The College of New Jersey
Campus Chemical Hygiene Plan

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INTRODUCTION

Laboratories present unique safety and health hazards due to the nature of the activities conducted in these spaces. Safety at The College of New Jersey (TCNJ) is achieved by providing a safe facility; sound policies, programs, and procedures; protective equipment; and appropriate education and training for all affected persons. The College's Office of Environmental Health and Safety has prepared this Campus Chemical Hygiene Plan as required by 29 CFR 1910.1450 (Occupational exposure to hazardous chemicals in laboratories, referred to in this document as the "Laboratory Standard"), N.J.A.C. Title 8:59 (New Jersey Worker and Community Right to Know Act Rules), and N.J.A.C. Title 12:100-7 (Standard for Hazard Communication), with the OSHA Globally Harmonized System, 29 CFR Parts 1910, 1915, and 1926 to ensure the safe use of hazardous chemicals in the laboratory. Some provisions of the Laboratory Standard require:

- Chemical fume hood evaluations;
- Establishment of standard operating procedures for routine laboratory operations;
- Research protocol safety reviews;
- Employee exposure assessments;
- Medical consultations/exams and/or recurring monitoring;
- Employee training;
- Labeling of chemical containers; and/or,
- The management of chemical safety information sheets (Safety Data Sheets) and other safety reference materials.

General laboratory guidelines incorporated in this program were collected from the National Research Council's (NRC) 1995 of "Prudent Practices in the Laboratory: Handling and Disposal of Chemicals" and their 2011 edition of "Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards". Any exceptions to the normal procedures outlined in this document must be approved by the Office of Environmental Health and Safety.

Affected laboratory users who are exposed or potentially exposed to hazardous chemicals, are required to comply with all the provisions outlined in this program. Any laboratory user who fails to adhere to the procedures contained within this document will be subject to disciplinary action, up to and including, termination of employment.

This program from the Office of Environmental Health and Safety (EHS) is to serve as a campus-wide chemical hygiene plan for basic hazards. Each department at the College shall develop their own Chemical Hygiene Plan (specific to their department and/or specific to each laboratory) to meet the specification requirements of employee and student protection. The departmental plan shall include procedures for adhering to their Chemical Hygiene Plan. The Laboratory Safety Manager, from the Office of Environmental Health and Safety (EHS), serves as the Chemical Hygiene Officer for this Campus Chemical Hygiene Plan. Both the Industrial Hygiene Manager and the Director of EHS serve as back up Chemical Hygiene Officers.

Members of the Laboratory Safety Committee have direct access to the Campus Chemical Hygiene Plan through shared access.

Purpose and Scope

This Campus Chemical Hygiene Plan documents our laboratory safety program, including the methods, practices and information necessary to protect all laboratory users from basic hazards of laboratory

chemicals. Many materials used by scientists, artists, and craftspeople can be hazardous to human health and the environment. Adverse health effects can include respiratory and skin irritation and allergies, cancer, acute and chronic poisoning, reproductive disorders, and other injuries and illnesses. Many solvents, thinners, varnishes, lacquers, and resins are flammable and may be toxic by inhalation, ingestion, injection, and/or skin absorption. While scientists, artists, and craftspeople may not develop serious health problems working with hazardous chemicals, there is still a strong potential that severe problems could develop. Therefore, it is important to understand that laboratory users can safely utilize many materials and processes, as long as appropriate safety precautions are followed.

Please note that any change in use to a space must be reviewed by the appropriate parties. An example is changing a classroom space into a laboratory space. A review of the space will be completed, usually by an engineer, to determine if the required ventilation controls are met for each piece of equipment and/or activity. Additionally, there may be electrical requirements (e.g. emergency shut-offs, etc.), necessary safety equipment (eyewash, showers, etc.), among other items. All areas are responsible for coordinating a change in space with the College's Office of Planning, Design, and Construction.

Any mention of "working" in a laboratory, throughout this plan, will encompass students, employees, visitors, and contractors, among others laboratory users. The implementation of this Campus Chemical Hygiene Plan is intended to provide laboratory users with the information and training necessary to maintain workplace safety and health, a safe learning and teaching environment, and to prevent chemical-related injuries and illnesses. The basic content of this Campus Chemical Hygiene Plan is compatible with general knowledge of laboratory operations and regulations.

Any exceptions to the normal procedures outlined in this document must be approved by the Associate Vice President for Facilities Management, or her/his designee.

Any employee who fails to adhere to the procedures contained within this document may be subject to disciplinary action, up to and including, termination of employment.

DEFINITIONS

Action Level – A concentration designated in 29 CFR 1910.1450 for a specific substance, calculated as an eight (8) hour time-weighted average (TWA), which initiates certain required activities such as exposure monitoring and medical surveillance.

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

Chemical Hygiene Plan (CHP) – A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment, and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) capable of keeping exposures below exposure limits.

The following elements shall be included in a Chemical Hygiene Plan:

Individual Chemical Hygiene Responsibilities.

Standard Operating Procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals.
Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including, in order: engineering controls, hygiene practices, and the use of PPE.
Particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous.
A requirement that fume hoods and other protective equipment are functioning properly, and specific measures that shall be taken to ensure proper and adequate performance of such equipment.
Provisions for employee information and training.
The circumstances under which a particular laboratory operation, procedure, or activity shall require prior approval from the laboratory supervisor before implementation.
Provisions for medical consultation and recurring medical monitoring, as is necessary, according to TCNJ's Injury and Illness reporting policy.
Designation of personnel responsible for implementation of the Chemical Hygiene Plan, including the assignment of a Chemical Hygiene Officer, and if appropriate, establishment of a Chemical Hygiene Committee.
Provisions for additional employee protection for work with particularly hazardous substances. These substances include select carcinogens (OSHA regulated carcinogen, on the list from the National Toxicology Program as known to be carcinogens, listed in Group 1 as a carcinogen to humans, and/or if it is in the IARC category of reasonably anticipated to be carcinogen Group 2A or 2B by IARC) or is under the reproductive toxins and substances which have a high degree of acute toxicity.

Department Laboratory Liaison – An employee designated by a department to monitor and enforce the campus and department Chemical Hygiene Plans**.** This employee is meant to act as a communication conduit between the department and the Chemical Hygiene Officer.

Designated Area - An area that may be used for working with select carcinogens, reproductive toxins, and/or substances that have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory, or an individual device (e.g. laboratory hood).

Emergency - Any occurrence, such as but not limited to, equipment failure, rupture of containers, or failure of control equipment which results in an uncontrolled release of a hazardous chemical.

Hazardous Chemical – Any chemical which is classified as a health hazard or simple asphyxiate in accordance with 29 CFR 1910.1200 (Hazard Communication Standard) and 29 CFR 1910.1450 (Occupational Exposure to Hazardous Chemicals in Laboratories).

Health Hazard – A chemical that is classified as posing one of the following hazards: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity; aspiration hazard. Further detail is in 29 CFR 1910.1200 and 1910.1200(c).

A chemical is considered a carcinogen or potential carcinogen if it is listed in any of the following publications (OSHA uses the term “select carcinogen”):

- National Toxicology Program, Annual Report on Carcinogens (latest edition)
- International Agency for Research on Cancer, Monographs (latest edition)

- Occupational Safety and Health Administration (OSHA), 29 CFR 1910, Subpart Z (Toxic and Hazardous Substances- 1910.1001 to 1910.1101)

A chemical is considered hazardous according to the OSHA standard if it is listed in any of the following:

- OSHA, 29 CFR 1910.1000 Table Z-1 through Z-3
- Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment, ACGIH (latest edition)
- The Registry of Toxic Effects of Chemical Substances, NIOSH (latest edition)

Over 600,000 chemicals are considered hazardous by the OSHA definition. In most cases, the chemical container's original label will indicate if the chemical is hazardous. Look for keywords such as “Caution”, “Hazardous”, “Toxic”, “Dangerous”, “Corrosive”, “Irritant”, “Carcinogen”, etc. Containers of hazardous chemicals acquired or manufactured before 1985 may not contain the appropriate hazard warnings. If you are not sure if a chemical you are using is hazardous, review the Safety Data Sheet (Safety Data Sheet) or the Hazardous Substance Fact Sheet (HSFS) for the substance, or presume it is hazardous and take all of the necessary precautions.

Laboratory – A facility where the “laboratory use of hazardous chemicals” occurs. It is an area where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory Supervisor – A faculty or staff person who trains laboratory users regarding chemical safety pursuant to the Chemical Hygiene Plan. This person also implements and enforces rules and standards. Attention to proper use of PPE, procedures, ventilation controls, and recordkeeping, are to be emphasized**.**

Laboratory use of chemicals – Handling or use of such chemicals in which all the following conditions are met:

1. Chemical manipulations are carried out on a “laboratory scale” (i.e., work with substances in which the containers used for reactions, transfers, and other handling of substances is designed to be easily handled by one person);
2. Multiple chemical procedures or chemicals are used
3. The procedures involved are not part of a production process, nor in any way simulate a production process
4. Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Laboratory User – Any user who is in a laboratory, whether they are actively working or not, shall follow all safe work practices, attend required training, and be familiar with the laboratory Departmental Chemical Hygiene Plan as well as the Campus Chemical Hygiene Plan

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

Permissible Exposure Limit (PEL) – For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory users’ exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z (Toxic and Hazardous Substances).

Physical Hazard - A chemical that is classified as posing one of the following hazardous effects: explosive, flammable (gasses, aerosols, liquids, or solids), oxidizer (liquid, solid, or gas), self-reactive, pyrophoric (gas, liquid or solid), self-heating, organic peroxide, corrosive to metal, gas under pressure, in contact with water emits flammable gas, or combustible dust. The criteria for determining these are in Appendix B of the Hazard Communication Standard (29 CFR 1910, parts 1200 and 1200(c)). In addition, there will be scientifically valid evidence that it is a combustible liquid, a compressed gas, an explosive, an organic peroxide, an oxidizer, or is pyrophoric.

Principal Investigator - The "PI" is the lead researcher for a project in a laboratory.

Protective Laboratory Practices and Equipment – Those laboratory procedures, practices, and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive Toxins - Chemicals which affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Chemicals classified as reproductive toxins in accordance with the Hazard Communication Standard (29 CFR 1910.1200) shall be considered reproductive toxins for the purpose of this section.

CHEMICAL HYGIENE RESPONSIBILITIES

Responsibility for chemical health and safety rests at all levels as indicated below.

Chemical Hygiene Officer

The EHS Laboratory Safety Manager serves as the Chemical Hygiene Officer for the entire TCNJ Campus. The Chemical Hygiene Officer oversees and manages the Chemical Hygiene Plan and has the following duties:

- Develop and implement College wide components of the Chemical Hygiene Plan to ensure consistent and well documented program procedures and policy decisions.
- Work with the chairpersons, laboratory supervisors, and departmental laboratory liaisons, to develop specific components of the Chemical Hygiene Plan. Special attention shall be given to the safe procurement, inventory, use, and disposal of chemicals.
- Advise laboratory supervisors on the implementation of all components of the Chemical Hygiene Plan and any specific concerns regarding the appropriate use of audits and employee training sessions.
- Conduct safety audits and follow-ups, and retain the documentation of such audits.
- Ensure that employees receive instructions and training on all necessary topics, such as but not limited to, safe work practices (initial and refresher), use of personal protective equipment, and the procedures for handling incidents involving toxic substances.
- Investigate incidents, and if applicable update or add procedures that mitigate the hazard and likelihood of recurrence.
- Ensure that action is taken to correct work practices and conditions that may result in the release of toxic chemicals.
- In addition, the Chemical Hygiene Officer will be responsible for knowing the contents of the relevant regulations (Occupational Exposures to Hazardous Chemicals in Laboratories, 29 CFR 1910.145, PEOSH Hazard Communication Standard (HCS), Globally Harmonized System,

N.J.A.C. 12:100-7 and NJ Right to Know Law, N.J.A.C. 8:59) and conduct any required updating of the Chemical Hygiene Plan as regulations require.
- Enforcing the restriction of personal pets not being allowed in laboratories.

TCNJ Departments

The Schools or Departments at TCNJ, which are required to implement this Chemical Hygiene Plan and any department specific Chemical Hygiene Plans, are as follows:

- School of the Arts and Communication
- School of Engineering
- School of Nursing and Health Sciences
- School of Science, Department of Biology
- School of Science, Department of Chemistry
- School of Science, Department of Physics
- TCNJ Center for the Arts
- Any other department conducting laboratory experiments or work

Each of these departments appoint a departmental laboratory liaison to enforce the Standard Operating Procedures within this Chemical Hygiene Plan and any Departmental CHP.

Laboratory Supervisor

The laboratory supervisor is most usually the individual that coordinates the teaching laboratories or the Principal Investigator (PI) for research laboratories. The laboratory supervisor has the responsibility, as defined in the OSHA Laboratory Standard and the TCNJ Campus Chemical Hygiene Plan to implement both the Campus Chemical Hygiene Plan and the Departmental Chemical Hygiene Plan, thus ensuring compliance with the regulatory requirements and maintaining a safe and healthful laboratory environment. The Laboratory Supervisor has the following duties:

- Ensure that all work is conducted in accordance with both the Campus and the Departmental Chemical Hygiene Plans.
- Train all laboratory users of specific hazards of their laboratory.
- Work with the Chemical Hygiene Officer to define the location of work areas where toxic substances will be used, and ensure that the inventory of these substances is properly maintained.
- Work with the Chemical Hygiene Officer to obtain, review, and approve standard operating procedures, detailing all aspects of proposed research and teaching activities that involve hazardous agents and/or practices not covered in the CHP.
- Report to the Chemical Hygiene Officer all incidents that cause (1) personnel to be exposed, or potentially exposed, to hazardous chemicals or materials, such as through the inoculation of a chemical through cutaneous penetration, ingestion of a chemical, or probable inhalation of a chemical, or that (2) constitute a danger of environmental contamination.
- Enforcing the restriction of personal pets not being allowed in laboratories.
- Make the approved Chemical Hygiene Plans available to employees.
- Supervise the performance of laboratory users to ensure the required chemical hygiene rules are followed.
- Ensure appropriate controls (engineering, administrative, and personal protective equipment) are available, used, and are in good working order.
- Obtain approval, when required, prior to using particularly hazardous substances (refer to Appendix B).

- Arrange for the proper labeling and disposal of unwanted and/or hazardous chemicals and materials.

HAZARD IDENTIFICATION

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

TRAINING & INFORMATION

Chemical Safety Training

All employees exposed, or potentially exposed, to hazardous chemicals while performing their laboratory duties must receive information and training regarding the OSHA Standard, the Campus Chemical Hygiene Plan, and laboratory safety for the specific laboratory(ies) being used or the Department Chemical Hygiene Plan. The training and information is provided upon employment and annually thereafter by EHS for the Campus Chemical Hygiene Plan.

The EHS training and information program shall include:

1. Methods and procedures for safely handling and detecting the presence or release of hazardous chemicals present in the laboratory.
2. Appropriate response in the event of a chemical emergency (spill, overexposure, etc.).
3. Chemical safety policies.
4. Applicable details of the Campus Chemical Hygiene Plan (such as the standard operating procedures for using chemicals).

The Departmental training and information program shall include:

1. Physical and health hazards of the classes of laboratory chemicals being handled
2. Chemical safety policies.
3. Applicable details of the Chemical Hygiene Plan (such as the standard operating procedures for using certain chemicals).
4. Training students and student workers for their Department Chemical Hygiene.

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

Every laboratory worker should know the location and proper use of the necessary protective clothing and equipment, and the emergency equipment and procedures. Information on protective clothing and equipment is contained in the Standard Operating Procedures (included within this Plan).

Chemical Safety Information Sources

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

1. The labels found on containers of hazardous chemicals
2. The substance's Safety Data Sheet (Safety Data Sheet)
3. NJ's Hazardous Substance Fact Sheet (HSFS)
4. Compliance based posted laboratory signs

Container Labeling

All containers of hazardous chemicals which could pose a physical or health hazard to an exposed employee must have a label attached. The labels must comply with applicable regulations, NJ Right to Know and PEOSH Hazard Communication Standard, as well as the Globally Harmonized System (GHS). Most labels will provide additional safety information, including but not limited to personal protection while working with the substances or products. This includes protective measures to follow when handling the material, clothing that should be worn, first aid instructions, storage information, and procedures to follow in the event of a fire, leak or spill.

If a container is found without a label, it must be reported to the supervisor. In addition, an individual that finds any label that is torn or illegible shall report it to their laboratory supervisor, so that the label can be replaced immediately, or marked for hazardous waste disposal if not being used. Existing labels on new containers of hazardous chemicals must never be removed or defaced, unless the container has been emptied and cleaned. If a worker uses secondary ("child") containers, that will take more than one work shift or scheduled laboratory time to empty, or if there is a chance that someone else will handle the container before it is finished, it must be labeled, as specified below. This is every laboratory user's responsibility to help protect other laboratory users and co-workers. Prior to using newly purchased chemicals, read the label, as it is possible the manufacturer may have added new hazard information or reformulated the product since the last purchase, and thus altered the potential hazards while working with the product.

All employees involved in unpacking chemicals are responsible for inspecting each incoming container to ensure that it is labeled with the proper information (as listed above). Notify the Designated Laboratory Liaison and/or laboratory supervisor if containers do not have proper labels.

The Office of EHS has developed a labeling guide specially for the unique laboratory setting. Please utilize the guide (for containers with and without hazards for proper labeling.

Safety Data Sheets and Right to Know

A Safety Data Sheet (SDS) is a detailed informational document prepared by the manufacturer or importer of a hazardous chemical which describes the physical and chemical properties and hazards of the substance or product. Hazardous Substance Fact Sheets are available from the Right to Know Program, and will provide information about chemicals. Information included in a Safety Data Sheet (SDS) and Hazardous Substance Fact Sheet (HSFS) aids in the selection of safe products, helps employers and employees understand the potential health and physical hazards of a chemical, and describes how to respond effectively to exposure situations.

Posted Laboratory Signs

The following signs and information shall be posted prominently and clearly in each laboratory:

- Telephone numbers of emergency contacts and laboratory supervisors OR the Red Emergency Preparedness Procedures Guide from Campus Police.

- Signs identifying locations for safety showers, eyewash stations, other safety and first aid equipment, and exits.
- Warnings at areas or equipment where special or unusual hazards exist, such as lasers and radioactive sources.

STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOPs) must be followed when laboratory work/research involves the use of hazardous chemicals. In addition to the following generic laboratory procedures, each department shall develop standard operating procedures specific to their operation. Include engineering controls, safe work practices, and selection and use of personal protective equipment in the procedures.

1. General Laboratory Procedures

Failure to follow these rules and procedures may result in injury and property damage.

- Perform only authorized procedures, with all appropriate safety equipment in place and functioning properly. Prior to beginning any new operation, know the safety rules and procedures, the potential hazards (e.g., chemical and/or physical), and appropriate safety precautions that apply to the work that is being done.
- No eating, drinking or applying cosmetics in the labs.
- No mouth pipetting of chemicals.
- Variation from standard procedures should be subjected to review by peers and/or Department Chairpersons to ensure that adequate safeguards are in place.
- If the proper equipment is not available to safely perform a task, do not improvise or alter available equipment, as this may increase the chance of injury or illness.
- Know the location of and how to use the emergency equipment in your area, as well as how to obtain additional help in an emergency.
- All workers must be familiar with emergency and evacuation procedures of the building(s) in which they work.
- All laboratory users and bystanders must remain out of the area of a fire or personal injury unless it is part of their responsibility to help resolve the emergency.
- Be alert to unsafe conditions and actions, and immediately call attention to them so they can be mitigated as soon as possible.
- Post warning signs at laboratory entrances and in affected areas of the laboratory when hazards exist, such as lasers, radioactive materials, chemicals of high acute toxicity, or other special hazards.
- Avoid behavior that might distract or startle other workers.
- For reasons of safety and security, it is prudent to avoid working alone in any laboratory, particularly after normal classroom hours. The department or the laboratory supervisor is responsible for teaching all lab users on using “the buddy system” and implementing procedures to provide for emergency notification and periodic checks of an individual working “alone” in the laboratory. This procedure must include the confirmation of the person(s) arrival and departure from the laboratory. The extent of the procedures is dependent on the nature of the laboratory work and the degree of potential hazard. For emergencies Campus Police should be notified at 609-771-2345 from a cell number if the campus is closed, and 911 from a campus hard-wired phone.

2. Health and Hygiene

- While in a laboratory, all laboratory users must wear safety glasses, which meet the requirements of the ANSI Standard for safety glasses (i.e., side shields in place, impact resistant lenses marked with Z-87 or similar, etc.). Safety glasses, or other PPE, are not allowed in write up rooms.

- Confine long hair (shoulder length or longer), loose clothing (including bell sleeves), and jewelry when in the laboratory.
- Never wear open-toed shoes in the laboratory.
- Wear protective laboratory coats whenever working in a BSL 1 or BSL 2 laboratory.
- Immediately remove and replace laboratory coats upon significant contamination.
- Never mouth pipette chemicals or use mouth to start a siphon; use a pipette bulb or an aspirator to provide vacuum.
- Avoid exposure to gasses, vapors, and aerosols. Use appropriate safety equipment whenever such exposure is likely, such as a fume hood or safety cabinet.
- Always use a laboratory fume hood to conduct operations involving hazardous chemicals.
- Immediately report any signs or symptoms of overexposure to the Department Chairperson, Human Resources and other appropriate individuals. Refer to Safety Data Sheets and labels for information regarding such signs or symptoms. If such signs or symptoms are reported, or when an incident occurs, the Department Chairperson and/or Chemical Hygiene Officer will evaluate the incident and, if appropriate, will make recommendations regarding the need to update the requirements for personal protective equipment and/or controls and/or changes in procedures to reduce actual or potential exposures.
- Properly remove laboratory coats and other personal protective equipment (gloves, goggles, Tyvek garments) prior to leaving the laboratory for any reason, other than to move between laboratories and to transport chemicals to another laboratory.
- Wash hands thoroughly, with soap and warm water, after removing personal protective equipment
- Do not use solvents for skin washing. Washing with a solvent can cause dermatitis and facilitate absorption of a toxic chemical.
- Lab coats shall remain in the laboratory unless being exchanged for clean apparel or walking to other laboratories.
- Gloves should not be worn outside the laboratory, except when transporting chemicals to another laboratory or waste collection area.
- When transferring a hazardous material or agent from one laboratory to another laboratory, personnel will place the material in a clean uncontaminated container, remove and discard their gloves, wash thoroughly and then proceed.
- If laboratory users may be required to do any additional work on a material at a different location, they should either bring a clean pair of gloves with them or obtain a clean pair of gloves at their destination.
- Smoking is not permitted in any TCNJ facility.
- Do not eat, drink, smoke, chew gum, or apply cosmetics in the laboratory.
- Do not store food, drinks, chewing gum, personal medicines, cosmetics, or handbags, among other items, in laboratory areas.
- Do not bring household pets to the laboratories.
- Do not use laboratory glassware or utensils for eating or drinking.
- Do not store food or beverages in laboratory refrigerators, ice chests, or cold rooms.
- Do not store laboratory samples in office areas or in refrigerators used to store food. To avoid confusion, label refrigerators, ice chests and cold rooms with regard to item storage.
- Do not use laboratory trash cans for food and drink disposal.

3. Laboratory Chemical Fume Hoods

Removal of air contaminants at the source is the most effective, as well as the most energy efficient, method of preventing chemical exposure. Laboratory fume hoods are the most common equipment for controlling gasses, vapors, and airborne particulates in laboratories. Other local ventilation devices such as ventilated storage cabinets, canopy hoods, and flexible ducts will be provided as needed.

- Use laboratory fume hoods for all operations likely to emit hazardous levels of chemicals, dusts, irritants, and/or nuisance odors. Do not use re-circulating or non-exhausted hoods to control toxic vapors or gasses.
- Keep hood bench space clean and uncluttered in order to perform operations safely.
- Overcrowding a hood with bulky apparatus or placing bottles in front of the rear baffle seriously interferes with good capture and must be avoided.
- Store materials in a hood only when absolutely necessary. If large objects must be present in the hood, they should be mounted on blocks to permit air to pass underneath.
- A properly functioning fume hood minimizes the build-up of flammable vapor in air concentrations during routine laboratory solvent operations (e.g., reflux, heating in open containers). The potential for flammable vapor concentrations may exist during non-routine activities (e.g., pouring operations, spills). Most electrical laboratory equipment (e.g., hot plates, stirrer motors, heating mantles) used in chemical fume hoods is not explosion proof and thus has the potential to generate sparks.
- The risk of fire/explosion can never be eliminated. Researchers must be cognizant of this potential hazard. This risk can be reduced by turning off electrical laboratory equipment when not in use, minimizing the quantities of flammable solvents handled and/or stored, and being careful to prevent potential spills.
- Electrical outlets located outside the chemical fume hood are not considered potential ignition sources.
- The use of electrical outlets inside fume hoods may be prohibited in certain circumstances and should be avoided whenever possible. Their use is prohibited inside fume hoods that handle large volumes of flammable solvents (e.g., 12-liter reaction vessel or greater). If a surge protector must be used inside hoods, they should be positioned outside the immediate work area (i.e., to minimize direct contact with a liquid splash). Electrical plugs must not be inserted or removed from these strips while flammable solvents are being handled (e.g., pouring). Electrical equipment to be used in hoods will be safe for its intended use.
- Electrical wires or tubing exiting the hood must route under existing aluminum sills, if possible.
- Work must be performed at least six inches from the hood's sash. Do not place any object on the airfoil.
- The sash of the fume hood should be positioned at the height marked during fume hood testing. The sash should never be left in a fully open position, except temporarily when moving equipment into or out of the hood.
- Check your specific fume hood for proper ventilation. Older style fume hoods will show a face velocity reading of 80-FPM (feet per minute) or less which is an indication that the hood is not performing adequately.
- In Chemistry Addition and STEM the low flow fume hoods and air handlers operate constantly. When the hood is closed the alarm light will be yellow, and when the sash is opened the alarm light will turn green. If the hood does not have enough exhaust flow, the alarm light will turn red, and an audible alarm will sound. Please contact Facilities immediately for fume hoods to be addressed.
- Check the date on the sticker to ensure that the hood has been tested within the last year. If it has not been tested within the last year, label the hood "DO NOT USE" and notify the

Chemical Hygiene Officer. The hood should not be used until it has been approved for use. Please notify Facilities with any issues.

- Be alert to signs of potential hood problems. These include, increases in odors from chemicals being handled within the hood, changes in sound (loudness or pitch), or obvious reductions or variations in air flow. If any of the above signs occur, report the problem to Facilities. The hood should not be used until it has been repaired and approved for use.
- Do not bypass or "tape–off" the fume hood alarm system. If a problem exists, immediately report it to Facilities.
- Do not allow amounts of solvents or hazardous wastes to evaporate under the hood. Use solvent disposal cans or other appropriate disposal methods.
- If the hood fails while performing an experiment with a hazardous substance, the researcher will shut down the experiment, if possible lower the hood/sash completely, alert all laboratory users to and evacuate the room, if necessary, and close all doors to the room. Do not re-enter the room without adequate protection until the atmosphere is safe. Immediately report the problem to Facilities. The hood should not be used until it has been repaired and approved for use.

4. Good Housekeeping

- Keep laboratory areas, storerooms, service rooms, aisles, and floors clean, dry, and free from obstructions.
- Do not use stairways and hallways as storage areas.
- Do not block access to exits or to emergency equipment such as eyewashes, showers, or fire extinguishers.
- Store equipment and chemicals properly. Clean up the work area following the completion of any operation or at the end of each day/shift/class.
- Keep reagent bottles and equipment properly labeled at all times.
- At the end of each shift, label all containers.
- Promptly dispose of unlabeled containers, chemical wastes, and excess or out of date reagents by using appropriate procedures in accordance with the TCNJ Hazardous Waste Program. Such materials, as well as chemicals that are no longer needed, should not be permitted to accumulate in the laboratory.
- Properly clean up spilled chemicals immediately, and properly dispose of the cleanup materials used.
- Do not dispense liquids from overhead.
- Label equipment that functions at temperature extremes with hot or cold warning labels.

5. *Occupational Laboratory Procedures for Building Services*

- Sweep, mop, wash the floors, and remove normal trash bags from any laboratory.
- Rooms which have a "Caution" sign, or other warning sign, may contain materials or equipment which, if used improperly, may cause harm.
- Do not touch any material, container, or waste container with a universal biohazard symbol or radiation symbol on it. Please refer to the TCNJ Regulated Medical Waste and Radiation Safety Programs for more information.
- Do not touch, disturb, move, or handle any containers of any chemicals or materials, except those issued to you by your supervisors in Building Services. If chemicals need to be moved to do work, contact your Building Services supervisor.

- If the contents of any containers belonging to the laboratory are spilled, DO NOT TOUCH THEM OR ATTEMPT TO CLEAN THEM UP. The Building Services employee shall notify their supervisor, who will then contact emergency response.
- When there is an active experiment running, personally protective equipment, such as safety glasses must be worn. A Building Services employee may choose to wear safety glasses, even if there is not an active experiment occurring.
- Eating, drinking, smoking, or applying cosmetics in a laboratory is prohibited.
- Direct questions to the following individuals, in the following order: Supervisor, Operations Manager, Director, and the EHS Lab Safety Manager.

6. *Occupational Laboratory Procedures for Facilities Staff and Contractors*

- Rooms which have a "Caution" sign, or other warning sign, may contain materials or equipment which, if used improperly, may cause harm.
- Do not touch any material, container, or waste container with a universal biohazard symbol or radiation symbol on it. Please refer to the TCNJ Regulated Medical Waste and Radiation Safety Programs for more information.
- Do not touch, disturb, move, or handle any containers of any chemicals or materials. If chemicals need to be moved to do work, contact your supervisor.
- If the contents of any containers belonging to the laboratory are spilled, DO NOT TOUCH THEM OR ATTEMPT TO CLEAN THEM UP. Notify the supervisor and or emergency Campus Police for emergency response.
- When there is an active experiment running, personally protective equipment, such as safety glasses must be worn. An employee may choose to wear safety glasses, even if there is not an active experiment occurring.
- Eating, drinking, smoking, or applying cosmetics in a laboratory is prohibited.
- Direct questions to the following individuals, in the following order: Supervisor, Director, Principal Investigator, and EHS
- EHS will establish and the appropriate shops will conduct a regular maintenance program to verify that safety equipment (i.e., eyewashes, showers, spill kits, fire extinguishers, etc.) is in working condition and compliant.
- All mechanical equipment shall have the necessary guarding, to protect the user and to prevent unauthorized access, such as to electrical connections or moving parts (e.g. belts, pulleys, etc.).
- Inspect equipment before using it to ensure that the guards are in place and functioning properly.
- Know the location of emergency shutoff devices before operating.

7. *Glassware*

- Store glassware so that it is reasonably protected against accidental breakage. Inspect all glassware before use and properly discard damaged items.
- Use adequate hand protection when placing any tubing on glass hose connections. Use plastic or metal clamps to secure the connection where possible.
- Obtain proper instruction from the Lab Supervisor or PI in the use of glass equipment designed for specialized tasks, which can represent unusual risks for the first-time user.
- Do not put a vacuum on a glass vessel unless it is designed for vacuum service. Guard glass vessels under vacuum by a shield (e.g., wire mesh cage) and/or by placing it in a hood. Handle vacuum jacketed glass apparatus with extreme care to prevent implosions.

Tape or shield equipment, such as Dewar flasks and roto evaporators, to prevent dispersion of glass fragments in the event of an implosion or explosion.
- Position and clamp reaction apparatus in order to permit manipulation without the need to move the apparatus until the entire reaction is completed. Combine reagents in appropriate order, and avoid adding solids to hot liquids.
- Thoroughly rinse glassware or equipment containing corrosive or noxious substances before discarding or placing in the dishwasher.
- Never pick up broken glass with bare hands. Sweep small pieces into a dust pan using a brush.
- Always use the proper receptacles to dispose of broken glassware. Never dispose of glassware in the waste paper or trash receptacles.
- Heated glass containers should be handled using heat-resistant gloves.
- Glassware that is to be heated must be Pyrex or a similar heat-treated type of glass.
- Remember that heated glassware looks cool several seconds after heating but can still burn skin.
- Beakers, flasks, and bottles should be protected by wire gauze when heating by direct flame.
- Beakers or flasks of over 1 liter must not be heated by flames or placed into direct contact with a hot plate.
- Avoid heating soft glass vessels by any means.

8. *Laser Equipment*

TCNJ has class 3B and class 4 lasers on campus. All lasers must be operated in a laser-controlled area. The minimum requirements for laser-controlled areas are:

- Entryway controls to allow only authorized personnel or approved spectators to enter the laser control area. (Administrative controls are acceptable)
- Laser safety eyewear available and used in accordance with the SOP for class 4 lasers.
- Beam control (barriers and beam blocks) to limit laser hazards within the controlled area.
- Written SOP for class 4 lasers.
- Training of operators of all class 3B and 4 lasers.
- Approved warning signs must be posted in areas where Class 3B and class 4 lasers are being used.
- Illuminated warning signs must be posted in areas where Class 3B and class 4 lasers are in use.
- Red warning light must be turned on when the laser is in use.

As described in the TCNJ Laser Program, any person interested in adding a new laser, must be in contact with the Laser Safety Officer (EHS Lab Safety Manager) prior to any purchase.

TCNJ has Class 2, 3, and 4 laser equipment in select laboratories. The TCNJ Laser Safety Officer has the responsibility and authority to assure departmental compliance with the Laser Safety Program. The principal requirements of the program and the Laser Safety Officer are:

- Perform hazard evaluations for all Class 3B and 4 lasers and laser work areas
- Specify control measures for all Class 3B and 4 lasers and assure implementation of such measures
- Approve SOP's, protective equipment, signs, and labels
- Assure that all laser personnel receive appropriate safety training

- Monitor the program and assure compliance
- Maintain program and training records
- Maintain a current copy of ANSI Z136.1

9. Use and Disposal of Sharps

- The techniques for handling syringes and needles will vary with size and with the liquid being handled.
- Never recap, clip, or bend/break needles. Dispose of needle/syringe immediately after use in a properly designed and labeled sharps disposal container. (The table in the following section describes proper containers for laboratory waste)
- Do not fill a syringe beyond its graduated capacity. With a slurry containing solid particles, do not fill the syringe more than halfway.
- The working pressure limits for glass syringes vary with diameter. Use large bore needles (e.g., #15 or #16 (the larger the number, the smaller the bore size)), to ensure that high pressure syringing of solutions is minimized. However, the larger the bore, the more likely it is for the needle to drip.
- Because many syringes are made of soft glass, never heat them above 250° F (120° C) at any time, and never chill or heat them suddenly.
- Use hypodermic needles with caution. Choose the shortest available needle that will serve the purpose, as it is less likely to bend or break. Do not leave the point of a needle exposed.
- Store syringes and needles in a secure manner.
- Handle scalpel blades with extreme caution. Use pliers when changing blades, if possible. Dispose of used blades in the sharps disposal container.
- All other sharps (e.g., glass, pipettes, broken glassware, etc.,) shall be disposed of in the appropriate containers. Ensure that sharps do not pose a risk to the waste material handlers or other laboratory personnel.

10. Guide for laboratory waste and their associated process

Type of Laboratory Waste	Waste Process
Paper towels used to dry hands after removing gloves and washing hands.	Regular trash container
Notebook paper	Recycling container
Animal carcasses	Set aside for collection with the hazardous waste
Clean glass (broken or whole)	Cardboard glass boxes
Liquid waste	Containers with liquid waste, segregated into: -Non-halogenated organic -Halogenated organic -Label contents with percentages
Contaminated gloves and paper towels	Lab contaminated debris is to be separated from the regular trash and placed for the hazardous waste collection
Solid chemicals Weigh boats/paper Pipette tips Contaminated glass	Lab contaminated debris is to be separated from the regular trash and placed for the hazardous waste collection

Silica gel Plastic test tubes Plastic multi-well plates Other solid waste items	
Needles Syringes Plungers for syringes Razor blades Other sharps	Sharps disposal containers or anything with the universal biohazard symbol and are truly Regulated Medical Waste will need to be scheduled with EHS for proper disposal.

11. Electrical Equipment

- A qualified electrician must install all fixed building wiring.
- Surge protectors and power strips that offer over-current protection (e.g. circuit breaker or fuse) are allowed. Multi-plug adapters and power strips without over-current protection are prohibited.
- Extension cords may only be used while an individual is present in the room. As this requires the extension cord to be unplugged at night, as well as other times, extension cords are usually not a feasible alternative to surge protectors.
- Surge protectors, power strips that offer over-current protection, and extension cords may only be plugged directly into a wall outlet. Never daisy chain, by plugging any of these items into each other.
- Inspect wire insulation and plugs periodically. Do not use damaged equipment or equipment with cracks in the wire insulation; report this equipment to the Department Chairperson. Never attempt to repair a damaged electrical cord.
- Keep all equipment and hands dry while handling electrical equipment. Use grounded outlets only. Protect electrical connections and appliances from water. Avoid using electrical equipment in or adjacent to laboratory sinks.
- Report any electrical failure or evidence of undue heating of equipment immediately to Facilities.
- Only properly trained personnel are authorized to work on electrical equipment.
- Never remove or defeat a Lockout/Tagout (LOTO) device, designed to prevent operation of equipment, unless you installed it.

12. Flammability Hazards

- Minimize use of electrical equipment, such as mixers or hot plates, around flammable solvents. Make sure electrical equipment used near flammable vapors is explosion proof.
- Do not use an open flame to heat a flammable liquid or to carry out a distillation under reduced pressure.
- Only use an open flame when necessary, and properly extinguish it as soon as it is no longer needed. Before lighting a flame, remove all flammable substances from the immediate area. Notify other laboratory users.
- Store flammable materials properly, such as within a closed and latched flammable cabinet.

13. Cold Traps and Cryogenic Hazards

Cryogenic fluids are liquefied gases that boil at -100° C or below. They are shipped and stored at low pressures in special insulated vessels. Liquid nitrogen is a cryogenic fluid that is commonly used in the laboratory. Oxygen sensors, or other air monitoring devices, may be necessary when gas cylinders, such as Nitrogen, are used or stored in labs or rooms. Liquid hydrogen and liquid helium are available for specialized laboratory operations.

The primary hazard of all cryogenic materials is their extreme coldness, which can cause frostbite if allowed to be exposed to skin. Additional hazards include fire, explosion, pressure buildup, and asphyxiation, since small quantities of these liquids/solids can be converted into large amounts of gas. A spill of any cryogenic material boils rapidly and releases large volumes of gas into the atmosphere. Hydrogen is highly flammable; oxygen can cause combustible materials to burn violently or explode. Massive amounts of nitrogen, helium, or other inert gas can displace oxygen and cause asphyxiation.

- Ensure that the container vents are free of obstruction at all times when working with cryogenic fluids, as they can develop extremely high vapor pressures if warmed. Be aware that water vapor can freeze in the outlet and obstruct the vent, causing excessive pressure to build up.
- An approved safety relief valve must be installed in the supply line or vessel if the possibility of trapped cryogenic fluids exists. This may help to vent any pressure buildup. The safety relief valve must be positioned in the direction of the nearest wall, so that it is not the path where someone may walk.
- If liquid nitrogen is exposed to the air, it will condense oxygen to a blue layer of liquid oxygen on the surface, and possibly on the outside of the container. If this blue color is observed, discard the material carefully (avoiding combustibles) and use fresh liquid nitrogen, if necessary. Liquid oxygen can cause spontaneous combustion or form explosive peroxides with organic materials.
- Extremely low temperatures can cause severe frostbite. Before working with cryogens, review the Safety Data Sheet to determine hazards and proper handling, and necessary precautions. Also, discuss hazards and proper procedures with the Department Chairperson.
- Eye and hand protection is required; protective aprons may be needed as well.
- Follow these procedures when working with cryogens:
    - DO wear proper eye and hand protection (insulated gloves).
    - DO use a face shield whenever there is any potential for splashing.
    - DO work with adequate room ventilation.
    - DO use adequate ventilation such as a fume hood whenever using large quantities of cryogenic materials. Most liquefied gases expand at least 750 times as they change from a liquid to a gas, and as a result, can displace breathing air.
    - DO avoid gases and vapors emitted by cryogenic materials. They are cold enough to damage the delicate tissues of the eyes.
    - DO handle cryogenic fluid containers with great care.
    - DO use tongs to move objects in contact with or immersed in cryogenic liquids. Never use your hands even if you are wearing protective gloves.
    - DO use only materials that can withstand very low temperatures, since many materials, including human skin, become very brittle when exposed to cryogenic liquids.
    - DO shield Dewar flasks, by wrapping in friction tape or using an outer protective device designed to reduce the hazard of flying glass in case of collapse.
    - DO keep vents open.
    - DO watch for the blue color indicating condensed oxygen.

- DO add dry ice slowly to the liquid portion of the cooling bath to avoid foaming over.
- DO NOT shake or bump cryogenic liquid containers.
- DO NOT touch cold fittings or lines or un-insulated storage vessels without gloves.
- DO NOT lower your head into a container of dry ice.
- DO NOT use liquid nitrogen or liquid air to cool a flammable mixture in the presence of air, because oxygen can condense from ambient air, leading to an explosion hazard.
- DO NOT vaporize large quantities of cryogenic liquid in a closed room.

14. Systems under Pressure or Vacuum

- All evacuated containers must be regarded as potential implosion hazards.
- Check all glassware used in the vacuum system for cracks, chips, or other problems that may weaken the glassware. Do not use any defective glassware.
- Shield Dewar flasks by wrapping in fiber-reinforced friction tape or using an outer protective device designed to reduce the hazard of flying glass in case of collapse.
- All glass vacuum desiccators must be shielded or wrapped in friction tape in a grid pattern.
- Completely close the fume hood sash and/or use a safety shield when evacuating any container.
- Do not allow water, solvents, or corrosive gases to be drawn into the building vacuum system. Use an appropriate trapping set-up to collect any substance that may be drawn off into the building vacuum system. Use a water aspirator for vacuum if water or corrosive (acid) gases are likely to be drawn off. Do not use the water aspirator for organics.
- Do not carry out reactions or apply heat to closed systems unless they are specifically designed for that purpose. Set up closed-system equipment in a hood if the reagents or reaction products are toxic.
- Check the pressure relief devices on pressure systems before using equipment. Relieve vacuum or pressure in all parts of the system before opening the apparatus.
- High Vacuum Systems: Always anticipate that water may be present in the line due to the method of generating high vacuum (steam ejectors). Never use the high vacuum system with water reactive chemicals due to the possibility of water in the line.
- Mechanical Vacuum Pumps: Protect the pump by using a trap to collect any substance that is drawn off. Vent the exhaust into a fume hood. Change the oil before further use if solvents or corrosive substances are inadvertently drawn into the pump. Keep the guard covering the belt and pulleys in place at all times during the operation.

15. Environmental Rooms, Refrigerators, Freezers and Incubators

- Assure that cold rooms or walk-in refrigerators, freezers, incubators, and other "environmental chambers" used for storing and preserving samples conform to National Fire Protection Association (NFPA) codes. These rooms must have a door latch that requires little strength or dexterity to open from the inside or outside. View windows should remain unobstructed. Equip cold rooms with suitable lighting and emergency lighting to facilitate evacuation.

- Chemicals stored in refrigerators, freezers, and environmental rooms shall be in closed containers. Stored materials shall be capped to be vapor tight and spill-proof whenever possible. Uncapped or unlabeled containers are not allowed.
- Dry ice cannot be stored in walk in freezers or in "cold rooms" because following sublimation it may displace sufficient oxygen, resulting in an oxygen deficient environment, which is "Immediately Dangerous to Life or Health".
- Environmental rooms, such as "warm" and "cold" rooms, are not ventilated. Hazardous material use in these rooms must be used or stored in very limited quantities. Therefore, storage of volatile toxic or flammable liquids, CHO approval gases, potentially explosive compounds, and extremely toxic compounds is not allowed in environmental rooms. Experiments or research activities involving chemicals shall not be performed in these rooms. Extreme care must be utilized to avoid hazardous material spills. Campus Police Services must be notified of any significant spill.
- Electrical equipment operated in an environmental room must be grounded and any electrical cords must be waterproof. High humidity conditions require the use of ground-fault circuit interrupters (GFCI).
- Environmental rooms shall be thoroughly cleaned annually and immediately after any significant contamination.
- Incubators can become the inadvertent and undesired repository of microorganisms because of their warmth and humidity. Moist surfaces, rubber gaskets, and fan mechanisms are among the areas in which microorganisms thrive. Although that can present a hazard to laboratory workers, they are also a source for contamination of cultures. Removable parts (e.g., trays) shall be autoclaved at least quarterly. Non-removable parts (i.e., interior) shall also be disinfected quarterly.
- Attention to vapors which may escape from improperly sealed containers, is necessary, especially when stored in incubators. If the vapors are toxic, an individual peering in to the incubator to find a container may be briefly exposed to above acceptable safe levels. If the material does not have a distinctive or offensive odor, the person using the unit may not even know they were potentially exposed or that a problem exists.
- If flammable vapors accumulate in a household-type refrigerator or freezer (i.e., not explosion proof), a major explosion and fire could occur.
- Refrigerators/freezers, which have been commercially designed to be safe for the storage of flammable materials, are designated as "Flammable Material Storage Units". The interior of these units is free from components that may spark. It is strongly recommended that all laboratory units, with the exception of ultra-low temperature units (which operate at temperatures lower than the flash points of any commonly used flammable liquids), be of the flammable material storage unit type. These must be labeled similar to: "CAUTION: This refrigerator or freezer is appropriate for safe storage of flammable liquids."
- Explosion-proof refrigerators and freezers not only protect against flammable vapors inside the unit, but are also designed to be operated in rooms that have a potentially explosive atmosphere around the unit as well. These are not necessary for solvent storage under ordinary circumstances.
- All laboratory units must be labeled similar to: "CAUTION: Do not use this equipment for storage or preparation of food or beverages."
- Freezers shall be defrosted at least annually, and the resulting water must be collected/contained. This allows for the removal of built-up ice that can compromise performance and for the review and removal of unneeded and damaged materials and contaminants.
- Do not lean into a freezer, especially if dry ice or liquid nitrogen is used for cooling.
- Visits to walk-in freezers should be brief; less than 15 minutes is suggested.

16. Thermometers

- Do not use unprotected mercury thermometers in drying ovens. Thermometers used in ovens and other heated equipment may be a dial type, using a bimetallic strip for sensing. Other suitable temperature sensors are thermocouples and metal bulb devices. If a mercury thermometer must be used, it should be in a metal well with oil for heat transfer. Mercury thermometers that are secured by specially engineered holders and part of a manufacturer's original piece of equipment are acceptable for use.
- Make provisions and be ready to control mercury spills when using thermometers and mercury filling devices such as barometers, manometers, gauges, etc. Use a mercury vacuum or spill pad for efficient spill cleanup and notify the Department Chairperson, then the EHS Chemical Hygiene Officer that a spill occurred.

17. Unattended Operations

- Conduct unattended laboratory operations, including robotic processes, only after review with the Department Chairperson.
- Design unattended operations to be safe in the event of failure of utility services such as electricity, water, and/or inert gas.
- In all cases place an appropriate sign on the door.

18. Flammable and Combustible Liquids

- The storage and handling procedures for flammable and combustible liquids are detailed in NFPA 30 and OSHA 29 CFR 1910.106. They require special precautions during storage, use, and handling. Allowable container sizes and quantities are based on the degree of the hazard (i.e., the "class" to which the liquid belongs as defined by NFPA). In paragraph (d)(3) of 29 CFR 1910.106, OSHA specifies that not more than 60 gallons of Category 1, 2, or 3 flammable liquids, nor more than 120 gallons of Category 4 flammables liquids may be stored within a single storage cabinet.
    - Category 1: flashpoint less than 100° degrees F
    - Category 2: flashpoint greater than or equal to 100° degrees F and less than 140° F
    - Category 3: flashpoint greater than or equal to 140° F
    - Category 4: flashpoints above 140 °F and at or below 199.4° F
- The vapor from flammable liquids must not come into contact with any source of ignition. Smoking is prohibited throughout the TCNJ facility, and outside where flammable liquids are stored, dispensed, processed, and/or handled.
- Flammable and combustible liquids must be stored in closed containers in the flammable liquid's storage cabinets. Hoods are not appropriate storage areas for flammable and/or combustible liquids. Storage of flammable or combustible liquids in hydrogenation hoods is of particular concern because of the increased chance for an explosion in these hoods. Therefore, the minimum amount of solvent necessary for the work being performed should be kept under the hood, and should be removed as soon as the work is completed.
- Flammable liquids will be identified by means of a warning label. Safety cans will be labeled.

- "Explosion-proof" electrical equipment will be used as specified in applicable regulations and standards governing flammable liquids usage and electrical systems.
- Flammable liquids will normally be dispensed to and used from approved safety cans. Use metal containers for flammable liquids. However, if a metal container would render the liquid unfit for use or excessively corrode and create a leakage hazard, glass or approved plastic containers, no larger than 1 gallon capacity, may be used for flammable liquids.
- No ignition sources may be located on or below the bench top, except for laboratory hoods.
- Use a laboratory hood or adequate ventilation when transferring or heating a flammable liquid. Combustible liquids, heated above the flash point, release ignitable vapors and must be treated as flammable liquids.
- When handling flammable liquids, ignition sources must be eliminated and adequate ventilation shall be provided. All metal containers of flammable liquids shall be properly bonded and grounded prior to transfer operations. Plastic and other non-metal containers cannot be bonded. All bulk storage drums should have breather vents and self-closing faucets.
- Positive displacement pumps or self-closing spigots will be used when dispensing flammable liquids from drums.
- The storage of flammable solvents in laboratories will be in accordance with NFPA 30 and OSHA 29 CFR 1910.106.
- Materials soaked with flammable liquids will be stored in metal containers with self-closing lids and be discarded as soon as practical, in accordance with established procedures.
- Fire extinguishers will be provided in rooms with flammable liquids storage cabinets, and near areas where the liquids are used. The type and distribution will be in accordance with applicable regulations and standards.
- Flammable solvents shall not be stored in refrigerators that are not explosion proof. All laboratory refrigerators shall be labeled explosion proof or not explosion proof as applicable.

19. Bonding and Grounding

While transferring flammable liquids from one container to another a fire hazard exists due to the possible creation of sparks that can ignite flammable vapors from the liquid. To mitigate the hazard OSHA may require both containers be bonded and grounded, depending on the circumstances. The procedures listed below will be followed in order to maintain proper bonding and grounding and minimize the potential for spark production from static electricity discharge. Caution and particular attention to safety, must be used when working with flammable liquids in the Flammable Storage Room C120A located in the Chemistry Building.

1. Prior to transferring any solvents, protective measures shall be taken to prevent the buildup of static electricity.
2. Bonding contact will be made prior to filling or transferring solvents between a dispensing container and receiving container.
3. The bonding wire will be installed in such a manner that the bonding wire clamp is always in metallic contact with the dispensing container and receiving container during solvent transfer.
4. A grounding wire will be installed on bulk solvent containers in such a manner that metallic contact is made. The grounding wire will then be connected to the building static grounding system.

20. Corrosive Chemicals

- Corrosive chemicals are severely destructive to the eyes, skin, and mucous membranes. Some examples include: sulfuric acid, nitric acid, glacial acetic acid, acetic anhydride, sodium hydroxide, sodium carbonate, calcium oxide, and amines.
- Emergency Procedures in case of contact:
    a. If skin contact occurs, immediately flood the affected skin or tissue with copious amounts of water from a deluge safety shower for at least 15 minutes.
    b. If eye contact occurs, immediately flood both eyes with copious amounts of water from an eyewash for at least 15 minutes. Lift the eyelids during irrigation.
    c. Do not use soap to wash the skin area and do not attempt to neutralize corrosive chemical splashes on the skin. Seek medical attention.
    d. Remove contaminated clothing during irrigation.
    e. If you are assisting an individual that has been in contact with a corrosive chemical, you must wear personal protective equipment, including, but not limited to, gloves and safety glasses, to avoid becoming injured as well.
    f. Immediately contact Campus Police Services, to begin emergency response.
- Always use a fume hood for work with concentrated acids and bases, phenol, and strong dehydrating or oxidizing agents.
- Contact with corrosive chemicals will be prevented by use of appropriate personal protective equipment (e.g. gloves, eye/face protection, etc.).
- A working eyewash and safety shower, located within 10-seconds of the work area, is required when working with corrosive material.
- Wipe off the outside of containers if contaminated during use. Wipe bench tops clean after working with corrosive chemicals.
- Never add water to a concentrated acid or base; always pour acid or base into water slowly.
- To prevent reactions with concentrated acids, glassware washers must rinse out glassware with water and let the water drain out before adding acid.
- While glassware if acid rinsed, the glassware washer must wear safety glasses and a face-shield, as well as gloves
- Use caution when opening bottles containing ammonium hydroxide and ammonium salts, as there is often a pressure build up.
- A commercial spill kit, with chemical neutralizers, must be accessible in the event of a spill.
- Storage
    a. Corrosives should not be placed above eye level. It is recommended that they sit in a tray or secondary containment large enough to contain all of the contents, if a spill or leak occurs.
    b. Store in dry, cool, and well-ventilated areas.
    c. Store and use only approved containers.
    d. Segregate acids from bases.
    e. Store away from sunlight and rapid temperature changes.
    f. Store away from reactive chemicals, organics, flammables, and other potential hazards, such as combustibles and toxicants.
    g. Only use clean rubber stoppers with alkaline solutions, do not use glass stoppers.

21. Unstable Chemicals

These chemicals are compounds that can decompose rapidly generating pressure, heat, and light. Elevated temperature, pressure, or mechanical shock can initiate explosive decomposition reactions. The following precautions will be taken when working with unstable chemicals such as picric acid:

- Do not order any unstable chemical without the written permission of the Chemical Hygiene Officer.
- The smallest amount available must be ordered, to prevent the need for storage of unstable chemicals.
- It is the responsibility of the end laboratory user to note the expiration date of any unstable chemical, and to ensure that it is disposed of upon expiration.
- All information about the material, its hazards, and the conditions causing decomposition must be obtained. If a differential thermal analysis shows an exotherm, the material is temperature sensitive.
- Plan work carefully. Use small quantities whenever possible.
- Place an appropriate shield between all laboratory users and the operation.

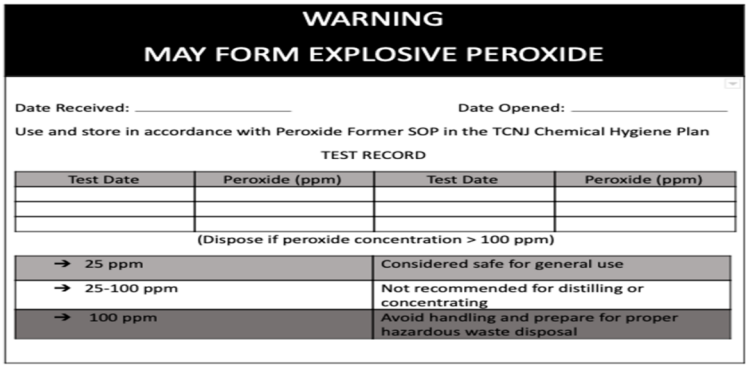
22. Peroxidizable Compounds

Peroxidizable compounds include but are not limited to those compounds listed in the Chemical Hygiene Plan. Check the label on the container and the Safety Data Sheet for information classifying the compound as peroxidizable.

- A number of compounds can form peroxides when exposed to air. These peroxides are usually explosive.
- Category A: Contains compounds whose peroxides explode without being concentrated. Order these chemicals only in the amounts actually needed. If you are unsure how much will be needed, purchase in several small containers (e.g., containers less than one liter), rather than one large container.
- Category B: Contains compounds whose peroxides explode only upon concentration, e.g., distillation or evaporation.
- Category C: Contains examples of vinyl monomers, which form peroxides which may initiate explosive polymerization of the monomer.
- Test all categories of peroxidizable compounds every 3 months after opening, to detect peroxide formation.
- Do not use any peroxidizable compound that is past the manufacturer's recommended expiration date. Arrange for proper disposal of peroxidizable compounds that are past their expiration date. Refer to Prudent Practices in the Laboratory 6.G.3.1.
- Do not distill or evaporate a peroxidizable compound unless it is known to be peroxide free.
- Do not allow a peroxidizable compound to evaporate to dryness.
- Store ethers in tightly sealed containers away from light. Most ethers, including cyclic ethers, form dangerously explosive peroxides on exposure to air and light. The peroxides may also change the course of the planned reaction.
- Prior to opening any container with a peroxidizable liquid, confirm there are no solids. If solids exist, do not open the container, seal the container cap closed with tape, and mark the label as "Do Not Open: Solids Present". The heat or friction of opening peroxide-containing vessels has been known to detonate the peroxide. Immediately

contact the Department Chairperson, EHS, or Chemical Hygiene Officer for disposal guidance.

- If there are any questions as to the stability of a compound (presence of peroxides) you are working with, either test for peroxides or do not use the compound and dispose of it properly.
- A positive peroxide test strip with greater than 1 ppm requires that the peroxidizable compound be disposed of as hazardous waste. Refer to Standard Operating Procedure, Disposal of Chemical, Organic Solvents and Product-Related Waste.
- Labeling
    - It is highly recommended that a systematic labeling scheme be used for peroxidizable solvents.
    - Peroxidizable solvents should be labeled and dated with a receipt date.
    - Researchers should fill in the date opened and then test for peroxides every three months and date the label according to this procedure.



WARNING

MAY FORM EXPLOSIVE PEROXIDE

Date Received: _____ Date Opened: _____

Use and store in accordance with Peroxide Former SOP in the TCNJ Chemical Hygiene Plan

TEST RECORD

Test Date	Peroxide (ppm)	Test Date	Peroxide (ppm)

(Dispose if peroxide concentration > 100 ppm)

→ 25 ppm	Considered safe for general use
→ 25-100 ppm	Not recommended for distilling or concentrating
→ 100 ppm	Avoid handling and prepare for proper hazardous waste disposal

<u>Examples of peroxidizable compounds</u>[1]

Category A- Peroxide hazard on storage
isopropyl ether
divinyl acetylene
divinyl ether
vinylidene chloride
*potassium metal
*potassium amide
*sodium azide

Label (for all categories)
Peroxidizable solvent
Date Received
Date Opened
<u>Date Tested</u>

TEST EVERY 3 MONTHS AFTER OPENING

*Testing not required. These compounds are both water and oxygen reactive.

Category B- Peroxide hazard on concentration
diethyl ether
tetrahydrofuran
dioxane
acetal
ethylene glycol dimethyl ether
vinyl ethers
dicyclopentadiene
diacetylene
methyl acetylene
decahydronaphthalene
tetrahydronaphthalene
cyclohexene

diethylene glycol dimethyl ether
cumene
cyclooctene
cyclopentene
furan
methyl cyclopentane
methyl-i-butyl ketone

Category C- Hazardous due to peroxide initiation of polymerization.
methyl methacrylate
chlorotrifluoroethylene
styrene
vinyl acetylene
acrylic acid
vinyl chloride
butadiene
vinyl pyridine
vinyl acetate
vinylidene chloride
chloroprene
tetrafluoroethylene
acrylonitrile

[1] List based on *1995 Prudent Practices in the Laboratory*. These are examples of peroxidizable compounds and do not constitute a complete list. Always refer to the safety data sheet and check the label on the container for information classifying the compound as peroxidizable.

23. Potentially Explosive Compounds

- Do not purchase, store, or synthesize excessive amounts of potentially explosive compounds in the laboratories at TCNJ.
- The compounds must be stored away from other hazardous and flammable materials and unused material removed from the work areas.
- The reaction must be run with only the minimum required quantities and scale-ups shall be handled with great care, considering the reaction vessel size and cooling, heating, and stirring rates.
- Before working with a potentially explosive compound, check the chemical literature for specific safety information necessary to safely complete the work.
- The planned reactions should be discussed with the Department Chairperson and, if possible, with someone who has experience working with the compound.
- Confirm the locations and current inspection of fire extinguishers, safety showers, and eyewashes in the area. In cases of exceptional hazard with known explosives (e.g., preparations involving greater than one mole of hydrogen azide, diazomethane and organic peroxides), the Department Chairperson and/or Chemical Hygiene Officer must be notified prior to initiating work with an explosive agent.

24. Food and Smoking

This section establishes procedures to prevent chemical exposure via ingestion when eating and/or smoking.

- Smoking is not permitted in any building at TCNJ. However, smoking is permitted outside of buildings at a distance of greater than 10 feet from the building entrances, openings, or air intakes. Smokers are asked to dispose of smoking products in provided smoking receptacles.
- Eating is forbidden in any laboratory area or any area where chemicals are present.
- All personnel who work in the laboratories must wash their hands thoroughly prior to eating, drinking, applying cosmetics, smoking, and similar activities to avoid cross contamination by hand or mouth.
- Food and/or tobacco product storage is not permitted in the laboratory areas or other areas where chemicals are stored, since food and tobacco can absorb chemical vapors and subsequently be ingested.
- All refrigerators in laboratory areas or any area where chemicals are stored must be labeled similar to – "No Food - Chemicals Only."

25. Personal Hygiene

The relationship between good personal hygiene practices and the handling of toxic chemicals in the laboratory is very important. Wash your hands after handling toxic chemicals and prior to eating, drinking, or smoking. Since the application of cosmetics is, also a potential means of contamination, this is not permitted in the laboratories.

26. Precautions in Handling Chemicals

The purpose of this section is to establish procedures to prevent exposure to and spills of hazardous chemicals within the laboratory.

- No chemicals are permitted to be discarded in the sink.
- All waste must be segregated as hazardous waste and disposed of separately.

27. Identification of Chemicals

Laboratory employees at TCNJ, are provided with information and training on hazardous chemicals in their work area at the time of initial assignment. In addition, the following can assist in identifying chemical identity:

- Labels
- Safety Data Sheets
- Right to Know information
- Laboratory signs

28. Leak Detection

Laboratory users should remain alert for leaking containers of hazardous chemicals. Visual detection is the primary means for identifying leaks. Chemical odors are also a means of detecting leaks. Some chemical reactions are accompanied by a characteristic odor, but the presence of an unusually strong chemical odor in the laboratory (particularly when a cabinet door is just opened) may signify that a container is leaking.

- Inform the Chemical Hygiene Officer if a leak, or potential leak, is detected either visually or through an odor.
- Do not attempt to clean up the leak or move the leaking container unless specifically trained to do so.
- The Lab Supervisor and/or Primary Investigator will conduct periodic inspections of hazardous chemical storage locations, in order to find leaking containers or containers that may leak.

29. Fume Hood Maintenance

Maintenance of equipment is critical to effective control of airborne contaminants. EHS and the Office of Energy Management Systems are responsible for establishing a regular maintenance program to verify that safety equipment is in working condition.

EHS staff is responsible for ensuring that laboratory fume hoods are inspected at least annually to ensure adequate performance. An outside vendor conducts the hood inspections with the following criteria:

- Face velocity is set properly. For the older versions an average face velocity of 90-110 feet per minute (fpm) must be maintained. Air flow into and within the hood, must not be excessively turbulent.
- Materials stored in the hood are not obstructing vents or airflow.
- Hood sash and sensing devices are functioning properly.
- The most recent inspection date will be posted on the hood.
- EHS will maintain the records of the annual inspections.
- Hoods that are not operating properly shall not be used for handling hazardous materials.

30. Biological Safety Cabinet Inspections

- The appropriate Department is responsible for the annual inspection and testing of biological safety cabinets in accordance with applicable regulations and the manufacturer's recommendations.
- An outside vendor provides the service. The Laboratory Safety Manager should receive a copy of the inspection from the Department.

31. Safety Equipment and Supplies

Facilities Operations coordinates recurring inspections of emergency showers and eyewashes.

- If a fire extinguisher has been used or found to be in need of replacement, contact the Office of Fire Safety for replacement. If it was used to extinguish a fire, inform Campus Police Services of the fire, even if it did not result in an evacuation or alarm activation.
- General laboratory ventilation should normally be at least 20 linear feet per minute (LFM) air flow through each room to allow comfortable breathing for workers. Since 20 LFM is not sufficient to prevent accumulation of chemical vapors, all hazardous chemical reactions must take place inside a laboratory fume hood.
- The Plumbing Shop conducts a monthly inspection of the emergency showers and eyewashes. Any equipment with inadequate flow or operational defects will be serviced promptly.
-

32. Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) is intended to reduce employee chemical and physical hazards where engineering and administrative controls are not sufficient to provide an adequate margin of safety. PPE is a last means of protection, with engineering then administrative controls being the primary means, as is feasible.

PPE is a key element in minimizing the potential for employee exposure to chemicals. PPE includes clothing and other items that are intended to prevent chemical contact with the skin and eyes, as well as other routes of exposure (e.g., sharps, ingestion, etc.). Examples of PPE include, but are not limited to: laboratory coats, close-toed shoes, eye/face protection, hand protection, etc.

The following PPE guidelines have been developed to describe the appropriate levels of eye, hand and foot protection required when certain chemicals are handled.

Eye/Face Protection

Appropriate safety glasses or splash goggles are required while inside a laboratory. All safety glasses and goggles must be of a type approved by ANSI (American National Standards Institute). All laboratory users, including contractors and visitors, are subject to these rules and will be provided with the necessary eyewear. Departments will notify laboratory personnel when contact lenses are not to be worn in the laboratory areas. The Department shall provide the necessary safety eyewear, including Over-The-Glasses (OTA) safety glasses, for individuals that wear prescription glasses. Prescription glasses are not an approved alternative to ANSI approved safety eyewear, unless the lenses of the prescription glasses are rated and labeled with a Z-87.

- Splash goggles shall be used while transferring or pouring liquids that may be injurious to the eyes or when working with hazardous liquid chemicals where the possibility of splashing exists.
- Goggles provide protection from dust.
- Safety glasses are used to protect the eyes from impacts with flying particles. Safety glasses must be equipped with side shields; otherwise, they are not ANSI approved safety glasses.
- While working with harmful ultraviolet (UV) light, appropriately shaded and UV protected glasses or goggles must be worn.
- Lab Supervisors and Principal Investigators must notify lab users that they cannot wear contact lenses prior to any specific laboratory experiment.

Hand Protection

Gloves are used to protect the hands from abrasive materials, hot and cold temperatures, and chemicals. Certain tasks may require protection against any one or more potential hazards. The PI and laboratory supervisors are responsible for ascertaining the need for specialized gloves and for providing them during the course of study in the laboratory areas.

- Appropriate chemical-resistant gloves shall be worn at all times when there may be skin contact with chemicals.
- If the hazard is unknown, at a minimum, a nitrile glove must be used.
- Leather gloves shall be worn when handling abrasive materials.

- Thermal-resistant gloves shall be worn for operations involving the handling of heated materials and exothermic reaction vessels. Thermal-resistant gloves shall be non-asbestos and shall be replaced when damaged or deteriorated.
- Cut resistant gloves shall be worn when handling materials or equipment that could create a laceration. Be aware that these gloves may not protect against a needle stick.

Foot Protection

Closed-toed shoes are mandatory while in a laboratory. Furthermore, sandals, perforated shoes, high heels, Crocs, flip flops, slides, Vibram, and bare feet are prohibited. Solid top shoes with slip resistant soles, or shoes with flats soles, are recommended.

Respiratory Protection

TCNJ minimizes employee respiratory exposure to potentially hazardous chemical substances through engineering control methods (such as local fume hoods) or administrative controls. TCNJ does maintain a Respiratory Protection Program; however, respirator use is prohibited in the laboratories. The CHO can be consulted for information on specific chemicals and exposure limits.

33. Storage Requirements

Only minimum quantities of toxic chemicals may be present in a laboratory to minimize clutter and potential incidents. All laboratories at TCNJ have extensive ventilation controls to ensure that negative pressure is maintained and that air vented from the fume hood is exhausted to the outside air without being circulated through any other room. The following precautionary measures have been implemented by TCNJ for site laboratories in accord with regulatory requirements:

- The chemical storage room has limited access.
- Incompatible chemicals are segregated.
- All containers are properly and clearly labeled.
- Cleanup equipment is readily available.

34. Housekeeping and Maintenance

Good housekeeping practices greatly contribute to chemical hygiene and safety. A clean work area is much safer than one that is cluttered. Some necessary housekeeping requirements are:

- Keep all walkways, aisles, hallways, and stairs clear of obstructions and storage.
- Chemicals shall be placed in their proper storage area at the end of the day.
- Incompatible materials must always be segregated. (see Appendix A for storage guide)
- All working areas and especially workbenches are kept clear of clutter, unnecessary equipment and obstructions.

35. Pipettes in the Laboratory

Pipettes are basic scientific apparatus universally employed for volumetric measurement of fluids and for the transfer of these fluids from one container to another. These fluids are frequently hazardous in nature, infected, toxic, or corrosive materials. Although it is forbidden, using mouth suction for pipetting is not uncommon and is a very serious hazard. Contaminants can also be transferred to the mouth if a contaminated finger is placed on the suction end of the pipette. There is also a danger of inhaling aerosols created in the handling of liquid suspensions when using unplugged pipettes, even if no liquid is drawn

into the mouth. The potential hazards associated with oral ingestion can be eliminated by the use of mechanical pipetting aids.

Laboratory users shall adhere to these directives:

- Always avoid crossing arms/hands when using a pipette.
- Pull the pipette straight out because holding it an angle alters the volume aspirated
- Pipetting by mouth is never permitted. Use mechanical aids only.
- Pipetting must be confined to the hood whenever volatiles or toxic fluids are being handled.
- Pipettes used for the pipetting of volatiles or toxic materials must always be plugged with cotton, even when safe pipetting aids are used.
- Biohazardous material must not be mixed by suction and expulsion through a pipette, or forcibly expelled from a pipette.
- Infectious cultures must not be dropped from the pipette. A disinfectant-soaked towel must be placed on the working surface and then autoclaved after use.
- Mark-to-mark pipettes are preferable to other types, since they do not require expulsion of the last drop.
- Discharge from pipettes must not be dropped from a height, but released as close as possible to a fluid or agar surface. Allow pipette contents to run down the inside wall when transferring to a tube or bottle.
- Biologically contaminated pipettes must be placed horizontally in a pan containing enough suitable disinfectant to allow complete immersion. Do not place them vertically in a cylinder.
- Store discard pans for used pipettes that handled biological material in the biological safety cabinet.
- Autoclave the pan and pipettes as a unit. Replace the unit (pan and pipettes) with a clean pan and pipette with fresh disinfectant.

36. Planning Chemical Laboratory Experiments

a. List all possible reactions including side-reactions before beginning.
b. Think through all reactants, intermediates, and products in terms of flammability, toxicity, and reactivity hazards.
c. Follow recognized safe practices concerning protective equipment, housekeeping, the handling of hazardous chemicals, and use of equipment as outlined in this chemical hygiene plan.
d. If conducting an unknown reaction, always start with small quantities of material and carefully observe reaction characteristics (i.e., temperature, color, viscosity, and physical state).
e. Obtain safety information about reactants and by-products. If the safety information is not available elsewhere, it may be obtained from outside laboratories that offer a testing service for the evaluation of explosion hazards, etc.
f. If possible, determine from the thermodynamic and kinetic considerations, the total quantity and the rate of evolution of heat and gases to be released during the reaction. Provide adequate cooling, ventilation, pressure relief, and gas purging. If possible, isolate the reaction vessel, and make frequent inspections of equipment during the reaction.
g. Do not leave a hazardous system unattended.
h. For each reactant, intermediate or product, ask:
    i) What is its flash point, flammability range, auto-ignition temperature, vapor pressure and vapor density?
    ii) Does it decompose? If so, how rapidly and to what products?
    iii) What is its stability in storage, to heat, light, water or humidity, metals, etc.?

iv) Is it impact sensitive?
v) Is it toxic? If so, what is the route of entry (e.g. inhalation, ingestion, skin contact)?
vi) What protective measures are required?
vii) What is the recommended first aid treatment in the case of an exposure?

i. About the reaction itself, ask:
i) How violent will it be?
ii) What is the effect of catalysts or inhibitors?
iii) Will water or air affect the reaction?

j. What would happen and what should be done if:
i) Electric power fails?
ii) Cooling system fails?
iii) Pressure gets out of hand?
iv) Water leaks into the system?
v) Air leaks into the system?
vi) The reaction container falls and breaks or spills its contents?

k. Remember that in addition to explosions and fires, asphyxiation can be caused by the accidental combination of potentially dangerous substances.

37. Emergency Procedures

An emergency is any event that requires an immediate stop in work and the following of a special procedure to protect life, health, and property.

The best time to know what to do in an emergency is before, not after, it happens. The best time to read this information is before the fire begins, and before the chemical is spilled. Though no single plan can possibly cover the range and combination of events that can constitute an emergency, it is expected that careful reading of the following emergency procedures will help you begin the planning process that will best fit your situation. Your experimental protocols or written procedures must always include specific and general safety measures, and at times may need to include specific and general emergency procedures. In any case, all such emergency procedures will need to be practiced and reviewed periodically.

Most emergencies will be small, consisting of a single unexpected event. Emergencies that are more serious involve a series of events, which usually stem from an initial root cause, with subsequent events leading to an unfortunate sequence and outcome. In such circumstances, decisions may have to be made quickly, often without complete or even adequate information, and there may be no precedent. Remain calm and use your best judgment, and try to stay within the following general priorities:

1) **LEAVE** the area of danger. This is of paramount importance to enable rescuers to focus on what is necessary to sustain life. If the area includes other people's workspace, direct them to leave too. If you can safely turn off equipment as you go, do so, but do not delay your escape.
2) **CALL Campus Police Services** from the nearest safe area. Calling takes precedence over everything except evacuation. This also applies for seemingly minor emergencies- it is far better to make an occasional unnecessary call compared to a fail to call and needlessly endanger life or health. For ALL emergencies, dial 609-771-2345 from a cell phone or 911 from a campus hard-wired phone. The dispatcher will likely ask the following questions, in order:
a) The location of the emergency
b) The nature of the emergency

c) Additional questions will likely include: Your name; whether an ambulance or firefighting equipment is needed; any hazards that might threaten persons on the scene or responding; and a phone number and location at the scene where you can be reached.
d) If necessary, contact the Poison Control Center, at 1-800-222-1222.

38. Compressed Gases

Gases are supplied in compressed gas cylinders under great pressure, some as much as several thousand pounds per square inch. If the valve is broken off or the cylinder punctured, the cylinder will likely become a deadly rocket, propelled with great momentum and high speed that can penetrate walls. Gas cylinders have been documented to cause extensive property damage, injury, and death. For this reason, all gas cylinders, full or empty, must always be properly secured (e.g. strapped or chained) to a sturdy support, preferably a fixed object, to prevent the cylinder from falling and possibly causing the valve to break off. All compressed gas cylinders must be treated as high-energy sources and therefore regarded as potential explosives.

In addition, released gas can rapidly displace the breathing air in a room, causing an oxygen deficient atmosphere (below 19.5%) and suffocation. Oxygen sensors, or other air monitoring devices may be necessary when gas cylinders, such as Nitrogen, are used or stored in labs or small rooms. Many gasses are toxic or corrosive and can cause injury if inhaled or upon contact with skin, in even small amounts. Many gasses are reactive with other materials or gases. An Oxygen enriched atmosphere, meaning a greater than normal concentration (over 23.5%), greatly increases the risk of fire and explosion.

Compressed gas cylinders have certain safety features, including special valves, fittings, and caps. For example, many gases have special valves that prevent the inadvertent mixing of incompatible gases. The best protection, though, lies in following the guidelines developed over years of experience with the hazards of compressed gas.

1. **Use**

   Begin with a thorough knowledge of the substances and equipment involved. Always know the identity of the gas in a cylinder; if for some reason a cylinder is unlabeled, return it to the vendor; do not use the cylinder or try to guess the contents. Know the properties and potential of the gas to be used, and the procedures for using it. Be careful not to exceed the design pressure of the apparatus. Always wear safety goggles when handling or using compressed gasses.

   Carefully inspect fittings, regulators, and apparatus for damage before using. Do not use damaged equipment. Use only regulators, gauges, and connections with matching threads and which are designed to be used with the gas and cylinders involved. Never lubricate, modify, force, or tamper with a cylinder valve.

   Only those tools approved by the cylinder vendor should be used on cylinder connections. Do not modify or alter cylinders or their attachments. Use cylinders and manifold systems only with their appropriate pressure regulators.

   Use cylinders only in well-ventilated areas. Corrosive gases shall be used only in locations with access to safety showers and eyewash stations. Corrosive, toxic, and flammable gasses shall be used only in fume hoods designed for use with the particular gas or group of gasses. Use flammable gasses only after proper bonding and grounding connections have been made.

Do not expose cylinders to temperatures higher than 50 °C (122°F), as some rupture devices on cylinders will release at about 65 °C (149°F). Some small cylinders, including those not fitted with rupture devices, may explode if exposed to high temperatures.

Open cylinder valves slowly. Rapid release of a compressed gas will cause an unsecured gas line to whip dangerously and may build up a static charge that could ignite a combustible gas. Never direct high-pressure gases at a person, or use compressed gas or compressed air to blow away dust or dirt because the flying particles can be dangerous. Close cylinder and bench valves when the cylinder is not in use, because the pressure regulator is not sufficiently strong to assure safe closure.

Always use a trap to prevent back-siphonage of liquid chemicals, and a check valve to prevent backflow of gasses into the cylinder. When gas is passed from a cylinder into a vessel containing a liquid, contamination of the cylinder gas with other chemicals is a real possibility. Such contamination makes the gas unsuitable for future use and may result in an explosion that may cause damage, injury, or even death. Use a safety trap to contain liquid and a check valve to prevent back flow of gas to eliminate this possibility. These items are installed immediately after the pressure regulator and before the vessel containing the liquid. The safety trap shall have a volume of about one- and one-half times the total liquid volume in the system.

Never bleed a cylinder completely empty. Always leave a residual pressure (about 25 psig (pounds per square inch gauge)) to keep contaminants out. Promptly remove the regulators from empty cylinders, being sure to bleed the gas from the regulator first. Then immediately replace the valve cap. Mark the cylinder “EMPTY” with removable writing (e.g. chalk). Never refill a cylinder.

2. Used Cylinders

Handle used cylinders as you would full cylinders. Keep them strapped or chained at all times.

Store the used cylinders separately from full cylinders so there is no chance of confusing them. Mark all used cylinders “EMPTY” with removable writing.

3. Leaking Cylinders

Cylinders that are leaking or otherwise damaged are an immediate danger. If they can be transported safely, they should be taken to an open place separate from all other cylinders to await vendor pickup.

Be very careful, however, in moving any cylinder that is leaking. Avoid inhaling gasses while carrying or loading such a cylinder, and try to avoid spreading gasses in corridors and stairwells. In the case of toxic or flammable gasses, call Campus Police Services at 609-771-2345.

4. Transportation

Never attempt to move a cylinder unless the valve cap is in place. Generally, cylinders must be transported on a hand truck to which they can be strapped or chained. Cylinders may be rolled on edge only for very short distances (i.e. to move it from the cart to the final location). Use an elevator to move cylinders to between floors. If you must move

the cylinder using stairs, use a hand truck that is designed for stairs. When handling cylinders, always consider them to be full. Do not allow them to strike each other, or to be dropped, cut, scraped, or otherwise damaged.

5. Storage

Keep only cylinders that are currently in use within a laboratory. Except during transport, all cylinders, whether in use or in storage, must be secured as stated above.

Store full and empty cylinders only in isolated areas that are ventilated and protected from direct sunlight, rain, snow, damp ground, heat, fire, and electrical contact. Temperatures in the storage location shall be maintained between -20°F and 120°F unless the manufacturer indicates otherwise. Storage can be indoors or outdoors under shelter. Never store or use cylinders in corridors, stairwells, or in high traffic areas.

Cylinders of the same gas should be stored together. Oxidizers should be separated from flammables and combustibles by at least 20 feet, or by a noncombustible barrier at least 5-feet high with a fire-resistant rating of at least one-half hour. In addition, store full and empty cylinders separately and clearly indicate whether they are empty.

Keep valve caps on all cylinders except when connected for use. Keep cylinders upright, whether in use or in storage. Consult the Hazard Communication Program for additional information on storage of gas cylinders.

39. Particularly Hazardous Substance Safety Review

Under some circumstances a particular chemical substance and associated laboratory operation, procedure or activity may be considered sufficiently hazardous, and requires prior approval from the Chemical Hygiene Officer prior to beginning such an activity. This approval process will ensure that safeguards are properly set up and that personnel are adequately trained in the procedure. A list of chemicals and threshold quantities requiring review and approval is located in Appendix B. Laboratory supervisors anticipating use of these materials in a manner requiring review must notify the Chemical Hygiene Officer (CHO). The CHO will visit the laboratory, conduct a survey of facility controls, and review the research protocol. The CHO will provide a report, to the affected laboratory personnel, identifying the required engineering and/or work practice controls, and/or PPE, for conducting the procedure, or a reason for disapproving this research.

40. Special Handling Requirements

Before beginning a laboratory experiment with a toxic chemical, all laboratory personnel must be familiar with the potential hazards as described in the Safety Data Sheet and HSFS. The overall objective is to minimize exposure to the laboratory worker to toxic substances by any route of exposure and by taking all reasonable precautions. The following precautions must be followed:

- Wear gloves and a laboratory coat to protect hands and forearms from skin contact with toxic chemicals.
- Procedures involving volatile toxic substances, and those involving solid or liquid toxic substances, that may result in the generation of vapors must be conducted in an approved hood or other suitable containment device. Direct any questions regarding the suitability of engineering devices to the CHO.
- After working with toxic chemicals, hands and arms must be washed immediately. Do not eat, drink, smoke, chew gum, apply cosmetics, take medicine, or store food in areas where toxic chemicals are being used.

To minimize hazards from accidental breakage of apparatus or spills of toxic substances in the hood, containers of such substances must be stored and used in pans or trays made of polyethylene or other chemically resistant material. Alternatively, the working surface of the hood can be fitted with a removable absorbent liner.

All laboratory users must be prepared for possible accidents or spills involving toxic substances. If a toxic substance contacts the skin or eye(s), immediately flush the area with running water for 15 minutes. If accidental immersion of any part of the body has occurred, immediately use the safety shower. If less than 1-liter spills, immediately attempt to contain it, using appropriate materials.it must be cleaned up by a person who has received training and is wearing the appropriate personal protective equipment. Proper spill cleanup materials are located in each lab and the cleanup material must be saved and discarded as hazardous waste.

41. CHEMICAL EXPOSURE ASSESSMENT

Regular environmental or laboratory user exposure monitoring of airborne concentrations is not usually warranted or practical in laboratories, because chemicals are typically used for relatively short time periods and in small quantities. However, sampling may be appropriate when a highly toxic substance is either used regularly (3 or more separate handling sessions per week), used for an extended period of time (greater than 3 to 4 hours at a time), or used in especially large quantities. Notify the Chemical Hygiene Officer if you are using a highly toxic substance in this manner.

A case in which an overexposure has happened will require and assessment by the Chemical Hygiene Officer. The first step involves a qualitative assessment and based upon the professional judgment of the Chemical Hygiene Officer, may be followed up by specific quantitative monitoring. A memo or report documenting the assessment will be sent to the Laboratory Supervisor within fifteen days of receipt of the results. A copy will be stored in the central exposure records file maintained by the Chemical Hygiene Officer.

42. VACUUM PUMP OPERATION

Vacuum pumps are used in a wide variety of experiment set ups. If vacuum pumps are not properly installed, trapped and exhausted, they may expose the lab user to hazardous chemicals and vapors.

Vacuum Pump In Use

- All vacuum pumps must be properly vented and include sufficient condensing capacity prior to the pump.
- Any rotary evaporator system using rotary vane pumps require a review to determine that the vacuum pressure is appropriate to the application and is well controlled
- Using the appropriate pressure and temperature when condensing a solvent and follow the “Delta 20 Rule” meaning the cooling temperature is set at 20 degrees cooler than the vapor temperature.
- Use a second cold trap between the pump and the experiment to minimize the amount of volatile chemicals reaching the pump.
- Empty the condenser trap immediately after evaporation is complete to eliminate the possibility that solvent will evaporate as the condenser warms at room temperature.
- At TCNJ vacuum pumps are not permitted to be in use while stored in a cabinet.
-

Vacuum Pump Not in Use

- Confirm that the vacuum pump is stored on a counter or a cabinet without any chemicals.

- Inspect the condenser traps to verify that they are empty.

43. ACTIVE EXPERIMENT SIGN

- If a laboratory user is running an experiment which must not be disturbed, a sign may be placed on the lab door with information regarding the primary and secondary contact persons if entry is necessary.
- The Active Experiment Sign is available to print and use by contacting EHS.
- When there is no longer a need to restrict access to the laboratory, the Active Experiment Sign must be removed from the door.

RECORDKEEPING

All exposure reports will be reported to and then maintained by the Office Human Resources.

REVIEW AND UPDATE OF CHEMICAL HYGIENE PLAN

This Chemical Hygiene Plan will be reviewed and evaluated for effectiveness by the Chemical Hygiene Officer, and updated as necessary.

Appendix A: General Chemical Storage Guidelines

Do not store incompatible chemicals next to one another, to prevent or minimize the possibility of unintended mixing. Mixing of incompatible chemicals may cause fires, explosions, or the production of toxic gases. For example, if an aqueous potassium cyanide solution is stored next to a container of glacial acetic acid and the containers are broken, toxic hydrogen cyanide gas will be generated. The following guidelines provide some protection against the unintended mixing of incompatible chemicals during storage:

General Guidelines

1. Chemicals must be properly segregated by hazard class in order to reduce the possibility of dangerous chemical reactions (e.g., acids mixed with sulfides). Typically, chemicals are segregated from one another by the following hazard classes:
    - Flammable and combustible liquids
    - Acids
    - Bases
    - Oxidizers
    - Reducing Agents
    - Chemical solids
    - Chemical liquids (non-flammable).
2. Do not store chemicals of different hazard classes together in the same storage cabinet or space. Segregate chemicals by hazard class in separate storage cabinets whenever possible or use secondary containment to create separation
3. Do not place any chemical reagents into storage until they are properly labeled, with the full chemical name and other required information. Grease pencil markings and abbreviations are not acceptable. Chemical waste containers must also be labeled with the proper Hazardous Waste label.
4. Confirm that chemical reagent containers are returned to the proper storage cabinet after they have been used.
5. Do not store chemical waste containers or reagent bottles inside the fume hood. Fume hoods are active work areas, and unnecessary containers become obstructions and possibly hazards. Hoods, which are filled with an excessive number of containers, may significantly reduce the flow rate of the hood or may create eddy currents that could exit the hood. Relocate filled hazardous waste containers to the Central Accumulation Area within 3 days of the container becoming full. Contact EHS for assistance.
6. Do not store old or outdated chemicals. Dispose of all unneeded chemicals promptly through the laboratory supervisor.
7. Do not store bottles holding liquids above eye level or on the floor. If you must store containers of liquids on the floor, use secondary containment to control spills in case the container is bumped. Also, place such containment areas away from heavily travelled walkways or place them under a table.
8. Store solid chemicals together on shelves or in cabinets. It is a good practice to segregate liquids from solid chemical reagents in order to prevent water reactive chemicals from coming into contact with leaks or spills. Oxidizers (e.g. nitrates, nitrites, permanganates, etc.) must be segregated from all other chemicals and are collected together in a plastic tub.

9. Large gas cylinders must be properly secured as specified in this document. Small lecture bottles of toxic compressed gases must be stored inside the fume hood.

Definitions for Flammable Liquids

Flash Point: The temperature at which a liquid or volatile solid gives off enough vapors to form an ignitable mixture with air. When a flammable liquid burns it is *not* the liquid, which ignites, but rather the volatile gas-air mixture.

Flammable Liquid: Any liquid that has a flashpoint below 100º F. The lower the flash point of a solvent the greater the potential fire hazard. Most alcohols have flash points below room temperature; therefore, spills must be handled with caution because a fire may occur if a source of ignition (e.g., spark, flame, etc.) is present. For example, ethyl ether has a flash point of minus 49º F, so even when this solvent is stored inside a freezer, there would be enough vapor present to cause a fire, should the container fail.

Combustible Liquid: Any liquid that has a flash point of at or above 100º F. The lower the flash point of a combustible liquid the greater the potential fire hazard. Many of the organic acids (e.g. acetic acid) are classified as combustible liquids. Formaldehyde 37% is also a combustible liquid.

Peroxidizable Solvents: A limited number of chemical solvents (e.g. ethyl ether, isopropyl ether, dioxane, tetrahydrofuran, etc.) have chemical structures that are prone to react with atmospheric oxygen or light to form unstable peroxide products during storage. If shock sensitive peroxide crystals are disturbed or heated (e.g. distillation) an explosion may occur. Mark the date of acquisition for peroxidizable solvents on the outside of the container. Purchase peroxide forming chemicals in small quantities (i.e. enough for immediate use only) and dispose of them in an appropriate time period (i.e. less than one year or by the expiration date).

Flammable and Combustible Liquid Storage: Store flammable and combustible liquids together and away from all oxidizers or oxidizing acids (e.g. nitric, perchloric). A flammable storage cabinet is required to store such liquids. The cabinet must be equipped with self-closing doors and a 3-point latch.

Non-flammable Solvent Storage: Non-flammable solvents (e.g., chloroform, methylene chloride, etc.) may be stored with flammable liquids.

Refrigerators: Never store flammable liquids in refrigerators that are not explosion proof. Refrigerators and freezers are considered a potential source of ignition, which may cause a solvent to ignite, possibly due to a leaking or open container.

Common Flammable Liquids (partial list)

Alcohols: methanol, ethanol, propanol, butanol, amyl alcohol, hexanol

Aldehydes & Ketones: acetaldehyde, acetone, methyl ethyl ketone, methyl isobutyl ketone (MIBK)

Alkanes (hydrocarbons): butane, hexane, heptane, octane, nonane, ligroin, naphtha, petroleum naphtha, petroleum ether, petroleum distillates, pentane, gasoline

Aromatics: benzene, bromobenzene, cumene, pyridine, toluene, xylene

Ethers: ether, ethyl ether, methyl ether, isopropyl ether, ethylene glycol monomethyl ether, cellosolve

Highly Toxic: acrolein, carbon disulfide, ethyleneimine, ethylene oxide

Miscellaneous: acetic acid, acetyl chloride, acetonitrile, cyclohexane, dichloroethane, dioxane, ethyl acetate, ethylenediamine, furan, methyl methacrylate, propylene oxide, tetrahydrofuran, triethyl amine, (outdated scintillation cocktail)

Common Combustible Liquids (partial list)

Organic acids: acetic acid, formic acid, propionic acid, butyric acid

Miscellaneous: acetic anhydride, dimethylformamide, diesel fuel oil, ethylenediamine,formaldehyde 37%, isoamyl alcohol, kerosene, mercaptoethanol, mineral spirits, phenol, pseudocumene

Requirements for Cold-Storage of Flammable Liquids

Flammable liquids cannot be stored in laboratory refrigerators, unless:

a. The refrigerator is specifically designated as a flammable materials storage refrigerator which complies with National Fire Protection Association (NFPA) 45 and is Underwriter's Laboratory (UL) listed, or
b. The refrigerator is specially designed as being an explosion-proof refrigerator, complies with OSHA 29 CFR 1910.307, and is UL listed for Class 1, Groups C and D hazardous locations.

***EXCEPTION:** A limited risk is associated with the small-quantity cold storage of **ethyl, methyl, and isopropyl alcohols.** An approved refrigerator may be used for these materials, provided:

1. The quantity in a container does not exceed 500 ml, and
2. The liquid is stored in a tightly sealed container with 25% of the bottle empty (for vapor expansion), and
3. There is sealed secondary containment, using a non-breakable container.
4. Only two containers are allowed per approved refrigerator.

Do not transfer liquids between containers near a cold storage unit, and only transfer such liquids in a well-ventilated area. **This exception DOES NOT APPLY to ethers or other flammable liquids, unless pre-approved by the CHO.** The consideration of other exceptions will be handled on a case-by-case basis, dependent on use, quantity, and safeguards.

Secondary containment using sealed, hard-sided plastic containers, such as those found at most grocery stores, is acceptable.

ACIDS

In general:

- Acids have the ability to donate a hydrogen ion (H+) or to accept an electron pair
- Acids turn litmus paper red
- The pH range of acidic aqueous solutions is from 6.9 to 0. The stronger an acid, the lower the pH number
- Acids have the ability to neutralize bases
- When acids come in contact with metals, they may generate flammable hydrogen gas
- Proper eye protection and personal protective clothing must be worn at all times when handling strong acids.

Storage:

- Acids must be segregated from bases in order to prevent unwanted neutralization reactions and corrosive vapors being generated
- Oxidizing acids (e.g. nitric acid, perchloric acid) must not be stored together with flammable liquids. Perchloric acid becomes explosively unstable in concentration of higher than 70%. Therefore, do not store them near strong dehydrating agents, such as concentrated sulfuric acid
- Hydrochloric acid is somewhat volatile, and it should be stored in a vented cabinet whenever possible to reduce corrosion. If you must store acids and bases together due to limited storage space, place all of the containers of one hazard class into plastic trays for secondary containment. Do not store acid containers next to metal gas lines.
- Segregate oxidizing acids (nitric, perchloric, chromic acid, chromerge) from organic acids (acetic, formic, etc.) to prevent fires. Many organic acids are also classified as combustible liquids, so they must be stored inside fire rated storage cabinets.
- Do not store acids near any cyanide or sulfide containing chemicals in order to prevent the generation of highly toxic hydrogen cyanide or hydrogen sulfide gas.

Examples of Mineral Acids: hydrobromic, hydrochloric, hydrofluoric, hydroidic, nitric, perchloric, phosphoric, sulfuric

Examples of Organic Acids: formic, acetic, propionic, butyric, valeric, hexanonic, oxalic, trichloroacetic, citric acid (Many organic acids are also classified as combustible liquids, so they must be stored in a fire rated cabinet.)
Examples of Water reactive acids: chlorosulfonic acid, fuming sulfuric acid, acetic anhydride

Examples of Oxidizing Acids: nitric acid, perchloric acid, chromic acid, chromerge

BASES AND CAUSTICS

In general:

- Bases produce the hydroxyl ion (OH-) which give bases their caustic character
- Bases have the ability accept protons or neutralize acids
- Bases turn litmus paper blue
- The pH range of bases is 7.1 to 14. The stronger a base, the higher the pH number
- Caustic chemicals are very slippery.
- Caustic chemicals are excellent conductors of electricity
- Concentrated bases are corrosive and extremely hazardous to the eyes and tissue, because they penetrate tissue very deeply.
- Proper eye protection and personal protective clothing must be worn at all times when handling strong bases.

Storage: Bases must be segregated from acids in order to prevent unwanted neutralization reactions and corrosive vapors from being generated.

Examples: ammonia, calcium oxide, potassium hydroxide, sodium hydroxide, sodium carbonate, sodium phosphate (tribasic), amines and ammonia derivatives

Ammonium hydroxide hazard:

- Concentrated ammonium hydroxide (30%) containers must be cooled prior to opening, to prevent gas and liquid from spraying out of the container
- Ammonia is a gas, and its solubility in solution is temperature dependent
- At elevated temperatures, a container of concentrated ammonium hydroxide may be under pressure.

OXIDIZERS

In general:

- Any compound that spontaneously evolves oxygen at room temperature or under slight heating is considered an oxidizer
- Oxidizers are also defined as a substance that easily gains electrons in oxygen reduction (redox) reactions
- Oxidizers may react vigorously at room temperature with carbon containing substances (organic solvents) to produce fires or explosions.

Storage:

- Store oxidizers together in a cool area away from paper and all other chemicals
- Oxidizers must be placed in a plastic tray, which is clearly marked with an oxidizer label.
- Some oxidizers are not compatible with one another, and need to be stored separately.

Common Oxidizers (not all inclusive)

Nitrates: ammonium, barium, cadmium, calcium, chromium, copper, ferric, lead, magnesium, mercury, nickel, potassium, propyl, sodium, uranyl, zinc

Bromates: ammonium, barium, calcium, potassium, sodium, zinc

Chlorates: ammonium, barium, calcium, potassium, sodium, zinc

Chlorites: calcium, sodium

Dichromates: ammonium, ferric, potassium, sodium

Iodates: ammonium, ferric, potassium, sodium

Perborates: sodium, zinc

Perchlorates: ammonium, barium, calcium, cesium, lead, magnesium, potassium, sodium

Peroxides (dioxides): barium, calcium, hydrogen peroxide, lead, lithium, manganese, magnesium, potassium, sodium, zinc

Permanganates: ammonium, potassium, sodium

Organic Oxidizers: amyl nitrate, benzoyl peroxide, butyl perbenzoate, cumene hydroperoxide, peroxyacetic acid

Oxidizing Acids: nitric acid, perchloric acid, chromic acid, chromerge

Miscellaneous oxidizers: bleach, bromine, fluorine, chromic acid, chlorine trifluoride, hydrogen peroxide, chromium trioxide, mercuric oxide, osmium tetroxide, periodic acid, nochromix

WATER REACTIVE FLAMMABLES

The following chemicals generate flammable gasses (e.g. hydrogen) on contact with water. Therefore, they must be segregated from aqueous liquids to prevent potential fires and explosions.

Alkali Metals: lithium, sodium, potassium, rubidium, cesium

Borohydrides: aluminum, calcium, lithium, potassium, sodium

Carbides: calcium, lithium (generate acetylene gas)

Hydrides: aluminum, calcium, lithium, potassium, sodium, zirconium

Methoxides or methylates: sodium or potassium salts of methanol

Ethoxides or ethylates: sodium or potassium salts of ethanol

WATER REACTIVE TOXICS

These materials generate extremely toxic gases on contact with water or acids and therefore must be segregated from aqueous materials.

Cyanides (hydrogen cyanide gas): (KEEP AWAY FROM ACIDS) Calcium, mercuric, ferric, potassium, sodium, silver, zinc (salts of ferrocyanides also generate cyanide gas)
Sulfides (hydrogen sulfide gas): (KEEP AWAY FROM ACIDS) ammonium, calcium, magnesium, potassium, sodium

Phosphides (phosphine gas): (KEEP AWAY FROM AQUEOUS LIQUIDS) aluminum, calcium, sodium, stannic

Miscellaneous Water Reactive: aluminum chloride (anhydrous), lithium silicon, sodium amide, sodium dithionite, sodium hydrosulfite, dimethyldichlorosilane, thionyl chloride

Appendix B: Chemicals Requiring Prior Approval

Acutely Toxic Gasses

The pressurized hazardous gasses identified below have been classified as particularly hazardous and require approval prior to purchasing new materials and for handling and storage of existing material.

Pressurized Gasses Requiring Review

Compound	Exempt Quantity
Arsine and gaseous derivatives	None
Chloropicrin in gas mixtures	None
Cyanogen chloride	None
Cyanogen	None
Diborane	None
Germane	None
Hexaethyltetraphosphate	None
Hydrogen cyanide	None
Hydrogen selenide	None
Nitric oxide	None
Nitrogen dioxide	None
Nitrogen Tetroxide	None
Phosgene	None
Phosphine	None

Regulated Chemicals & Chemicals with High Chronic Toxicity

The substances listed in the table, when stored or handled in quantities exceeding the exempt quantities, must be stored and handled according to special procedures that must be reviewed and approved by the Chemical Hygiene Officer prior to purchase.

Regulated Chemicals & Chemicals
With High Chronic Toxicity Requiring Special Procedures

Substance	Exempt Quantity Code (see below)
N-Acetoxy-2-acetylaminofluorene	2
2-Acetylaminofluorene	2 (OSHA Regulated)
Acrylonitrile	1 (OSHA Regulated)
Aflatoxins	2
o-Aminoazotoluene	2
4-Aminodiphenyl	3 (OSHA Regulated)
2-Aminofluorene	3
Asbestos	1 (OSHA Regulated)
Arsenic and arsenic compounds	2 (OSHA REG Regulated)
Azathiopurine	2
Benz[a]anthracene	2

Benzene	1 (OSHA Regulated)
Benzidine	3 (OSHA Regulated)
Benzo[a]pyrene	2
Bromoethyl methanesulfonate	2
1,4-Butanediol dimethanesulfonate (myleran)	2
Carbon tetrachloride	1
Chlorambucil	2
Chloroform	1
N,N-bis(2-chloroethyl)-2-naphthylamine	2
bis-Chloromethyl ethe	3 (OSHA Regulated)
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1nitrosourea	2
Cycasin	2
Cyclophosphamide	2
Diazomethane	2
Dibenz[a,h]anthracene	2
1,2-Dibromo-3-chloropropane	1 (OSHA Regulated)
3,3'-Dichlorobenzidine (& its salts)	3 (OSHA Regulated)
Diepoxybutane	2
4-Dimethylaminoazobenzene	2 (OSHA Regulated)
7,12-Dimethylbenz[a]anthracene	2
3,3'-Dimethylbenzidine	2
1,1-Dimethylethylenimine	1
l,l-Dimethylhydrazine	2
1,2-Dimethylhydrazine	2

Regulated Chemicals & Chemicals With High Chronic Toxicity Requiring Special Procedures (continued)

Substance	**Exempt Quantity Code (see below)**
1,4-Dinitrosopiperazine	2
p-Dioxane	1
Ethylene dibromide	1
Ethyleneimide	2 (OSHA Regulated)
Ethyl methanesulfonate	2
Ethylene oxide	1 (OSHA Regulated)
Ethionine	1
Ethylenimine	2
Formaldehyde	1 (OSHA Regulated)
Hexavalent chromium and its chromium compounds	1
Hydrazine	2
N-Hydroxy-2-acetylaminofluorene	2
Lead and lead compounds	1 (OSHA Regulated)

Mercury and Mercury salts	3 (OSHA Regulated)
3'-Methyl-4-aminoazobenzene	1
Methyl chloromethyl ether	3
3-Methylcholanthrene	2
4,4'-Methylene bis(2-chloroaniline)	2
Methylhydrazine	2
Methyl mercury	3
Methyl methanesulfonate	2
1-Methyl-3-nitro-1-nitrosoguanidine	2
alpha-Naphthylamine	2 (OSHA Regulated)
beta-Naphthylamine	3 (OSHA Regulated)
4-Nitrobiphenyl	3 (OSHA Regulated)
N-[4-(5-nitro-2-furyl)-2-thiazoyl]-formamide	2
4-Nitroquinoline-1-oxide	2
N-Nitrosodiethylamine	2
N-Nitrosodimethylamine	2 (OSHA Regulated)
N-Nitrosodi-n-butylamine	2
N-Nitrosodi-n-propylamine	2
N-Nitroso-N-ethylurea	2
N-Nitroso-N-ethylurethane	2
N-Nitroso-N-methylurea	2
N-Nitroso-N-methylurethane	2
N-Nitrosopiperidine	2
Polyclorinated biphenyls	2
Picric Acid	3
1,3-Propane sulfone	2
Thorium dioxide	2
m-Toluenediamine	2
Uracil mustard	2
Urethane	1
Vinyl chloride	2 (OSHA Regulated)

The exempt quantities are defined as:

Number	For Laboratory Storage	For Laboratory Use
1	<1 liter or 1000 grams	<50 milliliters or 50 grams
2	<0.1 liter or 100 grams	<5 milliliters or 5 grams
3	none	none

EPA "P" Listed Waste-requires approval prior to purchase

https://www.epa.gov/hw/defining-hazardous-waste-listed-characteristic-and-mixed-radiological-wastes#PandU

Procedures for Handling "Select Carcinogens", Reproductive Toxins, and Chemicals of High Acute Toxicity					
Chemical Category	Use in Designated Area	Notification/ Review of Use	Decontamination	Reproductive Hazard Evaluation	Avoid Working Alone
Select Carcinogens	X	X (Notify the CHO)	X		
Reproductive Toxins	X	X (Notify the CHO and review)	X	X	
Chemicals of High Acute Toxicity	X	X (Notify the CHO)	X		X