avoided, laboratory operations involving hazardous substances are sometimes carried out continuously or overnight with no one present. It is the responsibility of the PI to design these experiments to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water, and inert gas. General provisions for unattended experiments include:

- The PI must carefully examine how chemicals and apparatus are stored, considering the possibility for fire, explosion or unintended reactions.
- Laboratory lights should be left on, and signs should be posted identifying the nature of the experiment and the hazardous substances in use.
- If appropriate, arrangements should be made for other workers to periodically inspect the operation.
- Contact information for the responsible individual should be posted by the experiment in the event of an emergency.

7.7 WORKING ALONE

Individuals using hazardous chemicals should not work alone. Students are prohibited from working alone with hazardous chemicals. Where faculty or staff must work alone, the PI should develop an appropriate system for periodic check-ins, based on the risks of the materials and operations. The use of particularly hazardous substances or operations should never be conducted alone.

7.8 WASTE DISPOSAL

Waste disposal and treatment practices (except as they pertain to the general safe handling of hazardous chemicals) are beyond the scope of the Chemical Hygiene Plan as these practices are covered under the Environmental Protection Agency (EPA) Resource and Conservation Recovery Act (RCRA) not the OSHA Laboratory Standard.

Practices related to the disposal of hazardous waste can be found in DePaul University’s [Hazardous Waste Disposal Guide](#)

8. MEDICAL SERVICES

An opportunity for employee medical consultation, with evaluation, treatment and follow up as warranted, must be provided under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
- Whenever exposure monitoring indicates an exposure level that routinely meets or exceeds the OSHA action level (or PEL when no action level exists) for regulated substances for which there are exposure monitoring and medical requirements.
- 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.
- For all employees required to wear a respirator.
- For all emergency response team members.

All medical examinations and consultations shall be provided by or under the direct supervision of a licensed physician and shall be provided at no cost to the employee.

The consulting/treating physician must be provided with the following information as applicable:

- A description of the signs and symptoms of exposure.
- A description of the conditions under which the exposure occurred (e.g. chemical mixtures, amounts, fume hood use, etc.).
- The identity of the hazardous chemical(s) to which the exposure occurred, including any known byproducts of chemical mixtures that may have occurred. SDS sheets should be provided to the physician.

9. EMERGENCY PROCEDURES

9.1 INITIAL NOTIFICATION

All accidents and spills must be reported to the Public Safety Office. Public safety can be contacted at:

- **Lincoln Park Campus: 773-325-7777 (5-7777 from a university phone)**
- **Loop Campus: 312-362-8400**

When contacting the Public Safety Office it is helpful to have the following information ready:

- Type of incident (e.g., chemical spill).
- Extent of any injuries/illnesses. If applicable, inform Public Safety that an ambulance is required.
- Building/location where the incident occurred.
- Your name and phone number where you can be reached.
- Name and estimated quantity of chemical (if incident involves chemical spill/release).

9.2 CHEMICAL SPILLS OR RELEASES

The most important aspect of any spill contingency plan is the prevention of spills. General laboratory guidelines (e.g., capping all containers) must be practiced in the laboratory at all times. However, the risk for spills of hazardous substances cannot be completely eliminated when conducting laboratory work.

Most of the spills that are likely to occur at DePaul University Laboratories may be minor enough (e.g., small quantity and not extremely hazardous substances) to be handled by laboratory employees. For this to take place, employees must be provided the proper training and equipment/supplies to handle these minor, or “incidental,” spills. All laboratory personnel employed by DePaul must have adequate training in how to contain and clean up incidental chemical spills that may occur in the laboratory. Such training should cover basic spill containment and clean-up practices as well as precautions that are specific to the laboratory and chemicals they will be working with. DePaul employees are NOT authorized or instructed to clean up any spills of an emergency nature and should not place themselves or others at risk by attempting to do so, but should instead evacuate the immediate area and contact Public Safety to summon a properly trained and equipped hazardous materials emergency response team (see Section 9.2.3).

9.2.1 Spill Kits

A spill kit must be provided for each laboratory. The spill kit must be readily accessible and should be inspected or inventoried periodically. The spill kit should contain materials that are specific to the laboratory and the chemicals present in that laboratory. Basic materials that may be needed in a spill kit, depending on the specifics of the laboratory and chemicals present, include:

- Spill control pillows/socks and additional adsorbent materials suitable to chemicals present in the lab.
- Neutralizing agents for acids and bases.
- All PPE required for handling materials found in the laboratory. This should include a minimum of goggles, face shield, and gloves. Further PPE such as chemically resistant shoe coverings/booties, apron, chemical suit, etc. may be required.

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- Container(s) to place adsorbent materials and other contaminated debris. (Some available spill kits have spill materials enclosed in a container that is suitable for this purpose.)

It is the responsibility of the department to provide and maintain spill kit materials and to ensure that personnel are trained on the safe and prudent practices for containing incidental spills they may encounter.

9.2.2 Incidental Chemical Spills

All laboratory personnel employed by DePaul must have adequate training in how to contain and clean up incidental chemical spills that may occur in the laboratory. Such training should cover basic spill containment and clean-up practices as well as precautions that are specific to the laboratory and chemicals they will be working with.

Properly trained and equipped faculty and staff (not students) may clean-up incidental spills of hazardous chemicals using the materials provided in the laboratory spill kit and following procedures reviewed during training and as otherwise appropriate based on the materials involved and nature of the incident.

9.2.3 Emergency Spills or Releases

Laboratory personnel should not attempt to clean large spills or spills of extremely hazardous substances. The area should be evacuated and the campus emergency action plan should immediately be implemented. Actions to take in the event of emergency spills or releases of chemicals include:

- Do not expose yourself to a dangerous situation.
- If practical, turn off heat and ignition sources for spills involving flammable materials.
- Evacuate the area and alert others nearby.
- Immediately call Public Safety to inform them of the situation.
- Congregate at the site rally point. Be available to provide information about the spill or release.

9.3 CHEMICAL EXPOSURES/CONTACT

Chemical exposures can occur by eating, drinking, breathing or contacting harmful chemicals, either accidentally or intentionally. The following sections provide general guidance for response to chemical exposure or contact, based on the area/type of exposure (e.g., skin, eyes, etc.). Medical consultation and evaluation will be provided as required or otherwise necessary in the event of a chemical exposure incident (e.g., spill, splash). See Section 8, Medical Services, for details.

9.3.1 Contact with Skin

In the event of skin contact with a hazardous chemical, immediately drench the skin with copious amounts of water for at least 15 minutes.

- While rinsing, quickly remove any contaminated clothing and/or jewelry.
 - Use caution when removing contaminated pullover shirts or sweaters to prevent contamination of the eyes.
 - Discard contaminated clothing or launder them separately from other clothing. Leather garments or accessories that cannot be decontaminated should be discarded.

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- Consult the SDS and/or laboratory chemical safety summary for guidance on appropriate action and whether any delayed effects should be expected. It is important to determine all of the chemicals, including any intermediaries or mixtures, which the person may have come in contact with. The victim should be encouraged to seek medical attention regardless of the assumed severity of the injury/exposure.
 - Do not use solvents to wash skin. They remove the natural protective oils from the skin, can cause irritation and inflammation, and in some cases, may facilitate absorption of a toxic chemical.
 - Seek prompt medical attention, as needed.
 - Contact Public Safety for any potential emergency situations (e.g., contact with hydrofluoric acid or phenol concentrations greater than 10%).

9.3.2 Contact with Eyes

Where chemicals come in contact with the eyes (e.g., chemical splash, particulate, etc.):

- Immediately flush eye(s) with copious amounts of water for 15 minutes:
 - Hold the eye open so all surface area of the eyeball is rinsed.
 - The use of an eye wash fountain is desirable so hands are free to hold the eyes open.
 - If eyewash is not available, pour water on the eye, rinsing from the nose outward to avoid contamination of the unaffected eye.
- Remove contact lenses while rinsing. Do not lose time removing contact lenses before rinsing. Do not attempt to rinse and reinsert contact lenses.
- Seek medical attention regardless of the severity or apparent lack of severity. Call Public Safety for immediate medical attention.

9.3.3 Inhalation, Ingestion or Injection of Hazardous Chemicals

For *inhalation* of hazardous chemicals:

- Move affected personnel to fresh air and close containers, open windows or otherwise increase ventilation if necessary.
- If symptoms, such as headaches, nose or throat irritation, dizziness, or drowsiness occur, seek medical attention by calling Public Safety.
- Review the SDS to determine what health effects are expected, including delayed effects.

For *accidental ingestion* of chemicals, seek medical attention by calling Public Safety. Do not induce vomiting unless directed to do so by a health care provider.

For *accidental injection* of chemicals, wash the area with soap and water and contact Public Safety for medical attention if necessary.

9.4 INCIDENT REPORTS

All workplace injuries, accidents, illnesses, emergency spills, and/or potential overexposures to laboratory chemicals must be reported to the departmental office, Public Safety and the EHS Office.

All incidents related to the use of chemicals must have an Incident Report Form filed with the EHS Office as soon as practical and **within 48 hours**. Incident Report Forms are located on the EHS website: <http://ehs.depaul.edu/MasterPage/Form.html>

DePaul University maintains reports and records on all accidents, illnesses and exposures that occur while conducting DePaul University activities. In addition to meeting regulatory requirements, maintaining careful records is important to reducing future illnesses and injuries. By tracking incidents over time, trends become more apparent and corrective actions can be taken to reduce future accidents.

9.5 INJURY/ILLNESS AND EXPOSURE RECORDS

Records are maintained by the EHS Office according to the following provisions:

- All employee injuries and illness records must be maintained in the OSHA 300 log. (Note: OSHA dictates only employee injuries are to be entered in the 300 logs; student injuries and illnesses will be tracked elsewhere.)
- The EHS Office requires that an Incident Report Form be filled out within 48 hours of the incident. Incident Report Forms are located on the EHS website: <http://ehs.depaul.edu/MasterPage/Form.html>
- Records of any industrial hygiene or other related monitoring or hazard assessment will be maintained by the EHS Office. Records of personnel monitoring and medical consultations/examinations must be made available to the effected employee and/or their representative. Refer to Section 2.2.2.

Records of any maintenance or repairs to facilities or equipment that affect chemical hygiene are maintained by Facilities Operations. Records of any maintenance or repairs contracted by outside vendors hired by the department should be maintained by that department for no fewer than three years.

APPENDIX A: CHEMICAL HAZARD CATEGORIES

| CHEMICAL HAZARD CATEGORIES | |
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| Flammable Liquids | |
| <i>A liquid having a flash point below 100°F or 38° C with a vapor pressure less than 40 psi at 100°F is designated a Class I liquid with subclasses as follows:</i> | Class IA – A liquid having a flash point below 73°F (22.8°C) and having a boiling point below 100°F (38.7°C). |
| | Class IB – A liquid having a flash point below 73°F (22.8°C) and having a boiling point at or above 100°F (38.7°C). |
| | Class IC – A liquid having a flash point at or above 73°F (22.8°C) and a boiling point below 100°F (38.7°C). |
| Combustible Liquids | |
| <i>A liquid having a flash point at or above 100°F (38.7°C) and below 140°F (60°C). This class is subdivided as follows:</i> | Class II - is a liquid having a flash point at or above 100°F (38.7°C) and below 140°F (60°C). |
| | Class IIA - is a liquid having a flash point at or above 140°F (60°C) and below 200°F (93.4°C). |
| | Class IIIB - is a liquid having a flash point at or above 200°F (93.4°C). |
| Reactive Chemicals | |
| <i>Any chemical which fits any one of the following:</i> | Identified or described in the SDS or on the label as unstable or reactive. |
| | Ranked by the NFPA as 3 or 4 for reactivity. |
| | Determined by the U. S. DOT (49 C.F.R. 173) as an oxidizer, an organic peroxide, or an explosive. |

CHEMICAL HAZARD CATEGORIES

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| | <p>Determined by the U. S. EPA (40 C.F.R. 261.23) as reactive:</p> <ul style="list-style-type: none"> • It is normally unstable and readily undergoes violent change without detonating. • It reacts violently with water. • It forms potentially explosive mixtures with water. • When mixed with water, it generates toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment. • It is a cyanide or sulfide material which, when exposed to pH conditions between 2.0 and 12.5 generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment. • It is capable of detonation or explosive decomposition if it is subjected to a strong initiating source or if heated under confinement. • It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure. |
| Reactive Chemicals (Cont.) | |
| <i>Any chemical which fits any one of the following:</i> | <p>Meets the OSHA Laboratory Standard definition of Unstable:</p> <ul style="list-style-type: none"> • A chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure, or temperature. |
| | <p>In the experience of the User, is known or found to be reactive with ordinary substances.</p> |
| Corrosive Chemicals | |
| <i>Any chemical which fits any one of the following:</i> | <p>Is identified or described in the SDS or on the label as corrosive.</p> |
| | <p>Is identified by the DOT (49 C.F.R. 173) as corrosive.</p> |
| | <p>Meets the EPA (40 C.F.R. 261.22) definition of corrosive:</p> <ul style="list-style-type: none"> • An aqueous solution and has a pH less than or equal to 2.0 or greater than or equal to 12.5. • A liquid and corrodes steel at a rate greater than 6/35 mm per year at a test temperature of 55°C (130°F). |
| | <p>Meets the OSHA definition of corrosive: A chemical that causes visible destruction of or irreversible alteration in living tissue by chemical action at the site of contact.</p> |
| | <p>In the experience of the User is known or found to be corrosive.</p> |
| Contact Hazards | |

| CHEMICAL HAZARD CATEGORIES | |
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| <i>Any chemical which fits any one of the following:</i> | Is identified or described as an allergen or sensitizer in the SDS or on the label |
| | Is identified or described in the medical or industrial hygiene literature as an allergen or sensitizer. |
| | In the experience of the laboratory User is found to cause contact hazards |
| Carcinogens (Select Carcinogens) | |
| <i>Any chemical which fits any one of the following:</i> | Is identified or described as a carcinogen in the SDS or on the label. |
| | Is regulated by OSHA as a carcinogen. |
| | It is listed under the category, “Known to be Carcinogenic” or “Reasonably Anticipated to Carcinogenic” in the Annual Report on Carcinogens published by the National Toxicology Program (NTP latest edition). |
| | It is listed under Group 1, “Carcinogenic to Humans,” by the International Agency for Research on Cancer Monographs (IRAC latest edition). |
| Reproductive Toxins | |
| <i>Any chemical which fits any one of the following:</i> | Is identified or described as a reproductive toxin, mutagen, or teratogen in the SDS or on the label. |
| | Is known or suspected to affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetus (teratogenesis). |
| | Is identified or described in medical or industrial hygiene literature as a reproductive toxin. |
| Highly Toxic Chemicals | |
| <i>Any chemical which fits any one of the following:</i> | Is identified or described as highly toxic in the SDS or on the label. |
| | Meets the OSHA definition of highly toxic: <ul style="list-style-type: none"> • The median lethal dose (LD₅₀) is equal to or less than 50mg/kg of the body weight when administered orally to rats. • The median lethal dose (LD₅₀) is equal to or less than 200mg/kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of rabbits. • The median lethal concentration (LD₅₀) in air is equal to or less than 200 parts per million (ppm) by volume or less of gas or vapor, or equal to or less than 2 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to rats. |
| | The TLV or PEL is equal to or less than 5 ppm or 5 mg/m ³ . |

CHEMICAL HAZARD CATEGORIES

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| | The median tolerance limit is equal to or less than 10 ppm by weight of material in water, or the median aquatic lethal concentration is equal to or less than 10mg/L of material, when administered for 96 hours to a median sensitivity warm water or cold water species of fish. |
| | Is identified or described in the medical or industrial hygiene literature as being acutely toxic. |

APPENDIX B: SAFE WORK PRACTICES FOR HANDLING AND STORAGE OF LABORATORY CHEMICALS

This Appendix contains general standard operating procedures to be followed for safe use, handling and storage of laboratory chemicals. This is intended to be general guidance supplemented as necessary by more specific requirements provided by individual PIs, Departments, experimental protocols, equipment manuals, or otherwise as appropriate based on the nature and risks of the laboratory work. Additional guidance is also provided in other appendices of the DePaul Chemical Hygiene Plan:

- Appendix C: Guidance on Peroxide-Forming Chemicals
- Appendix D: Guidance for Storage of Incompatible Chemicals
- Appendix E: Guidance for Storage of Flammable and Combustible Liquids

In addition, other DePaul programs and procedures provide requirements and guidance on specific topics that may apply to certain types of laboratory work, such as: Hazard Communication; Personal Protective Equipment, Respiratory Protection; Radiation Safety; Biological Safety; Controlled Substances; and Hazardous Waste Disposal.

A. General Safe Laboratory Practices

1. Minimize exposure to all chemicals regardless of how familiar they are. Develop and encourage safe habits and avoid unnecessary exposure to chemicals by any route.
2. Be familiar with the symptoms of exposure for the chemicals in use and the precautions necessary to prevent exposure. The ability to recognize the signs and symptoms of chemical exposure is important. Then, if adverse effects do arise despite all precautions taken to avoid exposure, those effects can be recognized early and appropriate action taken.
3. Know the hazards of laboratory chemicals, equipment, and procedures prior to beginning work.
4. Avoid performing hazardous operations alone in a laboratory or chemical storage area.
5. Avoid behavior that might confuse, startle, or distract another worker.
6. Wear appropriate personal protective equipment at all times.
7. Use all laboratory equipment only for its intended purpose. Do not use damaged equipment, glassware, or other materials or laboratory devices that are not in good working order. Immediately remove or clearly tag damaged items for proper disposal or for service and repair by an authorized employee or vendor, as appropriate.

B. Hygiene and Housekeeping Practices

1. Do not eat, drink, smoke, chew gum or tobacco, or apply cosmetics in areas where laboratory chemicals are present.

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2. Wash hands frequently, after every experiment, before leaving the laboratory area, and especially before eating, drinking, smoking, chewing gum or tobacco or applying cosmetics.
 3. Do not wear laboratory coats outside the laboratory. Remove gloves before touching common equipment, such as phones, doorknobs, computer keyboards.
 4. Do not smell or taste chemicals.
 5. Do not consume or store food or beverages in laboratory areas or chemical storage refrigerators. Do not use laboratory glassware or utensils for food and beverage handling and/or storage.
 6. Maintain clear walkways, with unobstructed exits and no slipping/tripping hazards such as containers on the floor or outlet strips or extension cords across walkways. Keep all aisles clear of obstructions and tripping or slipping hazards.
 7. Keep the work area clean and uncluttered. At the completion of each work day or operation, clean the work area. Maintain reasonably neat and clean counter tops and shelves.
 8. Clean work surfaces after use or periodically as otherwise needed. Protect work surfaces from contamination where appropriate.
 9. Store all materials in secure positions/locations. Avoid storage on top of cabinets/shelving wherever feasible. Maintain clearance of at least 18" between top of highest item and sprinkler head.
 10. Do NOT block access to emergency exits or emergency equipment such as safety showers, eyewashes, spill kits, fire extinguishers, etc.
 11. Check that equipment is in safe operating condition, including: electrical wires in good condition and not overloaded to any one outlet, pumps, belt guards on pumps, all equipment electrically grounded, and refrigerators properly designated and used.
 12. Immediately report malfunctioning equipment to coordinate prompt repair or replacement. If being repaired, clearly label malfunctioning equipment with a tag indicating "do not use" and the status.

C. Laboratory Glassware and Vessels

1. Use care when handling and storing laboratory glassware to avoid damage and injury.
2. Inspect glassware before use.
3. Do not use damaged glassware. Dispose of chipped, broken, star-cracked, or badly etched glass into proper waste receptacle.
4. Use a lubricant and wear hand protection if pushing glass through rubber stoppers.
5. When handling heated glassware, use heat-resistant gloves and/or tongs.
6. Use plastic or shatter-proof glass containers, when possible.
7. When picking up containers, use both hands.
8. Use carts, caddies or other appropriate containment when transporting glass containers of chemicals outside the laboratory.
9. Be aware of implosion hazards when working with a vacuum.
10. Apply vacuum only to glassware specifically designed for that purpose, such as thick-walled, pressure resistant glassware (e.g., heavy wall filter flasks, desiccators, etc.). Where feasible, use plastic (e.g., polycarbonate) desiccators and other containers now on the market to reduce the implosion hazard.
11. Use shielding (hood sash or portable shield) to protect against flying glass.

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12. Do not allow water, solvents, or corrosive gases to be drawn into a building vacuum system (e.g., use traps where needed).
 13. High-pressure operations should be performed only in pressure vessels that are appropriately selected for the operation; properly labeled and installed; and protected by pressure-relief and necessary control devices. Vessels must be strong enough to withstand the stresses encountered at the intended operating temperature and pressures and must not corrode or otherwise react when in contact with the materials it contains.

D. Toxic Chemicals

Safe work practices for toxic chemicals include:

1. Evaluate whether a less toxic alternative is feasible.
2. Use the smallest amount of chemical that is consistent with the requirements of the work to be done.
3. Avoid inhalation of toxic chemicals. Conduct the procedure in the fume hood.
4. Avoid contact with toxic chemicals by wearing appropriate personal protective equipment.

While DePaul typically does not use such chemicals, where tasks will involve work with particularly hazardous substances, including select carcinogens, reproductive toxins and/or substances with high acute toxicity, certain provisions for additional employee protection may also be necessary, such as:

- Specification of designated area(s);
- Use of containment equipment such as fume hoods;
- Procedures for safe removal of contaminated waste; and
- Decontamination procedures.

Specific procedures should be developed as the need arises. General procedures for working with **Particularly hazardous substances** include:

1. Evaluate whether a safer chemical alternative is feasible.
2. Wherever feasible, conduct the procedure in a fume hood. Otherwise, use equivalent engineering or combinations of other controls.
3. Use the smallest amount of chemical that is consistent with the requirements of the work to be performed.
4. Wear appropriate personal protective equipment to prevent exposure.
5. Where work with carcinogens, mutagens, or reproductive hazards is to be conducted on a routine basis, establish designated areas (e.g., benches or hoods) for work with these materials, clearly label the designated area with a sign, restrict access, and implement special decontamination procedures.
6. Use care when weighing solids to avoid creation of aerosols. Where possible, use fume hoods or other vented enclosures for weighing highly hazardous chemicals.
7. Establish a schedule and procedure for decontamination of work surfaces and equipment (e.g., at the completion of the operation or at the end of the day). The decontamination solution must be compatible with the materials with which it is being used, and should be selected based on the properties of the materials it is being used to decontaminate.

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8. Establish proper housekeeping procedures. Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance is a dry powder.
 9. Carefully handle waste generated from procedures involving particularly hazardous chemicals. Follow all waste procedures (e.g., labeling of containers, keeping waste collection containers tightly closed when not in use, providing secondary containment for liquid waste containers, etc.) while waste is in storage.
 10. Store particularly hazardous chemicals in appropriately labeled, unbreakable, chemically resistant, secondary containers.
 11. Review each use of these materials annually or whenever a procedural change is made.
 12. Call Public Safety from a safe location for any emergency situations. Notify the EHS Office of all incidents of potential exposure or spills.

E. Flammable Liquids

Safe work practices for flammable chemicals include:

1. Keep only working amounts of flammable chemicals in the laboratory.
2. Store flammable chemicals in flammable storage cabinets when not in use, or in other approved flammable storage containers. Do not store flammable liquids in refrigerators or freezers that have not been designated for that purpose. Store flammable liquids in flammable-safe or explosion-proof refrigerators or freezers. Additional guidance is contained in the section on Chemical Storage.
3. Observe all posted limits for allowable quantities of flammable chemicals in laboratories.
4. Prohibit smoking and eliminate other possible sources of ignition (e.g., heat, direct sunlight, open flames, etc.) wherever flammable materials are stored or used.
5. Prevent accumulation of vapors through careful handling and use of ventilation. Conduct the procedure in a fume hood or other vented enclosure so that flammable vapors are exhausted from the laboratory.
6. Use proper bonding and grounding to avoid sparks from static charges generated when transferring flammable liquids in metal containers/equipment (e.g., metal lines and vessels bonded together and grounded to a common ground).

F. Corrosive Chemicals

Safe work practices for corrosive chemicals include:

1. Purchase corrosives in the smallest container size practical. Where available, purchase corrosives in bottles with a safety coating, to minimize the risk of breakage and spills.
2. Wear appropriate personal protective clothing for handling corrosives (e.g., eye/face protection, buttoned lab coat or splash apron, and impervious gloves).
3. Store liquid corrosives on low shelves or in acid or caustic storage cabinets. Avoid storage of corrosives above the bench or on upper storage shelves.
4. Segregate corrosives from incompatible chemicals, using storage bins as necessary to further segregate and provide secondary containment in storage. Check the SDS for proper storage (e.g., segregate oxidizing acids from organic acids, and flammable and combustible liquids; segregate acids from bases and active metals such as sodium, potassium, magnesium, etc.).

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5. Use proper pouring techniques when pouring acids into water. Always add acids to water. Use cold water; add slowly in small amounts.
 6. Use caution if transferring corrosives from one container to another. Dispense from only one container at a time. Finish all dispensing of one material before starting to dispense another. Make sure containers are tightly closed.
 7. If transferring corrosives to secondary containers, be sure to use the type of containers recommended by the manufacturer or supplier. Corrosives can damage or destroy containers made of improper materials.
 8. Protect containers against physical damage (e.g., banging, breakage) when transferring or using them. Make sure containers are tightly closed when not in use.
 9. Always handle corrosive material carefully to avoid the generation of dusts or other aerosols for solid corrosives, and mists or vapors for liquid corrosives.
 10. Use bottle carriers (or carts designed for chemical transport) for transporting corrosives in glass bottles.

G. Compressed Gases

Safe work practices for compressed gases include:

1. Keep all cylinders secured in place using chains, cages, straps, or special clamping devices.
2. Keep compressed gas container valves closed at all times except when in use. Keep removable caps and plugs on compressed gas cylinders at all times except when connected to dispensing equipment.
3. Always assume a cylinder is pressurized – handle it carefully and avoid bumping and dropping.
4. Ensure that the contents of any compressed gas cylinder can be clearly identified and know the identity of the gas in a cylinder. If a cylinder is unlabeled, return it to the vendor. Know the properties and potential of the gas to be used, and the procedures for using it.
5. Carefully inspect fittings, regulators, and apparatus for damage before using. Do not use damaged equipment.
6. Use only regulators, gauges, and connections with matching threads and which are designed for use with the gas and cylinders involved. Never lubricate, modify, force, or tamper with a cylinder valve.
7. When opening cylinder valves, do not hold the regulator. Open valve slowly, directed away from the face. Do not force threads that do not fit. Make sure that threads on regulator connections match those on the container valve outlet.
8. Use only those tools approved by the cylinder vendor. Do not modify or alter cylinders or their attachments. Use cylinders and manifold systems only with their appropriate pressure regulators. Be careful not to exceed the design pressure of the apparatus.
9. Do not place cylinders in any area where they:
 - a. Are subject to contact with a flame or temperatures above 125° F (51.7° C)
 - b. Are subject to low temperature extremes (unless approved by the supplier).
 - c. May become part of an electrical circuit.
10. Do not attempt to transfer compressed gases from one container to another. This must only be performed by the supplier or manufacturer.

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11. When empty, tag empty cylinders appropriately for return to designated storage.
 12. Do not drag compressed gas cylinders. Use a cart or manufacturer approved dolly with a restraining strap to move cylinders.
 13. In storage, group cylinders by type of gas and the groups further segregated as to compatibility. Store full and empty cylinders separately within the storage area. Ensure cylinders are properly secured by straps, chains, or other suitable devices.

H. Cryogenic Materials

Safe work practices for cryogenic materials include:

1. Use only containers specifically designed for holding cryogenic liquids. Where appropriate, tape containers and cold traps to prevent flying glass in case of breakage.
2. Do not store cryogenic liquids in a container with a tight-fitting lid as the pressure will build-up as the cryogen boils and the container may fail.
3. Store cryogenic materials only in large and well-ventilated areas so that the rapid boil-off of fluids will not displace oxygen to create a potentially oxygen-deficient atmosphere. Never lower your head into a dry ice chest, as the oxygen content may be inadequate and asphyxiation can result.
4. Wear required PPE, such as safety glasses with side shields and/or a full-face shield to protect the eyes and face from splash hazards and potential projectiles from pressure build-up. Use suitable gloves to protect hands from cryogenic materials.
5. Remove jewelry (or cover, if necessary), such as watches, rings, etc. to minimize the risk of cryogenic liquid being trapped beneath them, resulting in cold burns.
6. Put objects into a cryogenic liquid slowly, and pour liquids into containers slowly in order to minimize boiling and splashing. If using dry ice, add to liquid slowly and in small amounts to avoid foaming and boil over.

I. Peroxide-forming Chemicals

Refer to the table in Appendix C for additional guidance on peroxide-forming chemicals. Safe work practices for peroxide forming chemicals include:

1. Purchase only the quantity that will be used in a short time and in the smallest size of container that is practical. Purchase chemicals that have a peroxide formation inhibitor, where possible.
2. Upon receipt, use a permanent marker to label the container with the date received and initials.
3. Upon opening a new container of a peroxide-forming material, use a permanent marker to label the container with the date opened and initials. The length of time a peroxide-forming chemical can be safely stored depends on the particular material (e.g., some form peroxides on aging, others upon concentration, etc.). Refer to Appendix C, read the SDS and other sources of hazard information, or contact the EHS Office for assistance.
4. Do not open containers if the date of receipt indicates that it is past the recommended shelf life (or more than twelve months old), or if it's past the manufacturer's expiration date.
5. Inspect containers for peroxide formation before opening or moving the containers. Do not open, touch, or otherwise disturb any container if crystalline solids are observed in liquid peroxide-forming chemicals. From a safe location, immediately contact Public Safety.

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6. Store peroxide forming chemicals in airtight amber glass containers. The amber glass container protects the substance from excess light exposure and allows the user visual access to the substance without opening the container. Once material is removed from the source container it must not be returned to the reagent container.
 7. Before storing, ensure that bottles and caps are free of chemical residue. Keep containers tightly capped to minimize peroxide formation.
 8. Store peroxide forming chemicals away from heat sources, sparks, direct light, flammables, and combustibles. Check the SDS for any additional incompatibilities of the specific material.
 9. Avoid the use of metal implements, since metals contamination can lead to explosive decomposition. Use implements made of alternative materials such as wood, ceramics or Teflon®.
 10. Use extra caution when handling near-empty or empty containers of peroxide forming materials because the air space above the liquid can accelerate the formation of peroxides.
 11. If antioxidant inhibitors are used, be aware that the inhibitor may be consumed with time, making the compound again sensitive to peroxidation.
 12. Consider the need for additional controls, such as shielding of reactions. *[Note: Fume hoods sashes may provide some level of physical protection against minor explosions; however, most sashes are not explosion-proof.]*

J. Chemical Storage

While chemical storage requirements will vary depending on the nature of the laboratory work and the chemicals being stored, basic practices for safe chemical storage include:

1. Store chemicals only in compatible containers.
2. Segregate chemicals based on compatibility (see Appendix D).
 - a. Storing chemicals alphabetically, without regard to compatibility, can increase the risk of a hazardous reaction, especially in the event of container breakage.
 - b. Use common sense when setting up chemical storage. Segregation that disrupts normal workflow can increase the potential for spills.
 - c. In general, dry reagents, liquids and compressed gases should be stored separately, then by hazard class, then by any additional incompatibilities (and then alphabetically if desired).
3. Provide a specific storage location for each type of chemical, and return the chemicals to those locations after each use.
 - a. Make arrangements for the storage of highly reactive chemicals before procurement.
 - b. Avoid storing chemicals in the workspace within a laboratory hood or on lab bench tops, except for those chemicals currently in use.
 - c. If a chemical does not require a flammable storage cabinet or ventilated cabinet, store it inside a closable cabinet or on a shelf that has a lip to prevent containers from sliding off in the event of an accident or fire.
4. Ensure cabinets for chemical storage are of a solid, sturdy construction, preferably hardwood or metal. Be sure that the weight of the chemicals does not exceed the load capacity of the shelf or cabinet.

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5. Avoid storing materials and equipment on top of cabinets. If you must place things there, maintain a clearance of at least 18 inches from the sprinkler heads or (if no sprinkler heads are present) 24 inches from the ceiling.
 6. Do not store corrosive liquids above eye level. Use corrosion resistant storage trays or secondary containers to collect materials if the primary container breaks or leaks.
 7. Do not store flammable liquids in a refrigerator unless it is approved for such storage. Such refrigerators are designed with non-sparking components to avoid an explosion. Distinguish between refrigerators used for chemical storage and refrigerators used for food storage. Each refrigerator should be labeled "No Food" or "Food Only."
 8. Do not store chemicals near direct sunlight or heat sources.
 9. Avoid storing chemicals near exits, passageways, or emergency equipment.
 10. For Compressed Gas Cylinder storage:
 - a. Ensure cylinders are secured with a strap or chain.
 - b. Store cylinders away from sources of heat, flame, or mechanical damage
 - c. When cylinders are no longer in use, ensure that the valve is shut, pressure relieved from regulators, regulators removed, and the cylinder capped.

APPENDIX C: GUIDANCE FOR PEROXIDE-FORMING CHEMICALS

| Guidance for Peroxide Forming Chemicals | |
|---|---|
| Severe Peroxide Hazard Substances: Form Peroxides on Exposure to Air | |
| <i>The following chemicals present severe peroxide hazards on storage with exposure to air and should typically be discarded within 3 months of opening.</i> | |
| Butadiene (liquid monomer) | Potassium Amide |
| Diisopropyl Ether (Isopropyl Ether) | Sodium Amide (Sodamide) |
| Divinylacetylene (DVA) | Tetrafluoroethylene (liquid monomer) |
| Potassium Metal | Vinylidene Chloride(1,1-DiChloroethylene) |
| Concentration Hazard | |
| <i>The following chemicals present peroxide hazards on concentration. Do not distill or evaporate these chemicals without first testing for the presence of peroxides. These chemicals should typically be discarded or tested for peroxides within 6 months of opening.</i> | |
| Acetaldehyde Diethyl Acetal (Acetal) | Ethylene Glycol Dimethyl (Glyme) |
| Cumene (Isopropyl Benzene) | Ethylene Glycol Ether Acetates |
| Cyclohexene | Ethylene Glycol Monoethers (Cellosolves) |
| Cyclopentene | Furan |
| Decalin (Decahydronaphthalene) | Methylacetylene |
| Diacetylene (Butadiene) | Methylcyclopentane |
| Diethyl Ether (Ether) | Tetrahydrofuran (THF) |
| Dioxanes | Vinyl Ethers |
| Shock or Heat Sensitive | |
| <i>The following chemicals present hazards of rapid polymerization initiated by internally formed peroxides. These chemicals should typically be discarded or tested for peroxides within 6 months of opening (gases should be discarded or tested for peroxides within 12 months).</i> | |
| Chloroprene (2-Chloro-1,3-Butadiene) | Vinyl Acetate |
| Styrene | Vinylpyridine |
| Butadiene | Vinylacetylene (MVA) |

| | |
|---|------------------|
| Tetrafluoroethylene (TFE) | Vinyl Chloride |
| Other Potential Peroxide-Forming Chemicals: Form Peroxides Under the Right Conditions | |
| <i>There are a number of other compounds with the potential to form peroxide under the right conditions. For instance, compounds containing aldehyde or amide groups are easily peroxidizable, but may not necessarily accumulate peroxide at dangerous levels. Chemicals in this class should typically be discarded or tested for peroxides within 1 year of opening.</i> | |
| Diethoxymethane | 2-Methoxyethanol |
| 1-Pentene | n-Propyl ether |

APPENDIX D: GUIDANCE FOR STORAGE OF INCOMPATIBLE CHEMICALS

This list is provided to illustrate incompatibilities for common laboratory chemicals and is not a complete list; always consult the SDS for the chemical or other chemical hazard reference. The material on the left should be stored and handled so that it does NOT come in contact with the incompatible chemical(s) on the right.

| | Chemical Compound | Should Be Kept Out of Contact with |
|---|--|---|
| A | Acetic Acid | Acetaldehyde, ammonium nitrate, chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates |
| | Acetaldehyde | Acetic acid, acetic anhydride, ammonia (anhydrous) |
| | Acetylene | Chlorine, bromine, copper, fluorine, silver, mercury |
| | Acetone | Concentrated nitric and sulfuric acid mixtures |
| | Alkali and Alkaline Earth (e.g. Powdered Aluminum or Magnesium, Calcium, Lithium, Sodium, Potassium) | Water, carbon tetrachloride or other chlorinated metals hydrocarbons, carbon dioxide, halogens |
| | Aluminum | Ammonium nitrate, bromates, chlorates, iodates, bromine vapor, carbon disulphide vapor |
| | Ammonia (Anhydrous) | Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous) |
| | Ammonium Nitrate | Acids, powdered metals, flammable liquids, chlorates, nitrates, sulfur, finely divided organic or combustible materials |
| | Aniline | Nitric acid, hydrogen peroxide |
| | Arsenic | Any bromate, chlorate, or iodate |
| | Azides | Acids |
| B | Bromine | See chlorine |
| | Barium | Carbon tetrachloride |
| C | Calcium Oxide | Water |
| | Carbon (Activated) | Calcium hyperchlorite, all oxidizing agents |
| | Carbon Tetrachloride | Sodium |
| | Chlorates | Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials, sulphides |

| Chemical Compound | | Should Be Kept Out of Contact with |
|-------------------|-------------------------------------|--|
| | Chromic Acid | Acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol |
| | Chlorine | Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine |
| | Chlorine Dioxide | Ammonia, methane, phosphine, hydrogen sulfide |
| | Copper | Acetylene, hydrogen peroxide |
| | Cumene Hydroperoxide | Acids (organic or inorganic) |
| | Cyanides | Acids |
| F | Flammable Liquids | Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens |
| | Fluorine | Isolate from everything |
| H | Hydrocarbons (e.g. Butane, Benzene) | Fluorine, chlorine, bromine, chromic acid, sodium peroxide |
| | Hydrocyanic Acid | Nitric acid, alkali |
| | Hydrofluoric Acid (Anhydrous) | Ammonia (aqueous or anhydrous) |
| | Hydrogen Peroxide | Copper, chromium, iron, most metals or their salts, alcohols, acetone, ferrous sulphide, lead IV oxide, lead II oxide, lead sulphide, organic materials, aniline, nitromethane, combustible materials, flammable liquids, oxidizing gases |
| | Hydrogen Sulfide | Fuming nitric acid, oxidizing gases |
| | Hypochlorites | Acids, activated carbon |
| I | Iodine | Acetylene, ammonia (aqueous or anhydrous), hydrogen |
| M | Maleic Anhydride | Magnesium hydroxide, lithium metal |
| | Magnesium Metal | Mercury II oxide, nitric acid |
| | Mercury | Acetylene, fulminic acid, ammonia |
| | Methanol | Lead perchlorate, mercury II nitrate |
| N | Nitrates | Sulfuric acid |
| | Nitric Acid | Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, powdered magnesium metal, phosphorus, phthalic acid |
| | Nitroparaffins | Inorganic bases, amines |
| O | Oxalic Acid | Silver, mercury |
| | Oxygen | Oils, grease, hydrogen, flammable liquids, solids |
| P | Perchloric Acid | Acetic anhydride, aluminum, Bakelite, bismuth and its alloys, alcohol, paper, wood, plastics, nylon (polyamide), modacrylic ester (35-85% acrylonitrile), polyester, Lucite, cellulose-based lacquers, metals, copper and copper alloys, high nickel alloys, cotton, wool, glycerin-lead oxide, grease, oils |
| | Peroxides, Organic | Acids (organic or mineral), avoid friction, store cold |

| Chemical Compound | | Should Be Kept Out of Contact with |
|-------------------|--|--|
| | Phosphorus (White) | Air, oxygen, alkalis, reducing agents |
| | Phosphorus Pentoxide | Water |
| | Potassium | Carbon tetrachloride, carbon dioxide, water |
| | Potassium Chlorate | Sulfuric and other acids |
| | Potassium Perchlorate (See Also Chlorates) | Sulfuric and other acids |
| | Potassium Permanganate | Glycerol, ethylene glycol, benzaldehyde, sulfuric acid |
| S | Silver | Acetylene, oxalic acid, tartaric acid, ammonium compounds |
| | Selenides | Reducing agents |
| | Sodium | Carbon tetrachloride, carbon dioxide, water |
| | Sodium Nitrate | Ammonium nitrate and other ammonium salts |
| | Sodium Peroxide | Ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural |
| | Sulfides | Acids |
| | Sulfuric Acid | Potassium chlorate, potassium perchlorate, potassium permanganate (or similar compounds of light metals, such as sodium, lithium) |

Special Segregation of Incompatible Chemicals

In addition to the segregation noted in above, dangerously incompatible substances, even in small quantities, should not be stored next to each other on shelves or in such a position that accidental rupture of containers may allow mixing. For example:

| CHEMICAL | KEEP OUT OF CONTACT WITH: |
|--------------------------------|----------------------------------|
| Chlorine | Acetylene |
| Chromic acid | Ethyl alcohol |
| Oxygen (compressed, liquefied) | Propane |
| Sodium | Chloroform and aqueous solutions |
| Nitrocellulose (wet, dry) | Phosphorous |
| Potassium permanganate | Sulfuric acid |
| Perchloric acid | Acetic acid |
| Sodium chlorate | Sulfur in bulk |

Oxidizing agents are incompatible with reducing agents.

| OXIDIZING AGENTS | REDUCING AGENTS |
|---------------------|-------------------|
| Chlorates | Ammonia |
| Chromates | Carbon |
| Dichromates | Metals |
| Chromium trioxide | Metal hydrides |
| Halogens | Nitrates |
| Halogenating agents | Organic compounds |
| Hydrogen peroxide | Phosphorus |
| Nitric acid | Silicon |
| Nitrates | Sulfur |
| Perchlorates | |
| Peroxides | |
| Permanganates | |
| Persulfates | |

APPENDIX E: GUIDANCE ON STORAGE OF FLAMMABLE AND COMBUSTIBLE LIQUIDS

Flammable and combustible liquids should be stored only in approved containers. Approval for containers is based on specifications developed by organizations such as the US Department of Transportation (DOT), OSHA, the National Fire Protection Agency (NFPA) or American National Standards Institute (ANSI). Containers used by the manufacturers of flammable and combustible liquids generally meet these specifications.

General considerations for storage of flammable and combustible liquids include:

- Quantities should be limited to the amount necessary for the work in progress.
- No more than 10 gallons of flammable and combustible liquids, combined, should be stored outside of a flammable storage cabinet unless safety cans are used. When safety cans are used, up to 25 gallons may be stored on the first floor without using a flammable storage cabinet.
- Storage of flammable liquids must not obstruct any exit.
- Flammable liquids should be stored separately from strong oxidizers, shielded from direct sunlight, and away from heat sources.

Safety Cans and Closed Containers

Different types of containers may be required depending on the quantities and classes of flammable or combustible liquids in use. A safety can is an approved container of not more than 5 gallons capacity that has a spring closing lid and spout cover. Safety cans are designed to safely relieve internal pressure when exposed to fire conditions. A closed container is one sealed by a lid or other device so that liquid and vapor cannot escape at ordinary temperatures.



Flammable Liquid Storage Cabinets

A *flammable liquid storage cabinet* is an approved cabinet that has been designed and constructed to protect the contents from external fires. Storage cabinets are usually equipped with vents, which are plugged by the cabinet manufacturer. Since venting is not required by the local authority having jurisdiction and since venting may actually prevent the cabinet from protecting its contents, vents should remain plugged at all times. Storage cabinets must also be conspicuously labeled



"FLAMMABLE – KEEP FIRE AWAY".

Refrigerators

Use only those refrigerators that have been designed and manufactured for flammable liquid storage. Standard household refrigerators must not be used for flammable storage because internal parts could spark and ignite. Refrigerators must be prominently labeled as to whether or not they are suitable for flammable liquid storage.

