New Jersey Institute of Technology

Chemical Hygiene Plan

Environmental, Health and Safety Department

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Department of Public Safety

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Date:

NJIT Director of EHS

INTRODUCTION

The general intent of the NJIT Chemical Hygiene Plan (CHP) is:

- to protect laboratory workers from potential health hazards associated with the use of hazardous chemicals in NJIT laboratories, and
- to assure that NJIT laboratory workers are not exposed to substances in excess of the permissible exposure limits adopted by PEOSH (29 CFR 1910 subpart Z).

This Chemical Hygiene Plan encompasses the following area(s) (to be completed by Chemical Hygiene Officer):

Name of Department or Division: _____

_____

Name of Principal Investigator: _____

_____

Name(s) of Chemical Hygiene Officer(s): _____

_____

_____

List building/room(s) covered by the CHP: _____

_____

_____

EMPLOYEE ACKNOWLEDGEMENT AND REVIEW OF CHEMICAL HYGIENE PLAN

Principal investigators are responsible for communicating university, as well as their own safety requirements to individuals in their laboratory. EHS has prepared the following form to assist with documenting this communication and hands-on protocol-specific training. Additional copies of this form (PDF) are available from the EHS Department.

Specific safety requirements will vary based upon the individual and their assigned work activities in each laboratory. Principal investigators are expected to review relevant topics with individuals based upon their anticipated and assigned work activities. At a minimum, principal investigators need to review with their lab workers:

- The N.J. Hazard Communication Standard, including applicable provisions of the N.J. Worker Community Right-to-Know Act.
- For additional information and resources on these programs, go to: http://www.njit.edu/environmentalsafety/righttoknow/index.php
- The OSHA Occupational Exposure to Hazardous Chemicals in Laboratories (the Lab Standard) as it pertains to the standard (Appendix H of this Guide),
- Applicable exposure limits (Appendix J of this Guide),
- Location of the Chemical Hygiene Plan (where CHP is maintained in the lab),
- Location of Safety Data Sheets (SDS) for chemicals used in the lab,
- Specific information concerning hazardous chemicals used in the lab,
- Specific elements of the CHP.

The following employees have reviewed and understood the NJIT Chemical Hygiene Guide, this Laboratory's Standard Operating Procedures (SOP's), as well as the Safety Data Sheets (SDS's) for the chemicals they use:

Print Name	Sign Name	Date

DOCUMENTATION OF HANDS-ON TRAINING and LABORATORY-SPECIFIC STANDARD OPERATING PROCEDURES

The NJIT Environmental Health and Safety Department (EHS) acknowledges that the NJIT Chemical Hygiene Plan is generic in nature and cannot be specific to all laboratory activities occurring in each individual NJIT research or instructional laboratory. Therefore, it is required that Principal Investigators and Laboratory Supervisors insert laboratory-specific Standard Operating Procedures (SOPs) into this plan that are specific for the work being performed in the particular laboratory's covered by the plan. EHS is available for consultation on the development of laboratory-specific SOPs and a library of generic SOPs is appended to this document. Additionally, Principal Investigators, Laboratory Supervisors, and their designees are responsible for providing workers in their laboratory with protocol-specific hands-on training. In the spaces below, please insert the titles of the protocol Specific SOPs included in this plan as well as the names of lab workers who have been provided with hands-on training.

Laboratory Specific SOPs:

SOP Title	Nature of Hazard	Inserted in Section

Documentation of Hands-On Training:

Name	Title	Date	Procedure/Protocol	Trained By

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APPENDICES

1.0 PURPOSE, SCOPE AND RESPONSIBILITIES

All work performed in New Jersey Institute of Technology (NJIT) facilities shall conform to applicable local, state, and federal regulations relating to occupational health and safety, transportation and handling, and environmental protection.

Any controlled substances will be handled in accordance with applicable regulations.

1.1 PURPOSE

Laboratories present unique safety and health hazards due to the nature of the activities conducted there. Safety at NJIT is achieved by providing safe facilities; sound policies, programs, and procedures; protective equipment; and appropriate education and training for NJIT personnel and students.

A ***hazardous chemical*** is defined in the OSHA Laboratory Standard as "a chemical for which there is statistically significant evidence based on at least one study that acute or chronic health effects may occur in exposed employees." NJIT has prepared this Chemical Hygiene Plan (CHP) to ensure the safe use of hazardous chemicals in the laboratory. It specifies procedures, equipment, personal protective equipment and work practices that are designed to protect employees from health hazards presented by hazardous chemicals used in the laboratory. It also provides information necessary to comply with guidelines established by OSHA, NJIT, or national consensus associations. The CHP is intended for use by those laboratory personnel and students who may be exposed to hazardous chemicals in the course of their work, and those personnel with responsibility for health and safety in the laboratory. The CHP is available for review by all NJIT personnel and students.

Elements addressed or referenced by the CHP include:

- Designation of personnel responsible for implementation of the CHP, including the assignment of a Chemical Hygiene Officer (CHO);
- Standard Operating Procedures (SOPs) to be followed when laboratory work involves the use of hazardous chemicals;
- Control measures to reduce NJIT personnel and student exposure to hazardous chemicals, including engineering controls, the use of personal protective equipment and hygiene practices;
- Provisions for additional employee protection for work with select carcinogens, reproductive toxins and substances with a high degree of acute toxicity;
- Measures to ensure the proper functioning and adequate performance of laboratory chemical fume hoods and other protective equipment;
- Provisions for air sampling, medical consultation and medical examination and / or medical surveillance; and
- Provisions for NJIT personnel and student information and training.

The Plan will be reviewed and its effectiveness evaluated at least annually and amended as necessary. The Chemical Hygiene Officer is responsible for ensuring that this review is performed.

1.2 SCOPE

NJIT's CHP applies to all NJIT laboratory personnel who handle and may be potentially exposed to hazardous chemicals in research laboratories at NJIT. This includes research laboratories that may use small quantities of off-the-shelf potentially hazardous chemicals in the course of their research activities.

This CHP does not cover work with radioactive materials or biological agents. Procedures for work with these materials are addressed via NJIT's Radiation Safety Manual and Biosafety Manual, respectively.

1.3 DESIGNATION OF RESPONSIBILITIES

Personnel with responsibilities associated with the Plan include Environmental Health and Safety (EHS), NJIT personnel and students, and the Facilities Department. Their specific responsibilities are described below.

1.3.1 Administration

NJIT is responsible for ensuring the safety of its employees and for complying with all related requirements of state and federal regulations. Because of the importance the university places on safety, the administration encourages employees at all levels to promote positive attitudes regarding safety, to incorporate safety into their work practices, and to cooperate fully in the implementation of safety-related programs.

1.3.2 Faculty/Principal Investigator

The Faculty/Principal Investigator (PI) has responsibility for the health and safety of laboratory personnel working in his/her laboratory. The Faculty/PI may delegate the safety duties for which he/she is responsible, but must make sure that any delegated safety duties are carried out. In NJIT laboratories, the Faculty/Principal Investigator assumes the role and responsibilities of Chemical Hygiene Officer. In certain departments these responsibilities have been delegated to specific staff and/or faculty members.

The Faculty/Principal Investigator (PI) is charged with adapting and implementing a lab-specific Chemical Hygiene Plan (CHP). This includes maintaining a chemical inventory, ensuring access to material safety data sheets, developing written standard operating procedures (SOPs) for use of highly hazardous chemicals, enforcing safety practices, providing or scheduling employee training, and reporting hazardous conditions to the Department's Environmental

Safety and Health Officer or the EHS Department. The lab supervisor must also review the lab-specific SOPs and Chemical Hygiene Plan annually and update the documents as necessary.

The Chemical Inventory should be updated whenever new hazardous materials are brought into the laboratory and the updated list should be forwarded to the EHS Department.

Each July the EHS Department completes the NJ Worker and Community Right to Know Survey. Following the Right-to-Know chemical inventory in July, laboratories may request updated chemical inventories from the EHS Department. However, these inventories need to be updated by individual laboratories throughout the year.

Responsibilities of Faculty/PI under the CHP include, but are not limited to the following:

- Ensuring that appropriate protective equipment is available, in working order and used, and that appropriate training has been provided.
- Contacting the EHS for assistance in determining the required levels of protective apparel and equipment whenever there is the potential for a chemical overexposure.
- Being responsible for compliance with the current legal requirements concerning regulated substances used in the laboratories under his/her direction.
- Assessing the hazards associated with materials being ordered, and based on this assessment, ensuring that facilities and training for use of the material are adequate.
- Ensuring that safety and health considerations are incorporated into laboratory procedures involving the use of hazardous chemicals.
- Identifying hazardous conditions or operations in the lab, determining safe procedures and controls, and implementing and enforcing standard safety procedures.
- Establishing standard safety operating procedures (general and protocol specific) and performing literature searches relevant to safety and health that is appropriate for the work.
- Obtaining prior approval for the use of Restricted Chemicals and/or Particularly Hazardous Substances in the laboratory facilities under their supervision.
- Consulting with laboratory personnel on their use of higher-risk chemicals, such as Particularly Hazardous Substances or highly reactive chemicals, or conducting higher-risk experimental procedures, so that special safety precautions may be taken.

- Assisting the Department of Environmental, Health and Safety (EHS) with the yearly laboratory chemical inventory.
- Providing laboratory personnel under his/her supervision with access to the CHP and any individual Laboratory Safety Plans or Standard Operating Procedures (SOPs) specific to the laboratory under their supervision.
- Training laboratory personnel to work safely with potentially hazardous chemicals, equipment, processes and operations. Maintain records of training all laboratory-based training provided by the Faculty/PI or their designee. This includes informing laboratory personnel of the location and availability of Hazard Information described in the Hazard Information and Training Section.
- Maintaining copies of Safety Data Sheets (SDS) or providing access to SDS and Hazardous Substance Fact Sheets.
- Maintaining in functional working order appropriate work place engineering controls (e.g., fume hoods) and safety equipment (e.g., emergency showers/eyewashes, fire extinguishers, first aid kits), with emphasis on controls for Particularly Hazardous Substances. This includes coordination with the EHS Department and the Facilities Department to ensure that necessary repairs are completed in a timely manner.
- Providing adequate Personal Protective Equipment (PPE) suitable for all potentially hazardous materials being utilized in the laboratory.
- Conducting periodic laboratory inspections and maintaining records of inspections.
- Prompt reporting of laboratory accidents and injuries to Public Safety, Risk Management, and EHS.
- Making available required medical surveillance or medical consultation/examination for laboratory personnel.
- Informing facilities personnel, other non-laboratory personnel, and outside contractors, of potential lab-related hazards when they are required to work in the laboratory environment. Identified potential hazards should be minimized to provide a safe environment for repairs and renovations.
- If minors are working in the laboratory, complying with the requirements set forth in the document NJIT, Guidelines for Minors and Volunteers in Laboratories and Shops, (Updated April 2016).

1.3.3 Lab Workers

Lab Workers are responsible for observing all appropriate practices and procedures contained in the Chemical Hygiene Plan as well as other general safety practices, for attending designated training sessions, and for reporting hazardous or unsafe conditions to the PI, departmental safety officer, or EHS. Any deviation from procedures involving hazardous chemicals requires prior approval.

Lab Workers are responsible for planning and conducting laboratory operations in accordance with the CHP. Responsibilities of laboratory employees under the Plan include, but are not limited to the following:

- Develop good personal chemical hygiene habits and exercise prudent and careful work practices to ensure their personal safety as well as the safety of their fellow workers;
- Notify their Faculty/PI, either orally or in writing, of any potential health or safety concerns.
- Following the CHP and any individual Laboratory Safety Plan.
- Following oral and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.
- Keeping the work areas safe and uncluttered.
- Reviewing and understanding the hazards of materials and processes in their laboratory research prior to conducting work.
- Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls, PPE, and administrative controls.
- Understanding the capabilities and limitations of the PPE issued to them.
- Gaining prior approval from the Faculty/PI for the use of Restricted Chemicals.
- Consulting with Faculty/PI before using certain higher risk chemicals, such as Particularly Hazardous Substances or highly reactive chemicals, or conducting certain higher risk experimental procedures.
- Promptly reporting accidents and unsafe conditions to the Faculty/PI.
- Completing all required health, safety and environmental training.
- Participating in a medical surveillance program, if and when required.
- Informing the Faculty/PI of any work modifications ordered by a physician as a result of medical surveillance, an occupational injury, or exposure.

Added Duties of Laboratory Personnel Working Independently.

In general EHS discourages students from working in the laboratory independently. EHS does acknowledge that certain advanced and experienced graduate students may assume leadership positions in the laboratory and embark on independent laboratory research. In addition to the above responsibilities, laboratory personnel working autonomously or performing independent research are also responsible for:

- Providing the Faculty/PI with a written scope of work for their proposed research and obtaining the Faculty/PI written approval.
- Notifying and consulting with Faculty/PI, in advance, if they intend to deviate from their written scope or scale of work.

- Preparing SOPs and performing literature searches relevant to safety and health that are appropriate for their work.
- Providing appropriate oversight, training and safety information to laboratory personnel they supervise or direct.

1.3.4 Environmental, Health and Safety Department

The NJIT Environmental Health and Safety (EHS) Department is responsible for administering and overseeing the institutional implementation of the CHP Plan, not specific activities in individual laboratories. The Faculty/PI is responsible for specific activities in the laboratories under their supervision. The EHS Department provides technical guidance to personnel at all levels of responsibility on matters pertaining to laboratory use of hazardous chemicals as well as other issues related to environmental, health and safety.

Specifically, the EHS Department is responsible for:

- Assisting the Faculty/PI in the selection of appropriate safety control requirements, which include laboratory practices, PPE, engineering controls, and training.
- Monitoring engineering controls to determine proper operations and assist with scheduling necessary repairs.
- Performing hazards assessments, upon request.
- Maintaining area and personal exposure-monitoring records.
- Reviewing and providing advice on Laboratory SOPs, upon request.
- Providing technical consultation and investigation, as appropriate, for laboratory accidents and injuries.
- Helping to determine medical surveillance requirements for laboratory personnel, if required.
- Coordinating with NJIT's medical providers when laboratory personnel request to review their medical records.
- Reviewing plans for installation of engineering controls and new laboratory construction/renovation, as requested.
- Reviewing and evaluating the effectiveness of the Chemical Hygiene Plan at least annually and updating it as appropriate.

The EHS Department may also provide support to the CHP by providing management, oversight, or assistance in chemical compliance, transport, hazardous waste management, chemical inventory, and hazardous materials spill/release response.

2.0 USE OF PERSONAL PROTECTIVE AND OTHER SAFETY EQUIPMENT

2.1 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal protective apparel and equipment (safety glasses, goggles, face shields, ear plugs, aprons, gloves, etc.) are provided, based on laboratory activities, to prevent injury. The Faculty/PI is responsible for reviewing routine laboratory procedures and other planned procedures to ensure that PPE is appropriate to reduce the likelihood of employee exposure.

See NJIT 's Personal Protective Equipment (PPE) Program which contains information on:

- PPE Quick Guide
- Laboratory PPE Assessment Tool
- PPE Training Guidance
- Selecting Personal Protective Equipment
- Where to Acquire PPE

2.1.1 Eye and Face Protection

Safety glasses with fixed side shields meeting the requirements of ANSI Z87.1-2015 are the minimum eye protection required for laboratory operations. In a laboratory, the Faculty/PI and / or DEHSO may grant an exception under the following conditions:

- In a specified area using an optical instrument (e.g. microscope) when the eye protection prevents proper eye positioning.
- In a specified area not in close proximity to chemicals designated by the Faculty/PI and / or DEHSO as an “office” where only office-related tasks are conducted. Safety glasses shall be donned before leaving the designated office area.

Safety glasses must be available for lab workers in all research and instructional laboratories at NJIT. Safety glasses shall be donned before entering the laboratory whenever possible. The laboratory shall not be traversed to locate safety glasses.

Visitors shall be provided protective eyewear. Faculty/PI responsible for visitors are expected to make sure that visitors wear appropriate eye protection.

Chemical goggles or a face shield with safety glasses are required for bulk handling of chemicals (quantity > 4 liters), when working with corrosive chemicals and molten metals, or when splashes are possible.

In general, EHS discourages the wearing of contact lenses in research laboratories. It is always preferred that safety glasses are worn over prescription glasses. However the use of contact lenses in a laboratory may be permitted provided the following:

- The rationale for the use of contact lenses is described in the lab's written Standard Operating Procedures (SOPs);
- Safety glasses with side shields are worn whenever potentially hazardous chemicals are handled in the lab; and/or
- Safety glasses with side shields are worn whenever potentially hazardous processes are underway in the lab; and/or
- Safety goggles are worn if hazardous chemicals are handled, particularly those with appreciable vapor pressure or those that generate excess heat.

2.1.2 Hand Protection

The hands shall be protected from hazards such as skin absorption of chemicals, chemical burns, severe cuts, lacerations or abrasions, punctures, and harmful temperature extremes.

- Non-conductive tongs, protective mittens, etc. shall be used when handling hot/cold materials.
- Routine handling of hazardous chemicals shall require the use of latex, latex / nitrile or nitrile gloves, at a minimum. When handling liquids with potential for spill or prolonged contact with hands, review Safety Data Sheets (SDSs) and contact the Faculty/PI, departmental safety officer, or the EHS Department for assistance with glove material selection. At the present time, there are no gloves which provide an effective barrier against all hazardous chemicals that may be used in laboratories.
- Due to potential allergies to latex rubber, non-latex glove alternatives must be available for potentially allergic lab workers.

The following factors should be considered when selecting a glove material for a particular application:

- Toxic properties of the chemical;
- Performance characteristics of the glove; and
- Work activities to be undertaken (degree of dexterity required, frequency and degree of exposure, etc.).

The following types of gloves are available to employees:

Rubber Gloves	Natural (latex) or synthetic (nitrile), to prevent chemical contact. Light-weight gloves are used when dexterity or "feel" is important.
Reinforced Rubber Gloves	To protect the hands and lower arms from chemical action and also from abrasion.
Chemical Resistant Gloves	For use when rubber is incompatible with chemicals of concern.
Leather or Woven Gloves	For general use to protect the hands from cuts and abrasion.
Cryo-Gloves	To protect the hands and wrists from frostbite and cell damage in operations with low-temperature freezers, dry ice or cryogenic atmospheres.
High-Temperature Gloves	To protect the hands and wrists from burns in operations with autoclaves, working with high-temperature baths, etc.

2.1.3 Clothing

Laboratory coats are required over street clothes for routine laboratory work to prevent contact with dirt and minor chemical splashes or spills.

Laboratory coats shall be hung on hooks just inside or just outside the laboratory.

Laboratory coats are not to be worn in common areas such as the cafeteria, conference rooms, offices, wash rooms, libraries, or carpeted office space.

Laboratory coats can be worn when traveling to or visiting other laboratories within the same facility but shall be removed before entering a common area.

Chemical resistant aprons are recommended for operations involving the use of strong acids and other corrosive materials.

Laboratory visitors shall be provided a laboratory coat. Employees responsible for visitors are expected to make sure visitors wear a lab coat when appropriate.

Wearing shorts, capri pants, etc. in laboratory areas is prohibited.

2.1.4 Respiratory Protection

It is NJIT's policy to control contaminants in the laboratory through good engineering design and controls. Such engineering controls include ventilation,

chemical fume hoods, equipment improvements and process changes. Therefore, respiratory protective equipment is not required or necessary for most laboratory operations.

The use of respirators is limited to trained, medically-qualified, and fit-tested personnel only. Please contact the EHS Department for additional information concerning respiratory protection.

2.1.5 Other

Foot Protection: Appropriate non-slip, closed-toe and closed-heel shoes are required for routine laboratory work. Open-toe and open-heel shoes will not be worn in laboratories.

Hearing Protection: At the present time, there are no laboratory locations at NJIT where the 8-hour time-weighted average noise level is greater than 85 decibels on the A scale (dBA), the OSHA Action Level for occupational noise exposure. If additional equipment is installed that significantly increases noise levels, exposure monitoring will be conducted to assess the need for hearing protection under OSHA's noise standard, 29 CFR 1910.95.

2.2 LABORATORY SAFETY EQUIPMENT

2.2.1 Fire Extinguishers

Fire extinguishers are selected based on the hazard of the area. Hazard classification, selection of extinguishers, and their locations will be the responsibility of the Facilities Department. EHS will provide training in the use of fire extinguishers.

2.2.2 Safety Showers

Each Lab Worker must know the location of the nearest safety shower before beginning work in a new area. The floor space under and leading to a safety shower must be kept clear at all times. Safety showers or drench hoses should be used to drench the victim in case of a chemical accident or clothing fire. The safety shower is operated by pulling downward on the overhead bar or chain. Clothing should be removed immediately while the victim is standing under the shower. Severe injury can result from leaving contaminated clothing in contact with the skin.

Any safety showers found by Lab Workers to be malfunctioning should be reported immediately to the Facilities Department for servicing. Safety showers must remain accessible at all times - storage is prohibited in beneath or immediately adjacent to safety showers.

2.2.3 Drench Hoses

Drench hoses are receiving additional attention in recent years, as a credible method for irrigating the skin following partial body coverage from a chemical spill. Affected skin should be irrigated for a minimum of 15 to 20 minutes. Drench hoses are typically adjacent to laboratory sinks and are freed up for use by pulling on a retractable hose. Lab Workers should become familiar with the location and use of a drench hose if present in their laboratory. Drench hoses must remain accessible at all times and should not be cluttered with lab-ware.

2.2.4 Eyewash Stations

Each Lab Worker must know the location of the laboratory eyewashes before beginning work in a new area. Eyewash fountains shall be used to irrigate eyes in cases of chemical splashes to the eyes or face. For splashes to the eye, immediately flush with water for at least 15 minutes. Eyelids should be held away from the eyeball and the eyes moved up, down, and sideways to wash thoroughly behind the eyelids. Never attempt to neutralize chemicals splashed in the eye.

Eyewash equipment found by Lab Workers to be malfunctioning should be reported immediately to the Facilities Department for servicing. Eyewash equipment must remain accessible at all times and should not be cluttered with lab-ware.

2.2.5 First Aid Kits

First aid kits are located throughout the facility. Personnel trained in first aid and cardiopulmonary resuscitation (CPR) are available on-site during working hours (8:30 am to 5 pm). All work-related injuries should be reported to the Faculty/PI, NJIT Public Safety, and the EHS Department.

2.2.6 **VENTILATION**

- ***General Laboratory Ventilation***: Each laboratory shall be provided with general ventilation that: (1) provides a source of air for breathing and makeup for local ventilation devices; (2) ensures that laboratory air is continually replaced to prevent increase of air concentrations of toxic substances during the work day; and (3) directs air flow into the laboratory from non-laboratory areas and out of the building through the chemical fume hood exhaust and the general ventilation exhaust system.
- ***Special Ventilation Areas***: Exhaust air from glove boxes and isolation rooms where hazards exist shall be treated before release into the regular

exhaust system.

- ***Modifications***: Any alteration of the ventilation system will only be made after the Chemical Hygiene Officer determines that worker protection remains adequate or improves.
- ***Performance Rate***: 10 or more room air changes / hour is adequate ventilation if local exhaust systems such as hoods are used as the primary method of control.
- ***Quality***: General air flow shall not be turbulent and shall be relatively uniform throughout the laboratory. High velocity or static areas are not acceptable in the laboratory.
- ***Evaluation***: The quality and quantity of general ventilation shall be evaluated on installation, and re-evaluated whenever a change in local ventilation devices is made. The Facilities Department is responsible for the evaluation of ventilation system performance.

2.2.7 EQUIPMENT MAINTENANCE

Maintenance of equipment is critical to effective control of airborne contaminants. The EHS Department and the Facilities Department are responsible for establishing a regular maintenance program to verify that laboratory safety equipment is in working condition.

2.2.7.1 Laboratory Chemical Fume Hoods

The EHS Department is responsible for ensuring that laboratory chemical fume hoods are inspected at least annually to ensure adequate performance. In addition, they are certified following any major HVAC renovation or unit servicing. The following items shall be reviewed during these inspections:

- face velocity - an average face velocity of 80-120 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;
- smoke test to determine whether hood has reflux problems.

The most recent inspection date will be posted on the hood. Records of inspections shall be maintained by the EHS and Facilities Departments.

The EHS Department is responsible for submitting maintenance work requests for fume hoods found to be in need of repair or maintenance. Hoods shall not be used if not operating properly.

2.2.7.2 Biological Safety Cabinets

The EHS Department shall arrange for annual inspection and testing of biological safety cabinets in accordance with applicable regulations and manufacturers' recommendations. In addition, they are certified following any major HVAC renovation, unit relocation or unit servicing. Records of inspection and repair shall be maintained by EHS..

3.0 EMPLOYEE INFORMATION AND TRAINING

All NJIT staff and Lab Workers who work in laboratories are required to receive general lab safety training as well as lab-specific training. The EHS Department conducts *General Laboratory Safety Training that* covers requirements of the OSHA Chemical Hygiene Standard, as well as general laboratory safety rules.

The Faculty/PI is responsible for providing *Lab Specific Training* for all laboratory employees. This training is based on the contents of the lab-specific Chemical Hygiene Plan, including SOPs for highly hazardous chemicals.

3.1 HAZARD INFORMATION

Faculty/PI must inform laboratory personnel of the location and availability of the following information:

- NJIT's Chemical Hygiene Plan per OSHA 1910.1450 Occupational exposure to hazardous chemicals in laboratories. The above-referenced OSHA regulation requires employers to have a written Chemical Hygiene Plan. This Plan fulfills this regulatory requirement and is a resource for planning experiments and laboratory operations.
- "Permissible Exposure Limits (PEL) for Chemical Contaminants", OSHA 1910.1000 Z Tables. If a PEL has not been established for a specific contaminant, contact EH&S for guidance.
- Reference materials on the hazards, signs & symptoms of exposure, safe handling, and storage & disposal of hazardous chemicals at the various website links:
  - Safety Data Sheets
  - NJIT 's Chemical Safety Database
  - National Library of Medicine, National Institutes of Health

- State of New Jersey, Department of Health Right to Know Hazardous Substance Fact Sheets (http://web.doh.state.nj.us/rtkhsfs).

3.2 WORK DIRECTED BY FACULTY/PI

For work directed by a Faculty/PI, Faculty/PI must provide laboratory personnel with information and training at the time of initial assignment to the laboratory, and prior to assignments involving new exposure situations, work with Particularly Hazardous Substances, or other hazardous operations.

The frequency of refresher information and training will be determined by the Faculty/PI and the CHO to ensure continuing education of Lab Workers and compliance with workplace regulations regarding training.

All required training will be documented by the Faculty/PI. Documentation will include the name of the person trained, date(s) of training, topics covered and name(s) of persons conducting the training.

3.2.1 Types of Training

Laboratory personnel must receive general and laboratory-specific training as follows:

3.2.1.1 General Training

Faculty/PI must ensure that laboratory personnel, working under their supervision, attend annual training on the CHP. This is accomplished by having laboratory personnel attend the regularly scheduled Laboratory Safety Training provided by EHS.

- Laboratory Safety Training
- Chemical Hygiene Plan
- Chemical Safety for Laboratories
  - NJ Worker and Community Right to Know/Hazard Communication
  - Occupational Exposure to Hazardous Chemicals in Laboratories
  - General Laboratory Safety
  - Laboratory Emergency Response
  - Laboratory Waste Management

Additional trainings are available from EHS, including:

- Biosafety Training

- LASER Safety Training
- Radiation Safety Training

3.2.1.2 Laboratory-Specific Training

Laboratory-specific training is to be provided by the Faculty/PI or his/her designee, addressing the specific chemical hazards present and emergency procedures specific to the laboratory. Also, any lab-owned equipment may require specialized training to prevent equipment damage. This can be achieved via a combination of the following:

- Review of any individual Laboratory Safety Plan.
- Review of local/building safety information.
- Review of Standard Operating Procedure(s) involving hazardous chemicals.
- Other laboratory-specific training on particular safety procedures or hazards encountered in the laboratory environment.
- Laboratory–specific training shall be documented using the forms available at the beginning of the CHP.

3.2.1.3 WORK CONDUCTED AUTONOMOUSLY OR INDEPENDENTLY

Faculty/PI shall provide access to the CHP and any individual Laboratory Safety Plan, if one is developed, to persons working autonomously or performing independent research before they undertake work in NJIT laboratories.

Persons working autonomously are responsible for ensuring that they have any other training that is appropriate to the work they conduct in NJIT laboratories and shall fulfill all the responsibilities set forth in Sections 1.3.2 and 1.3.3, including providing appropriate oversight, training, and safety information to any laboratory personnel they supervise or direct.

3.2.2 Recordkeeping of Safety Training

All health and safety training records are to be maintained by EHS, the departmental safety officer, and the Faculty/PI or designee for at least three years.

For documenting SOP review by laboratory personnel, see the form ***Documenting SOP Review and Faculty/PI Approval***, Appendix C.

3.3 NJIT Pre-College Program

All NJIT personnel and students participating in the NJIT Pre-College Program must comply with the requirements contained in the NJIT Pre-College Program document. Please refer to the Program document contained on the EHS Department website.

4.0 MEDICAL EXAMINATIONS

4.1 MEDICAL CONSULTATION, EXAMINATION, AND SURVEILLANCE

Medical consultation, examination, and surveillance are provided as follows:

4.1.1 WHEN PROVIDED

Lab Workers who work with hazardous chemicals will be provided the opportunity to receive medical attention/consultation when:

- Symptoms or signs of exposure to a hazardous chemical develop.
- Exposure monitoring reveals an overexposure.
- A spill, leak, explosion, or other occurrence results in a hazardous exposure (potential overexposure).
- A regulatory standard triggers medical surveillance.

4.1.2 HEALTH CARE PROVIDERS

Medical examinations will be conducted by licensed providers and will be provided at a reasonable time and place at no cost. Medical consultations and examinations for employees are provided via the NJIT Occupational Health provider (Concentra). Concentra will document and provide as appropriate the following:

- Any medical condition that may place Lab Worker or employee at increased risk from work place hazardous chemicals.
- Statement that Lab Worker or employee has been informed of the results.
- The written report shall not reveal any specific findings of diagnoses unrelated to occupational exposure.

Employees are responsible for informing the Faculty/PI of any work modifications ordered by the clinician as a result of exposure.

4.1.3 INFORMATION PROVIDED TO PHYSICIAN

The EHS Department, the departmental safety officer, and/or the Faculty/PI will provide the following information to the physician:

- Identity of hazardous chemicals.
- Conditions of exposure, including exposure data, if available.
- Signs and symptoms of exposure.

4.2 RECORDKEEPING OF MEDICAL RECORDS / ACCESS TO MEDICAL RECORDS

Medical records will be maintained by the Occupational Health Provider for the duration of the employee's employment plus 30 years. Employees must have access to medical records within 15 days of request to the EHS Department, per OSHA's, *Access to Employee Records*.

5.0 RECORD KEEPING

Permanent records are maintained by EHS Department including:

- Environmental monitoring done to determine the presence and concentration of hazardous substances in laboratories.
- Chemical hood performance testing in laboratories.
- Results of accident investigations and recommendations for actions to minimize the risk of recurrence.
- Records of General Laboratory Safety Training.
- The following records are maintained by the Faculty/PI for each lab:
    - An up-to-date, accurate Chemical Hygiene Plan
    - Training records for lab-specific training which include employee signatures
    - SDS for all hazardous chemicals currently stored in the laboratory
    - The inventory of hazardous chemicals stored in the laboratory
    - SOPs for Highly Hazardous Chemicals currently in use in the laboratory

6.0 GENERAL CLASSES OF HAZARDOUS CHEMICALS

Chemicals have inherent physical, chemical, and toxicological properties that require laboratory personnel to have a good understanding of the related health and safety hazards. The main types of chemical hazards that lab personnel should be aware of are:

- Flammability
- Corrosivity
- Reactivity/Instability (including explosivity), and
- Toxicity (including irritation, sensitization, carcinogenicity, and reproductive toxicity)

Additionally, compressed gases and cryogenic liquids are often-used laboratory materials that present unique hazards. Below is a brief discussion of these major classes of hazardous chemicals. Refer to Appendix A for specific definitions of each hazard class.

6.1 FLAMMABLE AND COMBUSTIBLE LIQUIDS

Flammable and combustible liquids are classified according to their flash point, with flammable liquids having a flash point at or below 199.4 °F (93 °C) and combustible liquids having a flash point above 199.4 °F (93 °C). Both flammable and combustible liquids are considered fire hazards.

6.2 CORROSIVE MATERIALS

Corrosive materials cause irreversible destruction of living tissue through chemical action at the site of contact. As corrosive chemicals can be liquids, solids, or gases, corrosive effects can affect the skin, eyes, and respiratory tract. Examples of corrosive chemicals include sodium hydroxide, hydrochloric acid, and phenol.

6.3 HIGHLY REACTIVE AND UNSTABLE MATERIALS

Highly reactive and unstable materials are those that have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material. Examples of such substances are explosives, peroxides, water reactives, self-reactives, and pyrophorics.

6.4 COMPRESSED GASES, CRYOGENIC LIQUIDS, AND TOXIC GASES

Compressed gases and cryogenic liquids are similar in that they can create pressure hazards and can also create health hazardous and/or flammable atmospheres. One special property of compressed gases and cryogenic liquids is that they undergo substantial volume expansion when released to air, potentially depleting workplace oxygen content to hazardous levels.

Toxic gases pose additional potential acute health hazards to laboratory personnel and the public, and as such, are considered NJIT “Restricted Chemicals” that require prior approval by the Faculty/PI, Department Chair and Safety Committee. The use, handling, distribution and dispensing of toxic gases requires detailed SOPs to be reviewed and approved in advance of use. In addition, the SOPs contain specific provisions mandating facility permitting, engineering controls, protective equipment, storage requirements, emergency response plans, warning systems and employee training based on the type and quantity of toxic gas used. As usage of toxic gases may require special permits, contact EHS for further guidance.

6.5 PARTICULARLY HAZARDOUS SUBSTANCES

Select carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity are considered to be high-risk materials and are treated by NJIT as Particularly Hazardous Substances. Additional provisions for working with Particularly Hazardous Substances are described in Section 7.3.

6.5.1 Select Carcinogens

Carcinogens are chemicals or physical agents that cause cancer or tumor development, typically after repeated or chronic exposure. Their effects may only become evident after a long latency period and may cause no immediate harmful effects. See Appendix A for the definition of a Select Carcinogen.0

6.5.2 Reproductive Toxins

Reproductive Toxins are chemicals which affect reproductive capabilities. Possible effects include chromosomal damage (mutations), effects on fetuses (teratogenesis), adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Many reproductive toxins cause damage after repeated low-level exposures. Effects become evident after long latency periods.

6.5.3 Acutely Toxic Substances

Acutely Toxic Substances are categorized based on their LC50 or LD50 values. Substances with a **high degree of acute toxicity** have the ability to cause adverse effects after a single exposure/dose or multiple exposures/doses within a 24 hour period. Many of these chemicals may also be characterized as toxic gases, Select Agent Toxins, corrosives, irritants, or sensitizers.

6.6 Sensitizers

A sensitizer is a substance that can cause exposed people to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of sensitizers used in laboratories include formaldehyde, many phenol derivatives, and latex proteins (commonly found in latex lab gloves).

6.7 Irritants

Irritants are substances that cause reversible effects (e.g., swelling or inflammation) on skin or eyes at the site of contact. A wide variety of organic and inorganic compounds are irritants; thus, skin and eye contact with all laboratory chemicals should be avoided.

6.8 Restricted Chemicals

If not properly considered, managed, and overseen, the use of certain chemicals can result in conditions of higher risk for laboratory personnel and to facilities personnel. The approval of the Faculty/PI and DEHSO is required when certain Restricted Chemicals that carry a higher risk due to their inherent hazardous property are used in NJIT laboratories. Laboratory personnel may not use Restricted Chemicals in any NJIT laboratory without obtaining the prior written approval of the Faculty/PI or his/her delegate and the DEHSO.

INSERT LIST OF RESTRICTED CHEMICALS HERE

6.9 Nanomaterials

A nanoparticle is a collection of tens to thousands of atoms approximately 1 to 100 nanometers in diameter. Nanoparticles that are naturally occurring (e.g., volcanic ash, forest fires) or are the incidental byproducts of combustion processes (e.g., welding, diesel engines) are usually physically and chemically heterogeneous and often termed ultrafine particles. Engineered nanoparticles are intentionally produced and designed with very specific properties related to shape, size, surface properties and chemistry. These properties are reflected in aerosols, colloids, or powders containing these nanomaterials. Engineered nanoparticles may be bought via commercial vendors or generated via experimental procedures by researchers in the laboratory. Examples of engineered nanomaterials include: carbon buckyballs or fullerenes; carbon nanotubes; metal oxide nanoparticles (e.g., titanium dioxide); and quantum dots, among many others. The health effects of exposure to nanomaterials are not fully understood at this time. Until more definitive findings are made regarding the potential health risks of handling nanomaterials, researchers planning to work with nanomaterials must implement a combination of engineering controls, work practices, and personal protective equipment to minimize potential exposures to themselves and others.

6.10 Select Agent Toxins

Select Agent Toxins are certain toxins of biological origin which are subject to stringent regulatory requirements under 42 CFR 73 for their potential to pose a severe threat to public, animal, or plant health, or to animal or plant products. These toxins, along with specified biological agents (viruses, bacteria, fungi), fall under the oversight of the National Select Agents Registry (NSAR) Program which requires registration for possession, use, and transfer of the listed Select Agents. However, possession of small amounts of Select Agent Toxins as described below is exempt from registration with the NSAR Program. Contact EHS for additional information.

6.10.1 Possession of Permissible Amounts of Select Agent Toxins

The following Select Agent Toxins are not regulated if the amount under the control of a principal investigator does not exceed, at any time, the amounts indicated in the table below.

Select Agent Toxins / HHS Toxins [§73.3(d)(3)] Amount

- Abrin 100 mg
- Botulinum neurotoxins* (see note below) 0.5 mg
- Short, paralytic alpha conotoxins 100 mg
- Diacetoxyscirpenol (DAS) 1000 mg
- Ricin 100 mg
- Saxitoxin 100 mg
- Staphylococcal Enterotoxins (Subtypes A, B, C, D, and E) 5 mg

- T-2 toxin 1000 mg
- Tetrodotoxin 100 mg

*As of September 24, 2015, Botulinum neurotoxin use in a research setting is also regulated by Life Sciences Dual Use Research of Concern Oversight Policy.

Additionally, the following Select Agent Toxins are excluded:

1. Any Select Agent Toxin that is in its naturally occurring environment provided it has not been intentionally introduced, cultivated, collected, or otherwise extracted from its natural source.
2. Nonfunctional Select Agent Toxins. Use of these Select Agent Toxins in permissible amounts requires strict adherence to NJIT's requirements that address critical safety and compliance information including safe use, storage/security, and inventory management.

6.10.2 Possession of Select Agent Toxins Above Permissible Amounts

Possession of Select Agent Toxins in amounts above permissible amounts requires prior approval from the Vice Provost and Dean of Research and registration with the National Select Agent Registry (NSAR) Program. Also note, that effective 12/4/12, botulinum neurotoxins are categorized as Tier 1 agents, which trigger additional regulatory requirements. Failure to register with the NSAR Program is potentially punishable by up to five years in prison and/or large monetary fines. *(Public Health Security & Preparedness Response Act of 2002, Section 231(c), 18 USC 175(b), & Public Law (USA Patriot Act) 107-56 Sec. 817).* Contact the EHS Department for assistance.

7.0 PROCEDURES FOR HANDLING HAZARDOUS CHEMICALS

NJIT has developed a list of general safety rules for laboratories. Please review the list contained in Appendix B below.

For the general safety of laboratory personnel, all chemical usage must be conducted in adherence with the general safe laboratory practices below. The methods used to specifically control chemical exposures are categorized as follows: Engineering Controls, Administrative Controls, and Personal Protective Equipment.

7.1 ENGINEERING CONTROLS

7.1.1 Introduction

As general lab ventilation cannot be relied upon to protect personnel from localized exposures to hazardous levels of airborne chemicals, engineering controls such as laboratory fume hoods, glove boxes and other local exhaust systems (e.g., drop down flexible ducts) are often necessary to provide additional

exposure control. In general, laboratory fume hoods are recommended whenever using hazardous chemicals that:

- Have a high degree of acute toxicity, are carcinogens, or are reproductive toxins, except where there is very low risk of exposure (e.g., use of minimal quantities in a closed system).
- Have a permissible exposure limit of less than 50 ppm (or 0.25 mg/m3 for particulate matter).
- Are appreciably volatile (e.g., solvents) or are easily dispersible in air (e.g., dust).
- See the document ***Safe Fume Hood Use*** for information on their proper use.

7.1.2 Performance Verification of Engineering Controls and Safety Equipment

To assure that primary engineering controls and safety equipment provide proper and adequate performance, EHS and the Facilities Department provides performance verification checks on a routine basis.

7.2 ADMINISTRATIVE CONTROLS

Administrative controls for minimizing exposures to hazardous chemicals include:

- Substituting in less hazardous chemicals (e.g., using proprietary detergents instead of chromic acid for cleaning glassware; or, using toluene instead of benzene for liquid-liquid extraction or chromatography.)
- Isolating or enclosing an experiment within a closed system (e.g., glove box, sealed chamber).
- Micro-scaling the size of the experiment to reduce the amount of chemical usage.

7.3 ADDITIONAL PROVISIONS FOR WORK INVOLVING PARTICULARLY HAZARDOUS SUBSTANCES

Additional provisions for laboratory work with Particularly Hazardous Substances include:

- Establishment of a designated area.
- Use of containment devices such as fume hoods or glove boxes.
- Procedures for safe removal of contaminated waste.
- Decontamination procedures.

These provisions are further described in the Standard Operating Procedures for Carcinogens, Reproductive Hazards and Acute Toxins. See Appendix D for a list of Particularly Hazardous Substances.

7.4 GENERIC STANDARD OPERATING PROCEDURES

The NJIT Environmental Health and Safety Department (EHS) acknowledges that the NJIT Chemical Hygiene Plan is generic in nature and cannot be specific to all laboratory activities occurring in each individual NJIT laboratory. Therefore, it is required that Faculty/PI insert laboratory-specific Standard Operating Procedures (SOPs) into this plan that are specific for the work being performed in the laboratory. Laboratory personnel working autonomously or performing independent research are responsible for developing SOPs appropriate for their own work. EHS is available for consultation on the development of laboratory-specific SOPs and a library of generic SOPs is appended to this document.

Priority for SOP development should be given to any operation involving Restricted Chemicals, certain higher hazard chemicals such as Particularly Hazardous Substances and Highly Reactive Chemicals.

8.0 PRIOR APPROVAL AND SPECIAL PRECAUTIONS

8.1 RESTRICTED CHEMICALS REQUIRING PRIOR APPROVAL

Laboratory personnel shall seek and the Faculty/PI (or his/her delegate) must provide prior approval of any chemical usage involving the following Restricted Chemicals:

- Toxic gases (e.g., Diazomethane, Hydrogen cyanide, Hydrogen fluoride (anhydrous), Nickel carbonyl)
- Dimethyl mercury

8.2 METHODS FOR GRANTING PRIOR APPROVAL

The following options are available to for Faculty/PI to grant prior approval:

a. Faculty/PI completes the form ***Particularly Hazardous Substances - SOP Review and PI Approval.***

b. Faculty/PI signs and dates the laboratory personnel's laboratory notebook and indicates approval for the process, procedure or activity.

c. Faculty/PI provides other written approval, e.g. via e-mail or memo.

Such records of prior approval must be retained for at least one year.

8.3 SPECIAL PRECAUTIONS FOR OTHER HIGHER HAZARD CHEMICALS AND OPERATIONS

A. Laboratory personnel should consult with Faculty/PI on the following higher-risk chemical usage and operations in their laboratories, so that special safety precautions can be taken where appropriate:

1. Work involving Particularly Hazardous Substances or highly reactive materials.
2. A procedural change that significantly increases the overall hazard of an existing procedure, such as introduction of a high hazard chemical in a procedure, or scale-up of an experimental procedure or operation. Careful consideration of scaled-up work is critical to plan for the effects caused by an increase in chemical concentration/quantity and differences in dissolution rate and heat transfer.
3. Unattended operations that represent significant likelihood of fire, explosion, or exposure to personnel if a malfunction were to occur (such as a utility outage, runaway reaction, broken container, or chemical spill).
4. Working alone in the laboratory.
   - Each case should be evaluated on a case-by-case basis to determine if working alone will be permitted, considering:
   - Task and hazards involved in the work.
   - Consequences resulting from a worst-case scenario.
   - The possibility of an accident or incident that would prevent the laboratory personnel from calling for help.
   - The laboratory personnel's training and experience
   - The laboratory personnel's physical conditions or handicaps [consult with local Human Resources Officer for guidance and compliance with Americans with Disability Act (ADA)].
   - Time the work is to be conducted (during normal business hours, i.e., 7 am – 8 pm Monday through Friday) versus at night or on weekends/holidays.

B. In establishing special precautions for Particularly Hazardous Substances, consideration shall be given to the following, where appropriate:

1. Establishment of a designated area
2. Use of containment devices such as fume hoods or glove boxes
3. Procedures for safe removal of contaminated waste
4. Decontamination procedures

When working with select carcinogens, reproductive toxins, and chemicals of high acute toxicity, the Laboratory Standard requires that special consideration be given to the following:

- establishment of a designated area;

- use of containment devices such as fume hoods and glove boxes;
- procedures for safe removal of contaminated waste; and
- decontamination procedures.

When developing appropriate handling procedures, it should be noted that a process is not necessarily hazardous merely because a hazardous chemical is used. In cases where existing procedures, supported by industrial hygiene monitoring data or evaluation, document compliance with relevant exposure limits, only minor modifications to procedures may be necessary in order to comply with the requirements of the Laboratory Standard.

9.0 CHEMICAL EXPOSURE ASSESSMENT

Consistent adherence to general safe laboratory practices in conjunction with appropriate use of exposure controls are expected to keep laboratory chemical exposures to a safe level. Exposure risk is more likely to increase when handling hazardous chemicals outside of a lab hood, especially those chemicals that:

- Have a high degree of acute toxicity, are carcinogens, or are reproductive toxins, except where there is very low risk of exposure (e.g., use of minimal quantities in a closed system).
- Have a permissible exposure limit of less than 50 ppm (or 0.25 mg/m3 for particulate matter).
- Are appreciably volatile or are easily dispersible in air (e.g., fine powders).
- Are used in large volumes (e.g., greater than 1 liter).

For any concern involving the laboratory-use of hazardous chemicals, including the above scenarios, contact the EHS Department at 973-596-3059.

9.1 PERSONAL EXPOSURE MONITORING

A. When

Personal monitoring may be conducted by the EHS Department if there is reason to believe that exposure levels for a substance exceeds the action level (or in the absence of an action level, the permissible exposure limit). Examples where personal monitoring may be conducted include: (1) volatile chemicals are not used in a fume hood and/or (2) personnel develop signs or symptoms associated with possible hazardous chemical exposure.

B. Frequency

The initiation, frequency, and termination of personal monitoring are done in accordance with the relevant regulation.

C. Communication of Results / Recordkeeping

Monitoring results are provided to laboratory personnel per the time requirements of the relevant regulation or within 15 days of the EHS Department's receipt of monitoring results. EH&S maintains copies of exposure monitoring per the regulatory requirement.

10.0 CHEMICAL PROCUREMENT, STORAGE, DISTRIBUTION AND DISPOSAL

10.1 PROCUREMENT

Prior to, or at the time of receipt of a chemical substance, information on proper handling, storage, and disposal should be known to those who will be involved. No container should be accepted without an adequate identifying label and an available Safety Data Sheet (SDS) for the product. The chemical inventory should be checked to ensure that the chemical is added to the department or site inventory. The SDS should be forwarded to EHS.

10.2 STORAGE

Chemical inventory in the laboratory should be maintained at the lowest practical level. Larger quantities of frequently used solvents should be stored in approved flammable storage cabinets. These cabinets can be stored within the laboratories, but not in the corridors. Quantities will follow the guidelines listed in NFPA 30 for storage of flammable and combustible materials. Storage on bench tops and in hoods is not permitted; never store hazardous materials at or above eye level. Exposure to heat or direct sunlight should be avoided.

- Segregate toxic substances in well identified area with local exhaust, where practical. Segregate incompatible chemicals for storage using Table 1: Specific Chemical Incompatibilities and Table 2: Segregation of Acids and Bases as a guide.
- Highly toxic chemicals or other chemicals whose containers have been opened shall be tightly sealed and/or stored in unbreakable outer/secondary containers.
- Stored chemicals will be examined at least annually by the Chemical Hygiene Officer or designee for deterioration and container integrity.
- Storeroom / stockroom must not be used as a preparation or repackaging area, should be open during normal working hours, and should be controlled by one person, or as specified in department procedures.

TABLE 1: SPECIFIC CHEMICAL INCOMPATIBILITIES [a]

Chemicals in Groups A and B should be kept separate:

Group A	**Group B**
Acetylene and monosubstituted acetylene (R - C = CH)	Halogens Group IB and IIB metals and their salts
Ammonia and NH, OH	Halogens Halogenating agents Silver Mercury
Carbon, activated	*Oxidizing Agents* [a]
Hydrogen peroxide	Metals and their salts
Nitric acid	Metals Sulfuric acid Sulfides Nitrites, other reducing agents Chromic acid and chromates Permanganates
Mercury and its amalgams	Ammonia and NH_4OH
Oxalic acid	Silver Mercury
Phosphorus (yellow)	Oxygen *Oxidizing Agents* [a]
Phosphorus pentoxide	Water Halogenating agents
Sulfuric acid	Metals Chlorates Perchlorates Permanganates Nitric acid

[a] Oxidizing agents include the types of compounds listed in the entry for alkali and alkaline earth metals, etc.

TABLE 2: SEGREGATION OF ACIDS AND BASES

Chemicals in Groups A and B should be kept separate:

Group A	Group B
Alkali and alkaline earth metals carbides hydrides hydroxides oxides peroxides	Water Acids Halogenated organic compounds *Oxidizing agents* [a] Chromates, dichromates, CrO_2 Halogens Halogenating agents Hydrogen peroxide and peroxide Nitric acid, nitrates Perchlorates and chlorates Permanganates Persulfates
Inorganic azides	Acids Heavy metals and their salts *Oxidizing agents* [a]
Inorganic cyanides	Acids, strong bases
Inorganic nitrates	Acids Metals Nitrites Sulfur
Inorganic nitrites	Acids *Oxidizing agents* [a]
Inorganic sulfides	Acids
Organic compounds Organic acyl halides Organic anhydrides Organic halogen compounds Organic nitro compounds	*Oxidizing agents* [a] Bases Organic hydroxy compounds Bases Organic hydroxy compounds Aluminum metal Strong bases
Powdered metals	Acids *Oxidizing agents* [a]

[a] Oxidizing agents include the types of compounds listed in the entry for alkali and alkaline earth metals, etc.

Use storage trays or protective containers to minimize spillage in case of container breakage or leakage.

10.3 Labeling

Labels and Safety Data Sheets (SDSs) are the primary sources of information regarding the hazards of chemicals. Persons who work in the laboratory will be provided with information and training on these resources.

- Do not remove or deface labels on incoming containers of hazardous chemicals. Report containers without labels to the Faculty/PI. Faculty/PIs will be responsible for ensuring that labels including the identity of the chemical, CAS number and appropriate hazard warnings are added to containers without labels, including secondary containers and containers holding hazardous waste. The concentration, date a mixture was prepared or date a material was transferred should be included, if appropriate.
- When select carcinogens, reproductive toxins or chemicals of high acute toxicity are being used, post warning signs.
- Receiving personnel and Faculty/PIs shall ensure that SDSs received with incoming shipments of hazardous chemicals are forwarded to the EHS Department. Comprehensive sets of SDSs are maintained **INSERT LOCATION OF WHERE SDS ARE KEPT.**
- The following provisions shall apply to chemical substances developed in the laboratory:
    - if the composition of a chemical substance produced for the laboratory's use is known, Faculty/PIs shall ensure that a determination is made about whether the chemical is "hazardous" as defined under OSHA's Laboratory Standard (29 CFR 1910.1450) and Hazard Communication Standard (29 CFR 1910.1200);
    - for novel compounds produced by NJIT personnel, Faculty/PIs shall assume that the substances are hazardous, and handle accordingly;

A. All Hazardous Chemicals

Hazardous chemicals must be stored and labeled properly.

B. Select Agent Toxins

In addition to the requirements detailed above, for Select Agent Toxins (in permissible amounts), the laboratory must provide one additional layer of physical security (i.e., Select Agent Toxin secured within locked freezer, or secured within a permanently fixed lock box).

C. Controlled Substances

In addition to the requirements detailed in Section A above, Controlled Substances must be stored in a securely locked, substantially constructed cabinet, located where access is limited to those individuals with controlled substances authorization.

10.4 Chemical Inventory

A. All Hazardous Chemicals

A chemical inventory must be maintained for all chemicals stored in the laboratory as required in OSHA 1910.1200 Hazard Communication. Each laboratory must update their chemical inventory at a minimum of every 12 months.

Additional benefits for maintaining an up-to-date inventory include:

- Ability to identify unneeded materials that can be culled from laboratory storage, reducing overall chemical laboratory risks.
- Can better rely on the inventory to find needed materials, possibly avoiding unnecessary redundant purchases.
- Reduce compliance risks pertaining to the State of New Jersey Right To Know hazardous materials storage and reporting requirements.
- Aid in identification of the relative hazards of the chemicals in the inventory.

B. Select Agent Toxins

PI / Faculty/PIs working with Select Agent Toxins must ensure that permissible amounts are not exceeded by promptly updating their inventory after every container of Select Agent Toxin is acquired, depleted, or inactivated.

C. Controlled Substances

Faculty/PIs enrolled under the institutional DEA Controlled Substance Program must also maintain a continuous usage log using NJIT's Controlled Substance Usage Log.

11.0 LABORATORY INSPECTIONS

Laboratory inspections are an essential function to identify and address potential health and safety deficiencies and to fulfill regulatory compliance requirements.

11.1 LABORATORY SELF-INSPECTION REQUIREMENTS

Laboratories must be self-inspected as indicated per the guidance provided in the document *Lab Inspections*. Completed self-inspection checklists and the actions taken to correct identified unsafe conditions must be maintained by the PI/ Faculty/PI or their designee for the length of time specified for each type of inspection.

11.2 EH&S LABORATORY QUALITY ASSURANCE VISITS

Using a risk-based approach, EHS conducts visits of laboratories to assist labs in assessing their implementation and compliance with core health and safety issues, including but not limited to: storage, use, and disposal of higher hazard chemicals; correct management of controlled substances; and select agent toxins.

12.0 HAZARDOUS WASTE MANAGEMENT

Management of hazardous waste is both a critical compliance and health & safety responsibility of the lab.

- Refer to the Chemical Waste Disposal website for guidance on general waste management practices, segregation of waste, accumulation and storage of waste, labeling of waste, and requesting removal of waste.
- For compliance with the training and information requirements for hazardous waste regulations, all laboratory personnel are required to know the following:
    1. The hazards of the waste chemicals in the lab.
    2. How to properly contain and store the waste in the lab.
    3. What to do in an emergency involving the lab waste.

13.0 EMERGENCY RESPONSE - SPILLS AND EXPOSURES

All incidents involving hazardous chemical spills and exposures require prompt action by the responders and the victims in order to control chemical exposures to personnel and to minimize impacts to the environment and property.

13.1 CHEMICAL SPILL KITS

- Chemical Spill Kits, located outside of each laboratory, provide lab-specific chemical hazard information to emergency response personnel.
- Hazard labels on the front of the Chemical Spill Kits represent the different types of hazards that may be present within the lab.
- Information in the Chemical Spill Kits include:
    1. Cover page with hazard symbols representing the different types of hazards within the lab.
    2. NJITs emergency contact information.
    3. Chemical storage map.
    4. The lab's chemical inventory printout.

13.2 INCIDENT REPORTING

Laboratory personnel are to report all occupational injuries or illnesses to Faculty/PI as soon as practical. The Principal Investigator / Faculty/PI and laboratory personnel must submit the required paperwork to NJIT Public Safety and EHS.

Laboratory personnel are encouraged to report "near misses" as they are considered a precursor to actual incidents.

13.3 FOLLOW-UP

The Faculty/PI is to conduct (or coordinate) an investigation of all incidents and "near misses." The goal of the investigation is to identify and address any deficiencies that may have contributed to the incident.

14.0 Decommissioning a Laboratory

Prior to vacating or renovating a laboratory space, the Faculty/Principal Investigator is responsible for following the prescribed Laboratory Decommissioning Procedure

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APPENDIX A

Definitions

Action Level: A concentration designated for a specific substance, calculated as an eight-hour time weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance. The action level is always lower than the corresponding OSHA permissible exposure limit (PEL) and is designed to protect personnel from overexposure.

Acute Toxicity: (Per 29 CFR 1910.1200 App A.1) Acutely toxic substances cause adverse effects by any of the following exposure methods:

1. Oral or dermal administration of a single dose of a substance.
2. Multiple oral or dermal doses within a 24-hour period
3. An inhalation exposure of 4 hours.

By the criteria listed below, substances are placed in one of four toxicity categories according to their experimentally derived LD50 or LC50 values.

Exposure Route	Category 1	Category 2	Category 3	Category 4
Oral *(mg/kg body-weight)*	≤ 5	> 5 and ≤ 50	> 50 and ≤ 300	> 300 and ≤ 2000
Dermal *(mg/kg body-weight)*	≤ 50	> 50 and ≤ 200	> 200 and ≤ 1000	> 1000 and ≤ 2000
Inhalation – gases *(ppm by volume)*	≤ 100	> 100 and ≤ 500	> 500 and ≤ 2500	> 2500 and ≤ 20000
Inhalation – vapors *(mg/L)*	≤ 0.5	> 0.5 and ≤ 2.0	> 2.0 and ≤ 10.0	> 10.0 and ≤ 20.0
Inhalation - dusts and mists *(mg/L)*	≤ 0.05	> 0.05 and ≤ 0.5	> 0.5 and ≤ 1.0	> 1.0 and ≤ 5.0

*Note: Substances in Categories 1 and 2 are considered to have a "**high degree of acute toxicity.**" These substances are also referred to as "**Highly Acutely Toxic Substances**."*

Asphyxiant: See simple asphyxiant

Aspiration Hazard: (Per 29 CFR 1910.1200 App A.10) A liquid or solid chemical that causes severe acute effects if it infiltrates into the trachea and lower respiratory tract. Possible effects include chemical pneumonia, pulmonary injury, or death.

Carcinogen: (Per 29 CFR 1910.1200 App A.6) A substance or a mixture of substances which induce cancer or increase its incidence.

See also: Select Carcinogen

Combustible Liquid: (Per Cal/OSHA 8 CCR 5194) Any liquid having a flash point greater than 93°C (199.4°F).

Compressed Gas: See Gases under pressure nonnarcotic, which come under the jurisdiction of federal Drug Enforcement Administration (DEA) and state laws regulating their manufacture, sale, distribution, use, and disposal.

Corrosive: (Per 29 CFR 1910.1200 App A.2 and App A.3) A substance causing irreversible destruction of living tissue by chemical action at the site of contact. Major classes of corrosive substances include strong acids and strong bases. Corrosive substances may be classified as causing *skin corrosion*, *serious eye damage*, or both. Skin corrosives are further divided into 3 hazard categories (1A, 1B, and 1C; 1A being the most corrosive). The criteria for each category are available in 29 CFR 1910.1200 App A.2.2.1.

Cryogenic Liquids: Materials with extremely low boiling points (i.e., less than -150 °F). Common examples of cryogenic liquids are liquid nitrogen, liquid helium, and liquid argon. One special property of both cryogenic liquids and dry ice (frozen carbon dioxide) is that they undergo substantial volume expansion when converted to the gas phase, which can potentially lead to an oxygen-deficient atmosphere in areas where ventilation is limited.

See also: Refrigerated liquefied gas

Explosive: (Per 29 CFR 1910.1200 App B.1) A solid or liquid chemical which, by itself, can chemically react to produce gases at such a temperature and pressure and at such a speed as to cause damage to the surroundings. Pyrotechnic chemicals are included even when they do not evolve gases.

Flammable: (Per 29 CFR 1910.1200 App B.2, B.3, B.6, B.7) A substance that falls into one of the following categories:

- *Flammable gas* means a gas having a flammable range with air at 20°C (68°F) and a standard pressure of 101.3 kPa (14.7 psi).
- *Flammable liquid* means a liquid having a flash point of not more than 93°C (199.4°F).
- *Flammable solid* means a solid which is a readily combustible solid, or which may cause or contribute to fire through friction. *Readily combustible solids* are powdered, granular, or pasty substances which can be easily ignited by brief contact with an ignition source, such as a burning match, and for which flame spreads rapidly.
- *Flammable aerosol* means an aerosol containing any flammable materials. An *aerosol* is defined as a non-refillable receptacle containing a gas compressed, liquefied, or dissolved under pressure, and fitted with a release device allowing the contents to be ejected either as suspended particles in a gas, or as a foam, paste, powder, liquid, or gas. See also: Combustible liquid

Gases Under Pressure: (Per 29 CFR 1910.1200 App B.5) Gases which are: stored at a pressure of 29 psi (gauge) or more, liquefied, or liquefied and refrigerated. They are divided into the following four categories:

- *Compressed gas*: A gas which, when under pressure, is entirely gaseous at a temperature of -50°C (-58°F), including all gases with a critical temperature ≤50°C (-58°F).
- *Liquefied gas*: A gas which, when under pressure, is partially liquid at temperatures above -50°C (-58°F).
- *Refrigerated liquefied gas*: A gas which is made partially liquid because of its low temperature.
- *Dissolved gas*: A gas which, when under pressure, is dissolved in a liquid phase solvent.

Germ Cell Mutagen: (Per 29 CFR 1910.1200 App A.5) A substance that causes mutations in the germ cells of humans which can be transmitted to their offspring. Germ cell mutagens are further classified into 3 hazard categories (1A, 1B, and 2) based on the weight of evidence for their germ cell mutagenicity, with category 1A having the most conclusive evidence. The criteria for each category are available in 29 CFR 1910.1200 App A.5.2.

Hazardous Chemical: Any chemical which is classified as a health hazard or simple asphyxiant.

Health Hazard: A chemical classified as posing one or more of the following hazardous effects: 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 (single or repeated exposure), or aspiration hazard.

Hepatotoxin: Substances that produce liver damage (e.g., nitrosamines, carbon tetrachloride).

Highly Toxic / Highly Acutely Toxic: See Acute Toxicity

Incompatible: Materials that could cause dangerous reactions by direct contact with one another.

Irritant: (Per 21 CFR 1910.1200 App A)

- *Skin irritant:* A substance that causes reversible damage (such as swelling or inflammation) to the skin following an exposure.
- *Eye irritant:* A substance that causes changes in the eye following an exposure, which are fully reversible within 21 days of exposure.

Laboratory Personnel: Includes both employee and non-employee laboratory personnel who perform research activities, and covers individuals employed in the laboratory workplace who may be exposed to hazardous chemicals in the course of their assignments. Employees include faculty and staff and may include research associates, undergraduate and graduate students, and post-doctoral researchers, depending on their employment status. Non-employees include visiting scholars and may include research associates,

undergraduate and graduate students, and postdoctoral researchers, depending on their employment status.

Laboratory Safety Plan: An individual plan prepared by a PI that covers the safety procedures pertinent to activities conducted in his/her laboratory**.**

Faculty/PI: The individual in charge of the laboratory. It may be a Principal Investigator (PI), laboratory instructor, or laboratory manager.

LC50/LD50 (also referred to as "median lethal dose"): The dose required to kill half of a tested animal population. When the dose is expressed in units of mass (usually normalized to the mass of the animal tested), the abbreviation LD50 is used. Similarly, the abbreviation LC50 is used for doses expressed in units of concentration.

Microscaling (of process): Reducing the quantities of hazardous chemical used in a research operation to "microscale" quantities in order to reduce the risks to personnel and property and to minimize chemical waste streams. Microscale quantities range from 50-1000 milligrams and utilize glassware designed to hold less than 25 ml.

Nanoparticle: A collection of tens to thousands of atoms approximately 1 to 100 nanometers in diameter, which may either be naturally occurring or engineered. Examples include: carbon buckyballs or fullerenes; carbon nanotubes; metal oxide nanoparticles (e.g., titanium dioxide); and quantum dots, among many others.

Nephrotoxin: Substances causing damage to the kidneys (e.g., certain halogenated hydrocarbons).

Neurotoxin: Substances that exhibit their primary toxic effects on the nervous system (e.g., mercury, acrylamide, carbon disulfide).

Non-Laboratory Personnel: Laboratory personnel such as administrative staff, plumbers, and Heating, Ventilation & Air Conditioning (HVAC) technicians entering research laboratories to perform maintenance, administrative, or other non-research laboratory tasks.

Organic Peroxide: (Per 29 CFR 1910.1200 App B.15) A liquid or solid organic chemical which contains the bivalent -O-O- structure, and as such is considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals.

Oxidizer: (Per 29 CFR 1910.1200 App B.4, B.13, B.14)

- *Oxidizing gases* are gases which may cause or contribute to the combustion of other material more than air does, generally by providing oxygen.
- *Oxidizing solids and liquids* are substances which, while not necessarily combustible themselves, may cause or contribute to the combustion of other material, generally by yielding oxygen.

Oxidizing solids and liquids are each divided into three hazard categories (1, 2, and 3) based on their ability to accelerate combustion, with Category 1 being the strongest oxidizer. The criteria for each category are available in 29 CFR 1910.1200 App B.13.2 and B.14.2.

Particularly Hazardous Substances: These consist of select carcinogens, reproductive toxins, and substances that have a high degree of acute toxicity.

Permissible Exposure Limit (PEL): Per OSHA, the maximum permitted 8-hour time-weighted average concentration of an airborne contaminant.

Physical Hazard: A chemical that is classified as posing one of the following hazards: explosive, flammable, combustible liquid, oxidizer, self-reactive, pyrophoric, self-heating, organic peroxide, corrosive to metal, gas under pressure, in contact with water emits flammable gas, water-reactive, or combustible dust.

Precursor Chemical: Chemicals used in the course of legitimate research that can potentially be used in the illicit production of Controlled Substances such as methamphetamine, cocaine, heroin, and MDMA (ecstasy).

Pyrophoric: (Per 29 CFR 1910.1200 App B.9, B.10)

- *Pyrophoric gases* are gases that will ignite spontaneously in air at a temperature of 130 °F (54.4 °C) or below.
- *Pyrophoric solids and liquids* are chemicals which, even in small quantities, are liable to ignite within five minutes after coming into contact with air.

Reproductive Toxin: A chemical which affects reproductive capabilities. Possible effects include chromosomal damage (mutations), effects on fetuses (teratogenesis), adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring.

Restricted Chemicals: Use of the following chemicals requires prior approval by the Faculty/PI and EHS:

- Toxic gases (e.g., Diazomethane, Hydrogen cyanide, Hydrogen fluoride (anhydrous), Nickel carbonyl)
- Dimethylmercury

Sensitizer: (Per 29 CFR 1910.1200 App A.4)

- *Respiratory sensitizers* are substances that will lead to hypersensitivity of the airways following inhalation of the substance.
- *Skin sensitizers* are substances that will lead to an allergic response following skin contact.

Both respiratory and skin sensitizers are further classified into two categories (1A and 1B, 1A being the strongest sensitizers) based on the criteria in 29 CFR 1910.1200 App A.4.2.1 and A.4.2.2, respectively.

Select Agent Toxins: Certain toxins of biological origin identified by the United States Department of Health and Human Services (HHS), Centers for Disease Control and Prevention (CDC), the United States Department of Agriculture (USDA), and the Animal and Plant Health Inspection Service (APHIS) as posing a potential threat to public health or welfare. Selected biological organisms (bacteria, viruses, fungi) are also regulated as Select Agents.

Select Carcinogen: A substance or agent that meets one of the following criteria:

1. It is regulated by OSHA as a carcinogen.

2. It is listed under the category, “known to be carcinogens” in the most recent edition of the Annual Report on Carcinogens published by the National Toxicology Program (NTP).

3. It is listed under Group 1 (carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

4. It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

   (a) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;

   (b) After repeated skin application of less than 300 mg/kg of body weight per week; or

   (c) After oral dosages of less than 50 mg/kg of body weight per day.

Self-Heating Chemical: (Per 29 CFR 1910.1200 App B.11) A solid or liquid chemical that is not a pyrophoric liquid or solid, which, by reaction with air and without outside supply of energy, is liable to self-heat. These chemicals differ from pyrophoric substances in that they will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).

Self-Reactive Chemical (also referred to as “unstable”): (Per 29 CFR 1910.1200 App B.8) Thermally unstable liquid or solid chemicals which are liable to undergo a strongly exothermic decomposition even without participation of oxygen (air). This definition excludes chemicals classified as explosives, organic peroxides, oxidizing liquids, or oxidizing solids.

Simple Asphyxiant: A substance or mixture that displaces oxygen in the ambient atmosphere and can thus cause oxygen deprivation in those who are exposed, leading to unconsciousness and death.

Specific Target Organ Toxicity (STOT): (Per 29 CFR 1910.1200 App A.8 and App A.9) A *specific target organ toxicant* is a substance that has non-lethal toxic effects on specific organs or biological systems. This term includes all significant health effects that impair organ function and are not specifically covered by another hazard classification (e.g., acute toxicity, carcinogenicity, etc.). These toxicants are divided into two types by the number of exposures necessary for toxic effects to occur:

- *Single exposure (STOT-SE)*
- *Repeated exposure (STOT-RE)*

Both STOT-SE and STOT-RE are divided into two categories (Category 1 and Category 2) by the weight of the evidence for toxic effects in humans, with Category 1 having the most conclusive evidence. The criteria for each category are available in 29 CFR 1910.1200 App A.8.2 and A.9.2.

Substitution: When designing and planning a laboratory operation, using the least hazardous chemical possible to minimize risk to personnel and property.

Threshold Limit Value (TLV): As determined by the American Conference of Governmental Industrial Hygienists (ACGIH), a threshold limit value is the airborne concentration of a chemical substance under which it is believed that nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects.

Toxic Gas: (per NJIT 's Toxic Gas Table for a list of Toxic Gases)

- *Class I Material:* Has a median Lethal Concentration (LC50) in air of 200 parts per million or less by volume of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for an hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.
- *Class II Material:* Has a LC50 in air more than of 200 parts per million but not more than 3,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 30 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for an hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.
- *Class III Material:* Has a LC50 in air more than of 3,000 parts per million but not more than 5,000 parts per million by volume of gas or vapor, or more than 30 milligrams per liter but not more than 50 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for an hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Toxic Substance: See Acute Toxicity and Specific Target Organ Toxicity

Unstable: See Self-reactive

Water-Reactive (also referred to as "Chemicals which, in contact with water, emit flammable gases"): (Per 29 CFR 1910.1200 App B.12) Solid or liquid chemicals which, when exposed to water, can become spontaneously flammable or give off flammable gases in dangerous quantities. These chemicals are divided into three categories (1, 2, and 3) based on the strength of their reaction with water, with Category 1 being the most reactive. The criteria for each category are available in 29 CFR 1910.1200 App B.12.2.

APPENDIX B

Useful Links

- NJIT EHS Website
- NJIT EHS Forms
- RTK Hazardous Substance Fact Sheets
- Emergency Responders Quick Reference (QR)
-

APPENDIX C

NJIT Lab Safety Materials

1. NJIT General Laboratory Safety Rules

- Know the location of laboratory exits.
- Know the location and use of the safety showers and eyewashes.
- Know the location and use of fire extinguishers.
- Know the location and use of spill kits, when available.
- Know the location of the nearest phone, which can be used in an emergency.
- Know the potential hazards of the materials, facilities, and equipment that you will work. If you are uncertain ask your instructor, your supervisor, or the Safety Department.
- Use the proper safety equipment for your procedure. This could include a fume hood, glove box, biosafety cabinet, shield, or other equipment.
- Do not wear contact lenses in laboratories where chemicals are used.
- Wear eye protection in the laboratory. Splash goggles may be required for wet chemical work or work with dusts and powders.
- Wear other personal protective gear where laboratory or experimental conditions dictate. This includes laboratory coats, gloves, and eye protection.
- **Wear proper laboratory attire** - clothes that protect the body against chemical spills, dropped objects, and other accidental contact. Therefore, bare midriffs, shorts, open shoes, sandals, flip flops, and high heels are prohibited.
- Confine long hair when in the laboratory. Remove or secure articles of clothing or jewelry that might become entangled in equipment.
- Do not eat, drink, smoke or apply cosmetics or lip balm in the laboratory. Do not store food or drink in the laboratory, or use laboratory equipment for eating or drinking.
- **Do not pipette by mouth**. Use only mechanical pipette devices.
- Wash hands frequently when handling chemicals and before leaving the laboratory. Beware of contamination of clothing or of doorknobs, computer key boards, telephones, etc. Remove any protective gear before leaving the laboratory; this includes gloves and laboratory coats.
- Follow written protocols or instructions. Perform only authorized experiments. Do not move or disturb equipment in use without consent of the user.
- Do not work alone in the laboratory, particularly after hours.
- Do not play in the laboratory.
- Follow good housekeeping practices -- clean up as you go, and keep work areas, aisles and exits uncluttered.
- Do not deface labels on chemical containers. Make sure all container labels correctly identify their contents.

- Report all accidents and injuries immediately to your laboratory instructor or supervisor.
- Report unsafe conditions to your instructor, supervisor, or the Safety Department.

Additional Rules for Students

- Read and follow the Safety Rules listed previously.
- Know who is in charge of your laboratory.
- Perform only authorized experiments, and be sure you understand the procedures involved before you begin. If anything unexpected, dangerous, threatening, or unmanageable happens, immediately call your instructor.
- Do not use unfamiliar equipment without instruction and permission.
- Behave and dress appropriately for conscientious work in a potentially hazardous place.
- Never play in the laboratory.
- Report all accidents and injuries, however small, to your instructor.

Additional Rules for Instructors and Supervisors

- Take responsibility, in attitude and action, for the safety conditions of your laboratory.
- Observe all rules and see that they are enforced.
- Set an example by wearing protective equipment and by following proper laboratory procedures to promote safe work habits.
- Carefully review all laboratory experiments for possible safety problems before the experiments are assigned to students.
- Make both preventative and remedial safety measures part of your instruction. Be sure all students and laboratory workers are familiar with emergency procedures and equipment.
- Be alert for unsafe conditions. Inspect often and intelligently; take effective corrective action promptly.
- Assume responsibility for visitors and require that they follow the same rules as students and other laboratory workers.
- Keep a current file of publications on laboratory safety. Encourage its use. Review Safety Data Sheets (SDS) for materials used in laboratory protocols.

Rules for Custodial Workers

- You may sweep, mop, wash the floors and remove normal trash from any laboratory, including a radiation laboratory.
- Rooms, which have a Caution Sign and any of the nine different stickers on the door, may contain materials or equipment, which if used improperly, may cause harm.
- Do not touch any material, container, or waste container with a biohazard symbol or radiation symbol on it.

- You must not touch, disturb, move, or handle any containers of any chemicals or materials except those issued to you by your department. If you need chemicals or other laboratory materials moved in order to perform your duties, have the room supervisor arrange for this to be done, or contact your supervisor.
- If the contents of any containers (other than those issued to you) are spilled, DO NOT TOUCH THEM OR ATTEMPT TO CLEAN THEM UP. Tell your supervisor, who will then contact emergency personnel.
- Wear safety glasses if there are persons working in the laboratory.
- Do not eat, drink, smoke, or apply cosmetics in a laboratory.
- If you have any questions, contact the room supervisor first, your supervisor next, or finally, EHS.

Rules for Maintenance Workers

- Before working in a laboratory, or on a chemical fume hood, inform the room supervisor what you will be doing, and when you will be working. The room supervisor's name should be posted on the main laboratory door.
- The room supervisor is responsible for assuring that your work area within the room is free from physical, chemical, and/or biological hazards. Your work area may include hoods, sinks, cabinets and benches, bench tops, floors, and/or equipment. You may be required to repair, move, remove, replace, paint, etc. as part of your duties.
- Do not handle or move chemicals in the laboratory. If you need chemicals moved in order to perform your duties, have the room supervisor arrange for this to be done.
- Generally, you should not move or handle equipment in the laboratory. If your work requires you to move, remove, or replace a piece of equipment, have the room supervisor assure you that the equipment is free of any physical, chemical and/or biological hazards.
- Do not eat, drink, smoke, or apply cosmetics in the laboratory.
- In situations where the hazard cannot be totally removed, specific work procedures will be developed in conjunction with the room supervisor, and EHS. If there is a chance your work may bring you in contact with chemical hazards (e.g. working on laboratory sinks, working in areas where there is a chance of chemical contamination) or when working in rooms where chemical experiments are taking place, have the room supervisor provide you with the necessary protective equipment, including gloves, goggles, etc.
- When working on a fume hood, ask the room supervisor if the hood was used for perchloric acid or radioactive materials. Contact EHS before performing maintenance on any part of a perchloric acid or radioactive materials fume hood system (including: hood, base, duct, fan, stack, etc.). Lubricate perchloric acid hood fans with fluorocarbon grease only.
- If you have any questions, contact the room supervisor first, your supervisor next, or finally EHS.

Waste Disposal

- Please ensure that all waste materials generated by your experiments are stored and labeled properly.
- Please contact the Safety Department at 973-596-3059 or at healthand-safety@njit.edu to review laboratory waste requirements
- Please contact the Safety Department at 973-596-3059 or at healthand-safety@njit.edu to make arrangements to have waste removed from you laboratory
- Waste removal forms are located at: http://www5.njit.edu/environmental-safety/ehs-forms/

Emergency Notification

- In case of a minor laboratory incident or injury contact NJIT Public Safety at: 973-596-3111
- NJIT Public Safety may also be reached by dialing 911 from any Campus phone
- Severe incidents and injuries must be reported to the NJIT Public Safety by dialing: 911

2. Chemical Segregation Table

Hazard Category	GHS Pictogram	Hazard Class	Incompatibles	Storage
Compressed Gas		**Flammable**	Oxidizing gases Toxic gases Oxidizing solids	• Cool, dry area • 20 ft. away from oxidizing gases • Secure cylinders upright and immovable • Portable propane gas cylinders cannot be stored indoors
		Oxidizing	Flammable gases	• Cool, dry area • 20 ft. away from flammables or separated by 5 ft. high wall with 0.5hr fire resistance • Secure cylinders upright and immovable
		Toxic	Flammable gases Oxidizing gases	• Cool, dry area • Away from flammable gases and liquids • Secure cylinders upright and immovable
Corrosive		**Inorganic Acids**	Flammable liquids Flammable solids Bases Oxidizers Organic acids	• Separate, protected acid storage cabinet • NOT on metal shelves
		Organic Acids	Flammable liquids Flammable solids Bases Oxidizers Inorganic acids	• Separate, protected acid storage cabinet • NOT on metal shelves
		Oxidizing Acids	Flammable liquids Flammable solids Inorganic acids Organic acids Bases	• Separate, protected acid storage cabinet • NOT on metal shelves • Away from flammables
		Bases	Flammable liquids Oxidizers Poisons Acids	• Storage cabinet separate from all acids

Hazard Category	GHS Pictogram	Hazard Class	Incompatibles	Storage
Reactives		**Explosives**	All other chemicals	• Secure location • Away from all other chemicals • Not able to fall
		**Flammable Solids**	Acids Bases Oxidizers Poisons	• Separate, dry, cool area • Away from oxidizers • Away from corrosives
		Flammable Liquids	Acids Bases Oxidizers Poisons	• Flammable storage cabinet • Peroxide forming chemicals must be dated when opened
		**Water Reactive Chemicals**	All aqueous solutions Oxidizers	• Dry, cool location • Protect from water (including fire sprinkler system!!) • Label location “water reactive”
		**Oxidizers**	Reducing agents Flammables Organic materials	• Use a spill tray • Non-combustible cabinet • Away from flammables
Other		**Poisons**	Flammable liquids Acids Bases Oxidizers	• Vented, cool, dry area • Use a chemically resistant secondary container

3. **NJIT Regulated Waste Guidelines**

GUIDE CONTENTS

NJIT's Regulated *and Hazardous Waste Disposal Guide for Laboratory and Academic Shops* contains five (5) sections.

Section 1 Background provides an introduction to the concepts of various "regulated" and "hazardous waste" management definitions and information specific to NJIT's philosophy on proper waste management.

Section 2 Principles and Procedures for Laboratory Waste Management and **Section 3 Principles and Procedures for Academic Shop Waste Management** contain specific information pertaining to regulated waste management principles. Topics addressed are waste characterization, generator requirements, satellite accumulation areas, waste container management.

Section 4 Training and Educational Information describes when training is required; what training is required; and various sources of information, particularly waste identification, management requirements, appropriate containers, labelling and marking.

Section 5 Emergency Procedures and Contingency Planning discusses spill preparedness; incident response; and who to contact in the event of an emergency.

Section 1: Background

On October 21, 1976 the U.S. Congress passed the ***Resource Conservation Recovery Act*** (RCRA) to ensure the proper management of municipal and industrial waste. RCRA, which amended the Solid Waste Disposal Act of 1965, established national goals for:

- protecting human health and the environment from the potential hazards of waste disposal;
- conserving energy and natural resources;
- reducing the amount of waste generated; and
- ensuring that wastes are managed in an environmentally sound manner.

To achieve these goals, RCRA established three separate programs:

- RCRA Subtitle D: Solid Waste program
- RCRA Subtitle I: Underground Storage Tank (UST) program
- RCRA Subtitle C: Hazardous Waste program

The RCRA regulations are contained in Title 40 of the Code of Federal Regulations (CFR) Parts 239 through 299. 40 CFR Parts 239 through 259 contain the regulations for **solid waste**; the requirements for **underground storage tanks** are located in 40 CFR Part 280; and Parts 260 through 279 contains the regulations governing **hazardous waste management**. In addition, the New Jersey Department of Environmental Protection (NJDEP) promulgated statutes and regulations establishing parallel regulatory requirements for New Jersey based generators, transporters and waste management facilities.

Hazardous Waste Generator Regulations

The NJIT regulated waste management operating procedures are based on Parts 261 and 262 of Subtitle C of RCRA, and the NJDEP regulations for hazardous waste generators which are specifically found at N.J.A.C. 7:26G-6 et seq., which references 40 CFR Part 262 of the Federal regulations (with some exceptions and/or changes). These regulations require NJIT to ensure and document fully that the hazardous waste we produce is properly identified, contained and marked, stored and transported prior to off-site treatment, recycling or disposal.

Universal Waste Generator Regulations

N.J.A.C. 7:26A-7.4 and the management requirements for *large quantity handlers* are found at N.J.A.C. 7:26A-7.5. "*Universal waste handler*" means a person who treats (except under the provisions of N.J.A.C. 7:26A-7.2(d) 1 or 3, or N.J.A.C. 7:26A-7.3(d) 1 or 3), disposes of, or recycles universal waste, or a person engaged in the off-site transportation of universal waste by air, rail, highway, or water, including a universal waste transfer facility. N.J.A.C. 7:26A-7.2(d) 1 or 3, or N.J.A.C. 7:26A-7.3(d)1 or 3), disposes of, or recycles universal waste, or a person engaged in the off-site transportation of universal waste by air, rail, highway, or water, including a universal waste transfer facility.

Small Quantity Handler Requirements for Mercury Containing Devices N.J.A.C. 7:26A-7.2(d)1 or 3, or N.J.A.C. 7:26A-7.3(d)1 or 3), disposes of, or recycles universal waste, or a person engaged in the off-site transportation of universal waste by air, rail, highway, or water, including a universal waste transfer facility.

Generator Status

Generally, Subtitle C defines a "generator" as any person or facility that:

- creates or produces a hazardous waste or
- imports a hazardous waste into the United States.

Amount of Waste Generated

Under the RCRA statute there are three (3) classes of generators based on how much waste is generated and accumulated in a month:

- Conditionally Exempt Small Quantity Generators (CESQG) are defined as those facilities that produce:
    - 100 kg or less of hazardous waste per calendar month **or**
    - 1 kg or less of acutely hazardous waste per calendar month

    - No more than 1000 kg of hazardous waste, 1 kg of acutely hazardous waste, or 100 kg of any residue from the cleanup of an acutely hazardous waste at any time
- Small Quantity Generators (SQG) are defined as those facilities that produce:
    - Between 100 and 1000 kg of hazardous waste per calendar month **and**
    - Accumulate less than 6000 kg of hazardous waste at any time
- Large Quantity Generators (LQG) are defined as those facilities that produce:
    - 1000 kg or more of hazardous waste per calendar month **or**
    - 1kg or more of acutely hazardous waste per calendar month

Roles and Responsibilities

NJIT is committed to managing regulated waste generated by its laboratory and academic shop operations in a **safe, compliant, and environmentally sound manner**. The purpose of these Waste Guidelines is to ensure that the various categories of regulated waste are properly handled, stored, transported, and treated or disposed.

The mission of the NJIT **Department of Environmental Health and Safety** is to work with the campus community to develop and implement an efficient, convenient, comprehensive, and forward-looking regulated waste management program. Priorities are as follows:

- To develop waste management programs that protect the health and well-being of students, faculty, staff, and visitors at NJIT.
- To manage regulated wastes in an environmentally sound and cost-effective manner that minimizes NJIT's liabilities and risks.
- To assist the campus community in complying with federal, state, and local regulations, and NJIT's Standard Operating Procedures and Guidelines.
- To provide overall program management and be responsible for regulatory compliance.
- To represents NJIT with relevant regulatory authorities.

NJIT has recently expanded its research programs, laboratories and activities that have subsequently redefined NJIT as a ***Large Quantity Generator***. Therefore, NJIT Hazardous Waste Generator requirements must include the following:

- Register as a Large Quantity Generator with the appropriate federal and state environmental regulatory agencies;
- Comply with hazardous waste container requirements;
- Meet collection and storage requirements for **Satellite Accumulation Area** (SAA) and **Accumulation Areas** (AA) for Hazardous Waste;
- Prepare a **Contingency Plan** that documents NJIT's preparedness and spill prevention measures (40 CFR 265 Subpart);
- Ensure that following information is posted next to the telephones in all Hazardous Waste Accumulation and Storage areas;
    - name and phone number of the emergency coordinator and the back up emergency coordinator,
    - location of the spill control material, fire alarm, and fire extinguishers, and

    - telephone number of the local fire department;
- Ensure that all NJIT laboratory personnel involved in the generation or management of hazardous waste are familiar with emergency response and waste handling procedures within their work area(s);
- Establish and implement recordkeeping procedures for waste characterization, documentation of generator status registration, shipping manifests, exception reports, container inspection, land disposal restrictions, and correspondence with local emergency responders; and
- Develop and implement a formal Hazardous Waste Management training program.

Individual laboratories, academic shops, or other operations that generate regulated waste materials are considered "*individual waste generators*", and are responsible for the appropriate management of their waste materials while the wastes are being produced and stored prior to removal from the laboratory or shop by the NJIT EHS Department or NJIT's waste vendor. Individual waste generators are also responsible for immediately notify the NJIT EHS Department for any spill or release of regulated waste and for any non-compliant situation within their laboratory or shop.

Waste vendors, transporters, contractors used by NJIT to remove, transport and treat/dispose of regulated waste are required to possess all appropriate licenses, registrations, training, certifications, and insurance required by all relevant jurisdictions. Additionally, all vendors used by NJIT to remove, transport and treat/dispose of regulated waste are required to adhere to all applicable federal, state, and local regulations and guidelines. Copies of all bills of lading, shipping manifests, and ultimate treatment/disposal manifests will be supplied by the vendor to the EHS department as required to ensure that NJIT can document the proper management of its regulated wastes from "cradle to grave".

Section 2: Principles and Procedures for Laboratory Waste Management

Waste Identification

The first step in the hazardous waste management process is the proper characterization of each waste. The following determination process must be performed by the generator:

- Step 1- is the waste a **solid waste**?
- Step 2- is the waste **excluded** by regulations (e.g., specific regulatory exclusion), such as:
    - is the waste water discharged in accordance with federal, state or local waste water permits or regulations;
    - is the waste regulated by the US DOE as a radioactive waste;
    - is the waste a lab sample awaiting analysis; or
    - is the waste an "empty" container?

- Step 3- is the waste a **listed hazardous waste** (e.g., does the waste appear on one of the following regulatory lists)
    - F-List (40 CFR 261.31): non-specific source list
    - K-List (40 CFR 261.32): specific source list
    - P-List (40 CFR 261.33(e)): acutely hazardous waste that is an unused, discarded commercial chemical product or lab made products, generally 100% pure or one active ingredient
    - U-List (40 CFR 261.33(f)): toxic waste with the same criteria as described above (P-List)
    - State Listed Waste
- Step 4- is the waste a **characteristic hazardous waste** (e.g., demonstrates one of the following characteristics)
    - Ignitability (40 CFR 261.21): generally liquids with flashpoints less than 60°C (150°F)
    - Corrosivity (40 CFR 261.22): generally aqueous solutions pH $\leq$ 2 or $\geq$ 12.5
    - Reactivity (40 CFR 261.23): generally unstable, explosive, capable of detonation when heated under confinement, react violently with water, generate toxic cyanide or sulfur fumes when subjected to the pH conditions described above
    - Toxicity (40 CFR 261.24): contain specific regulated constituents as determined by Toxicity Characteristic Leaching Procedure (TCLP)

RCRA definition of hazardous waste: **Hazardous waste** is a waste with properties that make it dangerous or potentially harmful to human health or the environment. In regulatory terms, a RCRA hazardous waste is a waste that appears on one of the four hazardous wastes lists (F-list, K-list, P-list, or U-list), or exhibits at least one of four characteristics: ignitability, corrosivity, reactivity, or toxicity. To determine if a waste is hazardous, generators may use either knowledge or testing (40 CFR 262.11). If the generator is unsure the waste should be managed as if it is known to be hazardous.

Since NJIT laboratory researchers must be aware of each chemical used in a particular experiment, process, or procedure, generator knowledge is almost always sufficient in making an appropriate waste determination.

- If generator knowledge is insufficient to make an appropriate waste determination other means (e.g., testing) will be employed. These situations will be handled on a case by case basis.

Individual waste generators will adhere to the Satellite Accumulation Area (SAA) requirements listed below.

Hazardous Waste Management

A Satellite Accumulation Area (SAA) is a designated area for hazardous waste at or near the point of generation (e.g., near the process that generates the waste), and must

be under the control of the operator of that process (40 CFR 262.34(c)). Each NJIT laboratory will have an appropriate area designated as the SAA. Each generator of an SAA will adhere to the following requirements:

Accumulation Limits

No more than:

- 55-gallons of hazardous waste; and/or
- 1-quart of acutely hazardous waste per SAA.

Waste Container Management

- Waste must be stored in an approved leak-proof and sealed containers.
- Each waste container must be compatible with the containerized waste.
    - *Individual generators should contact the EHS Department for help selecting appropriate waste containers.*
- Never overfill waste containers, and always leave adequate head space in all waste containers to allow for expansion. Typically 1-inch of head space should be allowed.
- Waste containers must be in good condition.
- All waste containers must be properly labelled. See "**Container Labeling**" below.
- Retaining expired or off-specification chemicals is prohibited.
- Maintaining multiple containers of same waste is discouraged. Keep the number of waste containers to a minimum number and size.
- Lab personnel must monitor waste containers daily for signs of leaks or container deterioration.
- Waste containers must be **properly closed at all times**, except when adding waste.
- Waste containers must be stored in secondary containment to minimize the risk of leak or damage of the primary storage container. Secondary containment is not required for plastic and steel drums and plastic pails.
- Waste containers must be segregated by hazard class.

Container Labeling

- For Containers **Without** Manufacturer's Original Label
    - Apply the NJIT Hazardous Waste label (see Appendix III) to the container **immediately** once waste is placed in the container.
    - Do not label empty containers.
    - The hazardous waste label is to be filled out completely.
    - Write the full name of all the chemical constituents and the approximate percentage of each. Total should equal 100%.
    - The use of abbreviations, chemical formulas, molecular structures, and foreign languages are **not acceptable**.
    - Complete all necessary information including the generator contact information.
    - Date the label only **when EHS is contacted to remove the waste.** Do not date the label when waste is first placed into the container.

- **An example of the NJIT Hazardous Waste Label is included in Appendix III**

- For Containers **With** the Manufacture's Original Label (see Figure 1)

Figure 1

1. Leave the original label intact and write the words "**Hazardous Waste**" on the label.

2. For chemicals intended for recycling or reuse within the department or university, do not write "Hazardous Waste" on the label. EHS will assist in reusing and recycling the chemicals.

SAA Requirements

- Hazardous waste **must** be stored in the laboratory's designated Satellite Accumulation Area (SAA).
- The SAAs must accommodate all waste generated by the laboratory.
- Within the SAAs, incompatible waste must be separated by a physical barrier, such as High-density Polyethylene (HDPE) bins.
- SAA must be located at or near the point of generation.
- SAA must be under the control of the person generating the waste.
- Wastes must be segregated by waste type. (For example, flammable, poisons, acids, and alkalis must be stored separately.)
- Each HDPE bin within the SAA is limited to one compatible waste stream
- Each individual hazardous waste generator (laboratory) will have a designated Group member responsible for hazardous waste management compliance. This person may be the Principal Investigator, Laboratory Supervisor, Shop Supervisor or their designee.
- The designated individual must be:
  - knowledgeable about the waste generated by the laboratory;
  - familiar with the NJIT Hazardous Waste management procedures;
  - current with all mandatory laboratory safety training; and
  - familiar with all applicable NJIT emergency response procedures.

Removal of Hazardous Chemical Waste from an NJIT Laboratory

- Individual waste generators must contact the EHS department to schedule waste removal from their laboratory.
- Waste removal is scheduled by submitting a Waste Removal Request Form to the NJIT EHS Department.
- Waste Removal Request Forms may be found on the NJIT EHS Department Website listed under the tab for *Forms* and the tab for Waste Management.
- Individual waste generators must complete the form; listing each container and its contents on the form, as well as all appropriate laboratory or shop contact information.
- Completed forms may be e-mailed to the EHS Department as an attachment or completed and submitted as a fillable PDF directly on the EHS website.
- Completed *Waste Removal Request Forms* may be e-mailed to:

        - healthandsafety@njit.edu or
        - submitted directly from the EHS website by pressing the submit button.
    - The NJIT EHS Department can also be contacted at **973-593-3059** for assistance.
    - Replacement waste containers may be ordered by completing and submitting the *Waste Container Request Form* and submitting it in the same manner as described above.
    - Examples of both the *Waste Removal Request Form* and the *Waste Container Request Form* may be found in Appendix IV.

Biological and Regulated Medical Waste Management

There are multiple standards and regulations that govern the management of *biological waste*. Chief among them are the *OSHA Bloodborne Pathogen Standard* (29 CFR 1910.130); the NJ Solid Waste Regulations, Subchapter 3A, *Regulated Medical Wastes* (NJAC 7:26); the Joint CDC/NIH Guidelines entitled *Biosafety in Microbiological and Biomedical Laboratories*, 5th Edition and the NIH *Guidelines for Research Involving Recombinant and Synthetic DNA Molecules*, April, 2016.

Biological Waste

In broad terms, biological waste may be defined as:

- liquid or solid waste contaminated with infectious or potentially infectious microorganisms tissue culture
- cell cultures
- recombinant DNA
- genetically engineered organisms, plants, or products regulated by the CDC, NIH, USDA/APHIS, or other State and local authorities.

These materials may be classified by the biosafety level (BL) of the contaminant. The CDC/NIH Guidelines describe 4 biosafety levels (BL-1 through BL-4) with BL-1 being the least hazardous and BL-4 being the most hazardous. As NJIT laboratories only manipulate materials regulated at BL-1 and BL-2, no waste beyond BL-2 will be generated. In terms of hazard assessment, the NJIT *Institutional Biosafety Committee* and *NJIT Biosafety Manual* regulate human derived materials (e.g., human blood and body fluids, primary human tissue explants and cell lines, as well as commercially obtained human cell lines) at BL-2 containment.

Treatment of Biological Waste

The CDC/NIH Guidelines require that BL-1 and BL-2 waste be decontaminated prior to disposal. Typically, adequate disinfection may be achieved by employing either:

- physical means: typically taken to mean **autoclave** processing which employs a combination of time, temperature, and pressure to achieve disinfection; or
- chemical means: the application of a chemical disinfectant with the appropriate properties that, given the necessary contact time, adequate disinfection will be

achieved. Typically a concentration of **10% liquid chlorine bleach** in direct contact with the waste material for 20 to 30 minutes will be sufficient.

Potentially contaminated biological waste items are accumulated in the laboratory in red or orange autoclave bags. When almost full, these bags are closed, placed in a spill or leak proof tray for transport to the autoclave, if autoclave is located outside the laboratory. Autoclave tape or other sterility indicator shall be used to demonstrate that the bag has been adequately disinfected by the autoclave process. Spill or leak proof trays made of Nalgene, or other autoclavable material, shall be used in the autoclave to contain any leaking material. This is especially important when autoclaving liquid waste or solid waste containing moderate amounts of liquid (e.g., culture flasks and petri dishes).

Following adequate disinfection, biological waste will be placed into Medical Waste boxes, lined with red bags that are supplied by the NJIT EHS Department. An example of a properly labeled medical wasted box may be found in the Figure 2. The **NJIT Medical Waste label** will be applied to all Medical Waste boxes, once the laboratory begins placing waste into the Medical Waste box. An example of the NJIT medical waste labels can be found in Appendix III. Once properly sealed, full Medical Waste boxes will be stored in a secure location (typically the laboratory) to await monthly pick up by the NJIT's waste vendor. Medical Waste boxes must have proper labels supplied by the vendor and the NJIT Medical Waste label.

Figure 2

Regulated Medical Waste (RMW)

The State of NJ maintains a 2-step definition for *Regulated Medical Waste* (RMW). To be considered RMW, solid waste must meet both the process and classification definitions that follow.

- Process Definition: RMW is any solid waste generated from one of the following processes: the diagnosis, treatment or immunization of humans or animals; research pertaining to the diagnosis, treatment or immunization of humans or animals; or the production or testing of biologicals.
- Classification Definition: To be considered RMW items that are included in the above process definition must also belong to one of the following 7 classes:
    1. cultures and stocks of infectious agents and associated biologicals
    2. human pathological waste including tissues, organs, other body parts and fluids
    3. human blood and blood products
    4. contaminated sharps
    5. animal waste that may be potentially infectious
    6. isolation waste
    7. unused sharps

"Overclassified" Medical Waste

Some biological waste items generated in NJIT laboratories may resemble RMW in appearance and waste characteristics, but may not meet the specific NJDEP RMW definition. Regardless of the definition, laboratory waste that may have come into contact with potentially infectious material (for example soiled gloves or labware) shall be treated as if it were RMW. Overclassified medical waste must be packaged, labeled, and stored in the same manner as RMW and is collected by the medical waste vendor. It is important to note that if the generator classifies biological waste as RMW, the storage, containment and management of the waste are now subject to the NJDEP regulations for RMW regardless of the waste characteristics.

Treatment and Segregation of RMW

One of the principal differences between the regulations concerning biological waste (waste generated by research activities) and Regulated Medical Waste (waste generated clinically-associated activities) is the need for treatment of the waste prior to its placement in the Medical Waste box. In general, there is a regulatory requirement to pre-treat (e.g. disinfect) research waste prior to placing in the Medical Waste box for ultimate disposal. On the clinical side; however, there is no regulatory requirement for pre-treatment.

To avoid any misconceptions, all waste generated by NJIT laboratories that may be contaminated with potentially infectious agents, organisms, or products will be properly decontaminated prior to being placed in the Medical Waste box for ultimate disposal.

Examples of waste items that require decontamination prior to place in a Medical Waste Box include laboratory-generated materials with:

- human blood and other human body fluids;
- human, animal or plant pathogens;
- primary human tissue explants and their clonal derivatives;
- tissue and cell cultures;
- recombinant/genetically altered plants, organisms, or products;
- infected animal products; and
- other potentially infectious waste materials.

Storage of RMW

Full boxes of RMW will be stored at the point of generation to await regularly scheduled pick up by the EHS Department or Medical Waste vendor. Full boxes should be properly labeled and sealed securely. Small volumes of liquid waste (e.g., blood or cell culture residue) shall be placed in sealed containers with absorbent material prior to being deposited in the Medical Waste box. Volumes of liquid may not exceed 20cc per individual container.

Labeling of RMW

All containers of Biological and RMW must be properly labeled. This applies to the outer container (the Medical Waste box) as well as all inner containers (e.g. sharps containers or cell culture containers with associated liquid residue. Examples of inner and

outer RMW labels can be found in Appendix III. Generators of RMW are required to label the outer container and each individual container **immediately upon use**. Typically, the outer RMW container is labeled with the following information:

- generator's or intermediate handler's name and address
- the transporter's name and NJ DEP solid waste registration number
- date of shipment
- identification of contents as medical waste

NJIT has developed RMW labels for both the outer shipping container and the inner containers. Examples of these labels are provide in Figures in Appendix III and should be applied to both the outer shipping container and the individual inner containers. These labels are in addition to any label supplied by the vendor or pre-printed on the Medical Waste box.

Sharps

Figure 3

Sharps such as needles, scalpel blades, broken test tubes, syringes and other sharp instruments contaminated with biological materials present the greatest risk of transmission of bloodborne pathogens in the laboratory setting. Disposable glass or plastic syringes (with or without needles), scalpel blades, and other sharp items should be deposited into an appropriate leak-proof, puncture-resistant, and labeled sharps container, as shown in figure 3, immediately after use. Disposable needles should never be recapped, bent, broken, sheared, or removed from disposable syringes. If an NJIT laboratory worker sustains a needle stick the steps outlined in NJIT *Exposure Control Plan* located within the *NJIT Biosafety Guide* shall be followed.

Sharps containers should be located in all work locations where it is reasonably anticipated that sharps may be used. Sharps containers should only be filled to within one inch of the top of the container. Sharps containers should never be overfilled. Never attempt to force additional material into a full container.

As stated above, sharps containers should be properly labeled as an inner container prior to being placed in the Medical Waste box. Once filled, the properly labeled sharps container should be closed, sealed, and placed in a Medical Waste box, lined with a red bag, to await pick up by the medical waste vendor or the NJIT EHS Department.

Other Laboratory Waste Management

Certain wastes generated by laboratory procedures may not be considered hazardous waste by the RCRA or NJDEP regulations. However, due to toxological properties or other concerns these waste products may not be placed in the regular trash or poured down the laboratory. **Contact the NJIT EHS Department for specific guidance on waste characterization, containerization, labelling and accumulation.**

Non-Hazardous Chemical Waste Management

Non-hazardous chemical wastes may be described as waste chemicals that do not meet the criteria listed in Section I (Hazardous Chemical Waste – Waste Identification). However, these materials are not suitable for disposal in the regular trash or disposal via the sanitary sewer. Non-hazardous chemical waste should be accumulated, stored, maintained, and transported using the same methodology previously described for regulated hazardous waste. One exception is that these wastes should be labeled with the NJIT *Non-Hazardous Waste Label* for an example of the NJIT Non-Hazardous Waste Label. An example of the NJIT Non-Hazardous Waste Label can be found in Appendix III. **For assistance with waste characterization contact the NJIT EHS Department.** An example of a Non-Hazardous Chemical Waste is:

Ethidium Bromide (EtBr) and other Electrophoresis Gel Stains

EtBr is an example of a common molecular biology laboratory reagent, used to stain nucleic acids, that while classified as a mutagen, its disposal is not regulated by EPA regulations. Solid waste containing EtBr include gels, absorbent paper, gloves, weigh boats.

EtBr liquid waste may be either:

- pre-treated with a commercially available filtration or neutralization kit prior to disposing the treated liquid in the laboratory drain; or
- the saturated filter or neutralization media should be handled as solid EtBr waste by placing the waste in an appropriate container (glass bottle or plastic jug with tight fitting lid) and properly labeled with the Non-Hazardous Waste Label for disposal as chemical waste.

Empty Reagent Bottles Waste Management

RCRA (40 CFR 261.7) defines an empty container if:

(i) All wastes have been removed that can be removed using the practices commonly employed to remove materials from that type of container, e.g., pouring, pumping, and aspirating, *and*

(ii) No more than 2.5 centimeters (one inch) of residue remain on the bottom of the container or inner liner, *or*

(iii) (A) No more than 3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is less than or equal to 119 gallons in size; or

(B) No more than 0.3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is greater than 119 gallons in size.

Empty chemical reagent bottles should be triple rinsed and dried prior to disposal. If the empty container previously contained a regulated hazardous material the 1st rinsate should be retained as hazardous waste. If the empty container held an acutely hazardous material the container should not be rinsed, rather the container should be properly labeled and disposed as a hazardous waste in its entirety (container, cap, and residue).

An examples of the NJIT Hazardous Waste Label can be found in Appendix III. Once rinsed and dried empty reagent bottles (other than those that previously contained acutely hazardous materials) should have their labels defaced and be discarded as non-contaminated laboratory glass.

Laboratory Glass Waste Management

Clean/ Uncontaminated Laboratory Glass: Laboratory glass and broken laboratory glass that is free of contamination may be discarded in a broken glass box (e.g., a sturdy cardboard box lined with a plastic bag) and labeled as "**Clean Lab Glass**" (make figure). When filled, these boxes should be sealed with tape. Once sealed, please contact NJIT EHS Department for disposal. Care must be taken that the glass is properly packaged to prevent potential injuries to those who may transport and handle the waste.

Contaminated or Potentially Contaminated Laboratory Glass: Laboratory glass and broken laboratory glass that is that is potentially contaminated should be placed in a sturdy container, labeled as "Lab Glass: (see, and discarded as non-hazardous waste. Fiber drums may be requested from the EHS department for this purpose. Once sealed, please contact NJIT EHS Department for disposal. Care must be taken that the glass is properly packaged to prevent potential injuries to those who may transport and handle the waste downstream.

Universal Waste Management

Many laboratory activities generate waste materials that the USEPA and NJDEP regulate as *Universal Waste*. These materials may not be discarded in the regular trash. The following items should be collected, placed in an appropriate container, and labeled as "**Universal Waste**", and offered to the NJIT EHS Department for disposal. Examples of Universal Waste include:

- rechargeable batteries such as lead acid, NiCad, NiMH, and Li
- mercury containing devices such as thermometers, manometers, switches, thermostats, and mercury vapor lamps
- high intensity discharge lamps, neon lamps, high-pressure sodium lamps, and metal halide lamps
- although often characterized as universal waste, electronic components such as circuit boards and computer screens are managed by the NJIT IT Department E-Waste program.

Used Oil Management

Used vacuum pump oil should be collected in an appropriate container (glass bottle or plastic jug), labeled as "**Used Oil**" and offered to the NJIT EHS Department for disposal.

Section 3: Training and Educational Information

Initial Training

All NJIT employees who work with hazardous chemicals must be apprised of the hazards of chemicals present in their work area. **This training must be provided before initial assignment and before new exposure situations.**

Employees who work with chemicals in laboratories must be trained on the OSHA Laboratory Standard; employees who work with chemicals in places other than laboratories must be trained under the Hazard Communication (*Worker Right-to-Know*) program. If you are a NJIT employee and have not received such training, request that your supervisor make arrangements to provide you with such training. The NHIT EHS Department is available to assist in this training.

Topics to be covered during the initial training include the general safety topics discussed in this guide and the specific hazards that might be encountered on your job.

Refresher Training

The frequency for refresher training for employees trained under the OSHA Laboratory Standard is left to the discretion of the employer. At NJIT the frequency of refresher training is determined by Principal Investigators in concert with the NJIT EHS Department. The NJIT EHS Department recommends that refresher training for specific hazards of the research performed be conducted **annually.**

Additional or specialized training is required when new risk exposure situations arise. Such situations include: the use of new chemicals, greater quantities of chemicals, different laboratory procedures or shop operations and equipment.

Safety Data Sheets (SDSs)

SDSs should be the first source of information about the hazards associated with a chemical.

Typically, SDSs will contain the following information, usually in separate sections on the sheet:

- name, address, and phone number of manufacturer
- chemical name, synonyms, and Chemical Abstract Services (CAS) Number
- physical properties
- a listing of hazardous constituents for mixtures
- health hazard information
- first-aid measures
- fire fighting measures

- handling and storage precautions
- exposure controls/personal protection
- stability and reactivity

Newer SDSs will contain the following additional information:

- toxicological information
- ecological information
- disposal considerations
- transport information
- regulatory information
- other information

Manufacturers are required to provide a SDS for each chemical product sold. The NJIT EHS Department maintains a repository of all the SDSs received by the campus. If the NJIT EHS Department does not have a SDS for a product you are using, the NJIT EHS Department will obtain one. It may be faster to go to the manufacturer's or chemical supplier's website and find a copy or search an online database. Government regulations specify that SDSs must be readily available to employees. NJIT EHS Department recommends that each PI obtain hard copies of SDSs for the materials being used and maintain copies in a binder in the laboratory or shop.

Other Sources of Information

A list of chemical safety references available from the NJIT EHS Department are provided in Appendix II. Of these, *Prudent Practices and Safety in Academic Chemistry Laboratories* will be the most useful to laboratory workers.

The NJIT EHS Department personnel are also available to visit work areas and consult with individuals or small groups about specific chemical hazards and alternatives for mitigating those hazards.

Additional training offered by the NJT EHS Department include the following courses:

- Radiation Safety Training
- Biological Safety and BBP Training
- Laser Safety Training
- NJ Worker and Community Right-to-Know and Hazard-Communication Training
- Laboratory Safety Training
- Shop Safety Training

Section 4: Emergency Preparedness and Contingency Planning Summary

NJIT EHS Department has prepared a ***RCRA Contingency Plan*** in accordance with federal and state regulations that defines the procedures for responding to emergencies involving the hazardous wastes generated and managed at NJIT. The *Contingency Plan* is intended to minimize hazards to human health and the environment associated with the release of any hazardous waste or hazardous waste constituents to the environment. The *Contingency Plan* describes actions that personnel will take to protect the general public, including the NJIT community, and response personnel during emergencies involving hazardous wastes managed on campus property. In addition, the *Contingency Plan* is intended to minimize damage to the facility and the environment due to a release of hazardous, biological, RMW, non-hazardous and Universal waste. The information provided below summarizes many of the key aspects of the Contingency Plan. For more detailed information please refer to the complete NJIT RCRA Contingency Plan.

NJIT has established a Hazardous Materials Response Team (HMRT) to respond to a release of any hazardous waste or hazardous waste. The HMRT includes NJIT employees and private emergency response contractors into a singular responsive safety group. The HMRT is to act as a preventative or loss restraint team, and as a first response team. The NJIT EHS Department has the primary responsibility of managing the waste management program and providing initial response to incidents involving the hazardous waste generated on campus. To accomplish this, the NJIT EHS Department has designated two staff employees to perform the duties of Primary and Alternate Emergency Coordinators in the event of an emergency.

This Contingency Plan details response procedures for fires, Level I and Level II responses. The Level I response is intended to address minor spills, not involving fire or serious injuries, where all duties can be carried out by the Emergency Response Contractor. The Level II response is intended for serious incidents including incidents involving fire, large quantity spills, and/or severe injury that cannot be handled by NJIT staff.

Emergency Assistance

Call (973) 596-3059 NJIT EHS Department or NJIT Department of Public Safety (973) 596-3111 for assistance with the following kinds of emergencies:

- chemical or biological waste spills for which assistance is required
- medical assistance for injuries
- fires
- other sudden accidents

NJIT EHS Department will dispatch the Fire Department and/or ambulances as appropriate.

You should be ready to provide the following information:

- What is the name of the spilled waste?
- What quantity of the spilled waste?
- Where is the spill (building name and room number)?
- Is anyone injured or splashed with the waste?
- Is a fire or explosion involved in the spill?
- What is your name and phone number?

Spill Preparedness

Most laboratory chemical spills and many small chemical spills outside laboratories can be safely cleaned up by those who spilled the waste. If handled properly, these small spills are little more than a minor nuisances. On the other hand, some spills should be cleaned up only by specially trained emergency response personnel.

Since spills can greatly disrupt your activities, and, at worst, cause bodily harm or property damage, it is prudent to make preparations before spills occur. This section provides basic emergency preparedness information and gives general guidance on how you should respond to chemical spills.

Preventing spills: Listed below are some basic spill prevention steps that apply to the storage, transportation, and transfer of waste.

- General precautions
    - reduce clutter and unnecessary materials in your work areas
    - eliminate tripping hazards and other obstructions
    - have all needed equipment readily available before starting work
    - employ Storage precautions
        - use sturdy shelves
        - larger containers should be stored closer to the floor
        - containers on shelves should be stored back from the edge to reduce the danger of falling
        - storage shelves should have lips to further reduce the danger of falling
        - chemicals should be stored first by compatibility, then alphabetically
        - inspect the storage area regularly for leaking or defective containers
        - use appropriate storage containers
        - do not store unprotected glass containers on the floor
- Transportation precautions
    - use carts, where appropriate
    - use safety containers, where appropriate

    - use secondary containers, where appropriate
    - use bottle carriers for 2.5 and 4.0 liter bottles
    - use straps to secure containers, where appropriate
    - think about potential hazards before transporting wastes
    - consider purchasing plastic coated "shatter resistant" bottles
- Precautions in transferring wastes
    - pay careful attention to the size of container to avoid overfilling
    - use pumps or other mechanical devices rather than simple pouring
    - provide containment to capture leaks and spills

Preparing for spills: it is best to proceed in an organized manner for spill response. Evaluating potential hazards and establishing protocols in advance will be well worth the initial effort.

Before working with chemicals or biological materials you should determine what could go wrong (Hazard Assessment) and how you might respond to a spill. As a result of this evaluation, you should prepare written protocols for use in the event of a spill and make sure that you have all the necessary personal protective devices, safety equipment, and containment/clean up materials readily available. These protocols need to be communicated to all persons who might be affected by a spill and included in the training for the laboratory workers. Each individual who may be involved in spill response or clean-up must know the purpose and limitations of all personal protective equipment, safety equipment and clean up materials.

Spill control kits: Spill control materials should be available at all times. You may buy prepackaged spill kits from various vendors. NJIT EHS Department carries a combination caustic/acid/solvent spill kit.

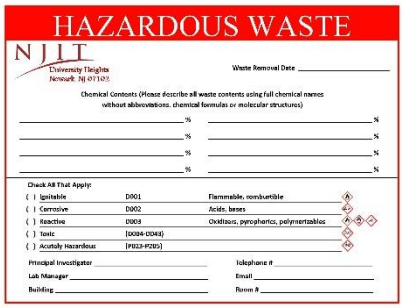
Because pre-packaged kits tend to be expensive, many chemical and biological material users prefer to make their own kits. Should you decide to make your own kit, include the following at a minimum:

- Disposable (nitrile or latex) gloves (1 box)
- Neoprene gloves (1 set)
- Safety goggles (ventless preferred)
- Poly scoop
- Poly dustpan
- Plastic bags
- Absorbent material
    - 3M Chemical Sorbent or similar material , or
    - 1:1:1 mixture of sand, soda ash, and kitty litter
- 5-gallon poly (plastic) pail

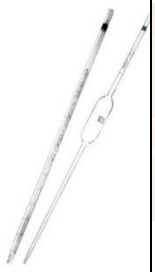
The location of spill control kits should be clearly marked and highly visible. Make sure all personnel know the location of the kit, are familiar with the contents of the kit, and understand the limitations of the kit.

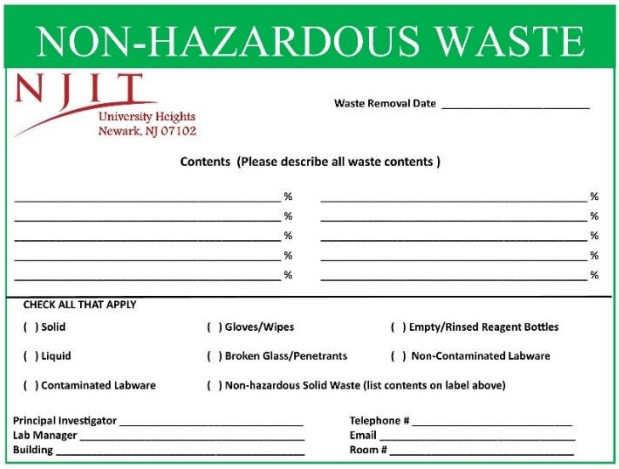
4. Hazardous Chemical Waste Disposal

Waste Type	Solid Waste	Liquid Waste		
Waste Type and Examples				
	Large and small containers of fine chemicals, metals (such as Cadmium, Lead), solids (such as Sodium hydroxide), pharmaceuticals (such as Cyclophosphamide, Warfarin)	Liquid chemicals in original containers with manufacture's label	Acids, Bases, Mixed corrosives, Non-solvents (oxidizers, others)	Haloginated solvent (any organic chemical that contains F, Cl, Br, or I: Chloroform, bromophenol blue, etc.), Non-haloginated Solvents (Acetone, Toluene, Xylene, etc.)

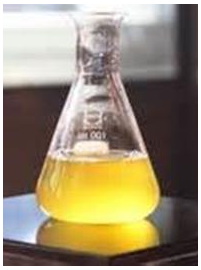
Waste Type	Solid Waste		Liquid Waste		
Container	Chemicals in original containers with manufacture's label - Leave the label intact and write the words "Hazardous Waste" on the label and/or container. For containers, pails, drums, etc. provided by NJIT EHS, or other containers re-used by the laboratory – Apply the NJIT Hazardous Waste Label. Always ensure that container being used is compatible with the waste material being place within it.	Plastic container, pail or drum   	Chemicals in original containers with manufacture's label - Leave the label intact and write the words "Hazardous Waste" on the label and/or container. For containers, pails, drums, etc. provided by NJIT EHS, or other containers re-used by the laboratory – Apply the NJIT Hazardous Waste Label. Always ensure that container being used is compatible with the waste material being place within it.	Plastic pail or drum   	Plastic pail or drum   Steel drum 
Labeling	Apply the **Hazardous Waste** label to the container when you begin to fill it. Please do not label empty containers. Fill the label out completely. Write down the full name of all the chemical components and the approximate percentage of each substance. Total should equal 100%. Do not use abbreviations, chemical formulas, or molecular structures. Please complete all necessary information including laboratory contact information. The label is dated when EHS is contacted to remove the waste.  HAZARDOUS WASTE NJIT University Heights Newark, NJ 07102 Waste Removal Date _____ Chemical Contents (Please describe all waste contents using full chemical names without abbreviations, chemical formulas or molecular structures) _____ % _____ % Check All That Apply: ( ) Ignitable D001 Flammable, combustible ( ) Corrosive D002 Acids, bases ( ) Reactive D003 Oxidizers, pyrophorics, polymerizables ( ) Toxic (D004-D043) ( ) Acutely Hazardous (P012-P205) Principal Investigator _____ Telephone # _____ Lab Manager _____ Email _____ Building _____ Room # _____		
Disposal	Place in waste accumulation area with similar or compatible waste types using secondary container when required.				
Contact EHS for Disposal. E-Mail completed Waste Pick Up Request to: healthandsafety@njit.edu If you have any questions, call 973-596-3059					

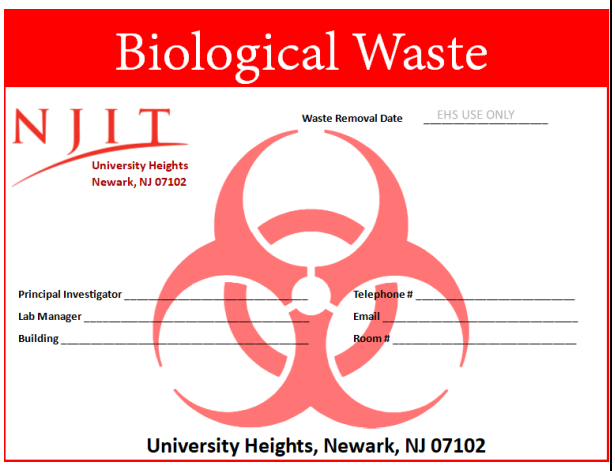
5. Non-hazardous Waste Disposal

Waste Type	Broken Glass	Solid Waste				Liquid Waste
Waste Type and Examples						Active pharmaceutical ingredients (such as baclofen, antibiotics, nimodipine), enzymes (such as pectinase, xanthine oxidase), media (such as agar), albumin, amino acid, sugars (such as glucose, sucrose), buffers (such as Tris buffer), salts (saline solution), glycerin, gelatin, pectin, certain photographic developers. Please contact EHS for help characterizing your lab's waste.
	Broken glass, non-biological or infectious needles, razors	Gloves, paper towels, chem wipes, weigh boats, spatulas, other potentially contaminated lab-ware	Empty glass bottles, non-broken glass pipettes	Other- cardboard, news print, paper, clean non-lab plastic, packaging material (recyclables)	Large and small containers of fine chemicals (such as magnesium sulfate, sodium bicarbonate, sodium sulfate, etc.), solids (such as silica gel), pharmaceuticals, salts, buffers, standards, reagents, and others (Soils & other loose materials)	

Waste Type	Broken Glass	Solid Waste			Liquid Waste
Container	Plastic pail or fiber drum 	Fiber drum 	Plastic recycling bin 	Plastic pail  Steel drum 	
Labeling	Apply the **Non-Hazardous Waste** label to the container when you begin to fill it. Please do not label empty containers. Fill the label out completely. Write down the full name of all the chemical components and the approximate percentage of each substance. Total should equal 100%. Do not use abbreviations, chemical formulas, or molecular structures. Please complete all necessary information including laboratory contact information. The label is dated when EHS is contacted to remove the waste.  NON-HAZARDOUS WASTE NJIT University Heights Newark, NJ 07102 Waste Removal Date _____ Contents (Please describe all waste contents) _____ % _____ % _____ % _____ % _____ % _____ % _____ % _____ % _____ % _____ % CHECK ALL THAT APPLY ( ) Solid ( ) Gloves/Wipes ( ) Empty/Rinsed Reagent Bottles ( ) Liquid ( ) Broken Glass/Penetrants ( ) Non-Contaminated Labware ( ) Contaminated Labware ( ) Non-hazardous Solid Waste (list contents on label above) Principal Investigator _____ Telephone # _____ Lab Manager _____ Email _____ Building _____ Room # _____				
Disposal	Place in accumulation area with similar or compatible waste types, secondary container. Except plastic recycling bin was taken by housekeeper.				
Contact EHS for Disposal. E-Mail completed Waste Pick Up Request to: healthandsafety@njit.edu If you have any questions, call 973-596-3059					

6. Biological, Recombinant, and Medical Waste Disposal

Waste Type	Sharps/tubing	Reusable contaminated glass and plastic lab ware	Solid waste	Liquid waste
Waste Type and Examples				
Waste Type and Examples	Razor blades, scalpels, syringes, specimen tubes, contaminated broken glass, Pasteur pipettes, broken microscope slides	Contaminated flasks, cylinders, beakers, vials, bottles	Culture dishes, petri dishes, tissues, cells, gloves, masks, and other solid contaminated items	Human blood or body fluids, liquid growth media, animal blood, Recombinant DNA Waste
Container	 Red Sharps Container	 	  	 

Waste Type	Sharps/tubing	Reusable contaminated glass and plastic lab ware	Solid waste	Liquid waste
Decontamination	Prior to placing in the Medical Waste box, full sharps containers contaminated with BL-2 material should be decontaminated by autoclaving or by chemical disinfection with 10% liquid chlorine bleach. Place in Regulated Medical Waste Box or Contact EHS for Disposal	Prior to drain disposal, liquid waste must be decontaminated with 10% liquid chlorine bleach solution, then carefully poured down the drain. Rinse with fresh water. Empty containers may then be handled as Solid Waste	Prior to placing in the Regulated Medical Waste box, Biosafety Level 2 waste must me decontaminated. Decontaminate with fresh 10% bleach soln. allow at least 20 minutes contact time OR Autoclave. Contact EHS for disposal	Prior to drain disposal, liquid waste must be decontaminated with 10% liquid chlorine bleach solution, then carefully poured down the drain. Rinse with fresh water. Empty containers may then be handled as Solid Waste OR Autoclave
Disposal		Drain Disposal. Reuse or dispose as solid waste		Drain Disposal
Labeling	Apply the **Biological-Medical Waste** label to the waste container when you begin to fill it. Please do not label empty containers. Fill the label out completely. Please complete all necessary information including laboratory contact information. The inner label is dated when EHS is contacted to remove the waste. Please apply the inner label to sharps containers and other containers that are placed in the RMW box. The outer label goes on the outside of the RMW box. <u>Example:</u> DRAFT			
Contact EHS for Disposal E-Mail completed Waste Pick Up Request to: healthandsafety@njit.edu If you have any questions, call 973-596-3059				

7. Waste Labels

HAZARDOUS WASTE

NJIT University Heights Newark, NJ 07102

Waste Removal Date _____

Chemical Contents (Please describe all waste contents using full chemical names without abbreviations, chemical formulas or molecular structures)

_____ % _____ %
_____ % _____ %
_____ % _____ %
_____ % _____ %

Check All That Apply:

( ) Ignitable	D001	Flammable, combustible	
( ) Corrosive	D002	Acids, bases	
( ) Reactive	D003	Oxidizers, pyrophorics, polymerizables	
( ) Toxic	(D004-D043)		
( ) Acutely Hazardous	(P023-P205)		

Principal Investigator _____ Telephone # _____
Lab Manager _____ Email _____
Building _____ Room # _____

NON-HAZARDOUS WASTE

NJIT University Heights Newark, NJ 07102

Waste Removal Date _____

Contents (Please describe all waste contents)

_____ % _____ %
_____ % _____ %
_____ % _____ %
_____ % _____ %
_____ % _____ %

CHECK ALL THAT APPLY

( ) Solid ( ) Gloves/Wipes ( ) Empty/Rinsed Reagent Bottles
( ) Liquid ( ) Broken Glass/Penetrants ( ) Non-Contaminated Labware
( ) Contaminated Labware ( ) Non-hazardous Solid Waste (list contents on label above)

Principal Investigator _____ Telephone # _____
Lab Manager _____ Email _____
Building _____ Room # _____

Biological Waste

NJIT University Heights Newark, NJ 07102

Waste Removal Date EHS USE ONLY

Principal Investigator _____ Telephone # _____
Lab Manager _____ Email _____
Building _____ Room # _____

University Heights, Newark, NJ 07102

UNIVERSAL WASTE

NJIT University Heights Newark, NJ 07102

Waste Removal Date _____

CHECK ALL THAT APPLY

( ) Battery (ies) ( ) Mercury Containing Device
( ) Mercury Thermostat(s) ( ) Thermometer
( ) Lamp(s) ( ) Manometer
( ) Electronic Device(s) ( ) Switches
( ) Elemental/ Drained Mercury ( ) Gauges
( ) Other, Describe :_____

Principal Investigator _____ Telephone # _____
Lab Manager _____ Email _____
Building _____ Room # _____

ELECTROPHORESIS WASTE

NJIT University Heights Newark, NJ 07102

Waste Removal Date _____

State of Contents (check one)

☐ Solid Waste ☐ Liquid Waste

Chemical Constituents (Check one or write in)

☐ Ethidium Bromide ☐ SYBR® Green
☐ Propidium Iodide ☐ Methylene Blue
☐ Other _____

Principal Investigator _____ Telephone # _____
Lab Manager _____ Email _____
Building _____ Room # _____

Used Oil

NJIT New Jersey Institute of Technology

Waste Removal Date _____

General Information

Principle Investigator: _____ Telephone: _____
Lab Manager: _____ E-mail: _____
Building: _____ Room #: _____

University Heights, Newark, NJ 07102

8. **Satellite Accumulation Areas**

Satellite Accumulation Areas (SAA) Guidelines

- Hazardous waste must be stored only in the laboratory's designated Satellite Accumulation Area (SAA)
- The waste labels are to be filled out completely – include Lab Contact Information
- Write the full name of all the chemical components and the approximate percentage of each substance. Total should equal 100%.
- The SAAs in a laboratory must accommodate all waste streams generated by the laboratory
- Within the SAAs incompatible waste types are separated by a physical barrier
- SAA is located at or near the point of generation (e.g., in the lab)
- SAA is under the control of the person generating the waste
- Hazardous waste must be segregated by waste type – all incompatibles, including flammables, oxidizers, poisons, acids, and alkalis must be stored separately
- Each SAA is limited to one waste stream or compatible waste streams
- Each lab or shop will have designated individuals responsible for hazardous waste management
- The designated individuals will be:
  - Knowledgeable about the waste generated by the laboratory or shop operations;
  - Familiar with the NJIT Waste removal procedures;
  - Current with all mandatory laboratory and shop safety trainings; and
  - Familiar with applicable NJIT emergency response procedures.

SATELLITE ACCUMULATION AREA—HAZARDOUS WASTE (DRAFT)

Prepare Waste Area

- Maintain your designated waste collection area at or near the site of generation
- Display this sign close to the collection area
- All liquid waste must be stored inside a secondary container when there is risk of breakage

Accumulate Waste

- Attach a Chemical Waste Label to each waste container
- Label all chemical contents using full chemical names (No abbreviations, chemical formulas or molecular structures)

Request Pickup

- Submit a waste removal request form via the Environmental Health and Safety Website under EHS Forms: https://www5.njit.edu/environmentalsafety/
- Waste container request forms can also be accessed from the site
- All waste containers must be properly labeled before the waste can be removed

Work Safely

- Segregate incompatible materials (Acids/Bases, Flammables/Oxidizers, etc.)
- Follow your laboratory's written standard operating procedures (SOP)
- Wear PPE (lab coats, safety glasses, and appropriate gloves) at all times in the lab
- Shorts and open toe shoes are prohibited in the lab

Contact NJIT Environmental Health and Safety at
(973) 596 3059 or healthandsafety@njit.edu

NJIT
New Jersey's Science & Technology University

APPENDIX D
Standard Operating Procedure (SOP) Template

APPENDIX E

Generic SOP Library

1. BASIC

IRRITANTS and SENSITIZERS

ACIDS (NONOXIDIZING)

BASES (ALKALIS)

BASIC FLAMMABLE and COMUSTABLE LIQUIDS

GASES UNDER PRESSURE (EXCLUDING TOXIC and HIGHLY TOXIC GASES)

STRONG OXIDIZING AGENTS

CRYOGENS (LIQUID NITROGEN, LIQUID HELIUM, DRY ICE)

IRRITANTS AND SENSITIZERS

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

This SOP deals with two classes of related materials:

- Skin/eye irritants
- Sensitizers

Although the mechanism/target of their toxicity may vary, these materials are similar in that they generally don't present a physical hazard (fire, explosion, high reactivity) and are of less concern than "Particularly Hazardous Substances" (acute toxins, reproductive toxins, carcinogens – see SOP library). Their primary hazard are their short-term and reversible affects via skin contact (usually) or inhalation. Therefore, the engineering controls and personal protective equipment used to protect an individual are generally the same for these substances. The individual Safety Data Sheet (SDS) for a particular material should always be consulted before beginning work.

Definitions and Hazards

- **Irritants** are chemicals which are not corrosives, but which can cause a reversible inflammatory effect on living tissue at the site of skin or eye contact. Examples: chlorine, alkalis, some solvents.
- **Sensitizers** are chemicals which cause a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical. Poison oak is a good example of a natural sensitizer.

Labelling

Irritants and sensitizers are identified by the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS). Irritant or sensitizer containers manufactured after the implementation of GHS will have this symbol:

Work Practices

These materials have in common the fact that direct contact must be avoided. Careful handling and stringent controls are essential in order to minimize risk to researchers and the environment. **Note that this standard operating procedure describes the baseline requirements for handling these classes of compounds**. There are many cases where specific chemical entities require additional or modified handling procedures.

General information about working with hazardous chemicals can be found free in Prudent Practices in the Laboratory, National Research Council, 2011 Chapters 4 to 6. Specific information on these two classes of materials are in Sec. 4.C.3.

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the New Jersey Institute of technology (NJIT) Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

At minimum, complete protection of the eyes and skin is essential.

3. ENGINEERING/VENTILATION CONTROLS

Should always be used in a fume hood, glove box, or in totally-sealed containers. For further information see these pages in Section 2 of the NJIT CHP:

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

4. SPECIAL HANDLING PROCEDURES and STORAGE REQUIREMENTS

- Avoid working alone with hazardous materials.
- Eliminate or substitute for a less hazardous material when possible.
- Design your experiment to use the least amount of material possible to achieve the desired result.
- Do not exceed the scale or deviate from the experimental parameters which may be outlined in the lab-specific information section below without the approval of the PI.
- All hazardous materials must be labeled with their identity as well as all applicable warning statements. Manufacturer labels will contain all the necessary information. However, if material is repackaged or synthesized in the laboratory, please follow the protocols described in the CHEMICAL LABELLING section of the NKIT CHP.

5. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE; decontaminate equipment and bench tops using sodium bicarbonate and water. Dispose of all used contaminated disposables as hazardous waste following the Waste Disposal Section.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

9. DESIGNATED USE AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA SHEETS

Insert the location of SDS for chemicals used in the lab

11. LAB-SPECIFIC INFORMATION (required) *(Examples of appropriate content)*

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

ACIDS (NON-OXIDIZING)

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Acids are corrosive to eyes, skin, and mucous membrane and are generally immediately painful. Corrosive effects can occur not only on the skin and eyes, but also in the respiratory tract and, in the case of ingestion, in the gastrointestinal tract as well. The international symbol (GHS system) for a corrosive to skin/eyes (acid or base) is:

The pH range of acids is 0 to 6.9 (water = 7.0 = neutral). A pH of approximately 0 to 3 represents a **strong acid**. Some inorganic acids fall within this range. Weak acids (pH of 3 to 7) include diluted acetic acid solutions and boric acid. **Weak acids** irritate the skin with short contact and can cause burns with prolonged contact.

Heat is released when strong acids are mixed with water. When water is added to acid, an extremely concentrated solution of acid is initially formed and the solution may boil very violently, splashing concentrated acid. When acid is added to water, the solution formed is dilute and the small amount of heat released is not significant to vaporize and spatter it. **Always add acid to water, and never the reverse.** Aqueous solutions of inorganic acids are not in themselves flammable. Acids also react with many metals, resulting in the liberation of hydrogen, a highly flammable gas.

Some acids like nitric and perchloric are strong **oxidizing agents** and can react destructively and violently when in contact with organic solvents and organic acids like acetic. Due to the unique and highly reactive nature of oxidizing acids, there are *separate* UCSB SOP templates for nitric and perchloric acids that labs should adopt. Numerous accidents have occurred on campus via the mishandling of nitric acid. There is also a separate SOP for **hydrofluoric acid** given its unique hazards

2. HAZARDOUS NON-OXIDIZING ACIDS

All acid solutions are considered hazardous. The following is a list of the common non-oxidizing acids used: *hydrobromic acid; hydrochloric; hydrofluoric; acetic; benzoic; chloroacetic; formic; phosphoric; sulfuric; trifluroacetic*

3. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Given the severe and immediate effects of acids on the eyes and skin, and because PPE is required per OSHA regulation and New Jersey Institute of Technology (NJIT) policy, it is essential that proper PPE always be employed.

See the PPE information under Section 2 of the NJIT Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

4. ENGINEERING/VENTILATION CONTROLS

In general, acids should always be used in a properly functioning fume hood.

For further information see these pages in Section 2 of the NJIT CHP:

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

5. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

Acids can be only used in areas properly equipped with a certified eye wash/safety shower that can be reached within ten seconds. It is essential that all strong corrosives be stored separately from other laboratory chemicals with which they may react. Ensure secondary containment and segregation of incompatible chemicals. Also, follow any substance-specific storage guidance provided in Safety Data Sheet (SDS) documentation.

The corrosive properties of these materials and their ability to produce fires or explosions by combination with combustible materials make the following considerations mandatory in the selection of a storage site:

- A relatively cool, dry environment free from extremes of temperature--humidity should be maintained.
- Acids must be stored in a manner that separates them from other materials
- Stored acids in material that is acid-resistant; this facilitates flushing and other cleanup procedures in the event of leaks or spills.
- Store on low shelves or in acid/base storage cabinets.
- Segregate oxidizing acids from organic acids, and flammable and combustible liquids. This is crucial to avoid fires/explosions!
- Segregate acids from active metals such as sodium, potassium, magnesium, etc.
- Use bottle carriers for transporting materials when possible.
- When mixing acids and water, always add acid to water. NEVER add water to acid!
- Store mineral acids together, separate from oxidizing agents and organic materials.
- Store acetic acid and other organic acids with the combustible organic liquids.

Vented corrosives storage cabinet

6. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

7. DECONTAMINATION

Wear proper PPE; decontaminate equipment and bench tops using sodium bicarbonate and water. Dispose of all used contaminated disposables as hazardous waste following the Waste Disposal Section.

8. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

9. PRIOR APPROVAL/REVIEW

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

10. DESIGNATED USE AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

11. SAFETY DATA SHEETS

Insert the location of SDS for chemicals used in the lab

12. LAB-SPECIFIC INFORMATION (required) *(Examples of appropriate content)*

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

BASES (ALKALIS)

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this Standard Operating Procedure (SOP), add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Bases are generally chemicals containing the hydroxide (OH^-) anion, or materials that form hydroxide when added to water, e.g., carbonates. Bases are "corrosives" (like acids) and will destroy body tissue. The extent of injury depends on factors such as the type and concentration of the chemical, the route of exposure, the type of tissue contacted, and the speed used in applying emergency measures. Skin contact with strong bases usually goes unnoticed, since pain does not occur immediately.

The eyes are especially susceptible to bases and must be immediately flushed with water for at least 15 minutes if exposure occurs. Inhaling airborne dust and mist from bases irritate the nose, throat, and lungs. Pulmonary edema, a severe irritation of the lungs resulting in fluid production that prevents the transfer of oxygen to the bloodstream, can also occur from extreme airborne exposures. Secondary toxic effects may occur if the material is absorbed from the lungs into the bloodstream. The extent of these effects depends on the concentration in air and the duration of exposure.

Dilution of bases is exothermic and can result in the surface boiling and spattering. Therefore, always add the base to the water, thereby having a more dilute solution surface heating. This is particularly true for potassium hydroxide. Concentrated solutions of inorganic bases are not in themselves flammable.

HAZARDOUS BASES

All base solutions are considered hazardous. The following is a list of common bases: *Ammonium hydroxide; Barium hydroxide; Calcium hydroxide; Potassium hydroxide; Sodium hydroxide; Lithium hydroxide; Bicarbonate salts Carbonate salt*

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Given their tissue-damaging characteristics, it is crucial that appropriate PPE be used while handling bases. See the PPE information under Section 2 of the New Jersey Institute of Technology (NJIT) Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria

- respirator use, etc.

3. ENGINEERING/VENTILATION CONTROLS

All concentrated bases should be transferred and dispensed in an annually certified laboratory chemical fume hood with the sash at the certified position or lower.

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

- Bases can be only used in areas properly equipped with a certified **eye wash/safety shower** that can be reached within ten seconds.
- A relatively cool, dry environment free from extremes of temperature--humidity should be maintained. Some NJIT labs have ventilated “corrosive” cabinets built-in beneath the fume hood.
- Follow any substance-specific storage guidance provided in Safety Data Sheet (SDS) documentation.
- Bases should be stored in a manner that separates them from incompatible materials. Each base should be stored in a manner consistent with its properties.
- Bases should be stored in material that is base-resistant; this facilitates flushing and other cleanup procedures in the event of leaks or spills.
- Store on low shelves or in base storage cabinets.
- Use bottle carriers for transporting materials when possible.
- Store solutions of inorganic hydroxides in polyethylene containers.
- Use small quantities whenever possible. Monitor your inventory closely to assure that you have tight control over your material.

5. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE. Collect any crystals with a brush – avoid creating dust. Decontaminate equipment and bench tops. Dispose of all used contaminated disposables as hazardous waste following the Waste Disposal Section.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW REQUIRED

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed before an individual can do the operation.

9. DESIGNATED AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA SHEETS

Insert the location of the SDS for the chemicals used in the lab

11. LAB-SPECIFIC INFORMATION (required) *(Examples of appropriate content)*

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

BASIC FLAMMABLE and COMBUSTIBLE LIQUIDS HANDLING

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

This Standard Operating Procedure (SOP) is for work in which flammable/combustible liquids are NOT used in operations that often generate static electricity which can act as an ignition source; including the pumping or pouring of solvents between metal containers. Those operations require grounding and/or bonding of the containers to prevent static buildup and a different SOP template in the NJIT SOP Library should be used: ADVANCED FLAMMABLE AND COMBUSTIBLE LIQUIDS HANDLING

(See also these related UCSB SOPs: *"Peroxide-Forming Chemicals"*)

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Flammable and combustible organic solvents are amongst the most dangerous chemicals in the lab. A measure of how ignitable a particular solvent is the **flashpoint;** defined as the lowest temperature at which a material can form an ignitable mixture with air and produce a flame when a source of ignition is present. **The lower the flashpoint, the more easily the liquid can be ignited.** Most common organic solvents in the lab are readily ignited, with the exception of chlorinated solvents like dichloromethane which require more extreme conditions to burn.

Flammable liquids (flash point < 100ºF) are divided into three classes:

Class	Flash Point	Boiling Point	Examples
IA	Below 73°F	Below 100 °F	Ethyl Ether
IB	Below 73 °F	At or above 100 °F	Acetone, Benzene, Toluene
IC	At or above 73°F and below 100°F		Isopropanol, Xylene

Combustible liquids (flash point > 100ºF) are divided into three classes:

Class	Flash Point	Examples
II	100-139 °F	Acetic acid, cyclohexane, and mineral spirits

IIIA	140-199 °F	Cyclohexanol, formic acid and nitrobenzene
IIIB	200 °F or above	Formalin and vegetable oil

A particular organic solvent may have other hazards beyond their flammability. For example, benzene is recognized carcinogen. Check the Safety Data Sheet (SDS) for the particular solvents in use.

The international symbol (Globally Harmonized System) for flammable liquids/gases/solids is:

Diethyl ether initiated fire

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the New Jersey Institute of Technology (NJIT) Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

In general, workers who use flammable liquids will be issued a free fire-resistant lab coat.

3. ENGINEERING/VENTILATION CONTROLS

All chemicals should be transferred and used in an annually certified laboratory chemical fume hood with the sash at the certified position or lower. The hood flow indicator should be checked to be operating correctly prior to using the hood. For further information see the following pages in Section 2 of the NJIT CHP*:*

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

- Safety Shielding: Shielding is required any time there is a significant risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of flammable liquids which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.
- Special Ventilation: Manipulation of flammable liquids outside of a fume hood may require special ventilation controls in order to minimize exposure and reduce the fire risk. Fume hoods provide the best protection against exposure to flammable liquids in the laboratory and are the preferred ventilation control device. If your research does not permit the handing of large quantities of flammable liquids in your fume hood, contact EH&S to review the adequacy of all special ventilation.

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

Use in an area that is properly equipped with a certified eye wash and safety shower that is available within ten seconds of travel.

Store in a tightly closed, labeled container and in a cool, dry, well-ventilated area. Segregate from incompatible materials. Repackaged chemicals must be labeled clearly. For example, squirt bottles and acid/base cleaning baths. Follow any substance-specific storage guidance provided in Safety Data Sheet documentation.

- **Flammable Liquid Storage Cabinets**
  - ✓ One or more Flammable Liquid Storage Cabinets (FLSC) are required for laboratories which store, use or handle more than 10 gallons of flammable or combustible liquids.
  - ✓ Containers of flammable liquids that are one gallon and larger must be stored in a flammable-liquids storage cabinet.
  - ✓ The storage of flammable and combustible liquids in a laboratory, shop, or building area must be kept to the minimum needed for research and/or operations. FLSC are not intended for the storage of highly toxic materials, acids, bases, compressed gases, or pyrophoric chemicals.
  - ✓ In most NJIT laboratories, flammable liquids storage is provided under the chemical fume hood. These cabinets are clearly marked “Flammable Storage” and are often ventilated via a stainless steel hose into the fume hood exhaust duct. Flammable liquids storage cabinets are constructed to limit the internal temperature when exposed to fire. When additional storage is needed, NFPA-approved FLSC may be purchased. All containers of flammable liquids must be stored in a FLSC when not in use. The following requirements apply:

    General Requirements

    - Cabinets shall be marked “Flammable - Keep Fire Away”
    - Cabinets should be kept in good condition. Doors that do not close and latch must be repaired or the cabinet must be replaced.
  - ✓ Flammable liquids storage cabinets are equipped with a grounding system that can be connected to a building ground. If you are pouring from a container in the storage cabinet and if the container being poured into is conductive then a bonding strap must be attached between them as explained in **PROCEDURES TO AVOID STATIC ELECTRICITY**.

FLSC involved in fire

- **Labeling**
  - ✓ All flammable liquids must be clearly labeled with the correct chemical name.
  - ✓ Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.
  - ✓ The label on any containers of flammable liquids should say “Flammable” and should include any other hazard information, such as “Corrosive” or “Toxic”, as applicable. Example: lab squirt bottles, or acid/base baths.

- **Heating/Open flame**
  - ✓ Do not permanently store flammable liquids in chemical fume hoods or allow containers of flammable liquids in proximity to heating mantles, hot plates, or torches.
  - ✓ With the exception of vacuum drying ovens, laboratory ovens rarely have any means of preventing the discharge of material volatilized within them. Thus it should be assumed that these substances will escape into the laboratory atmosphere, but may also be present in sufficient concentration to form explosive mixtures within the oven itself. Venting the oven to an exhausted system will reduce this hazard.
  - ✓ Drying ovens should not be used to dry glassware that has been rinsed with organic solvents until all of the solvent has had the opportunity to drain or evaporate at room temperature.

5. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE; decontaminate equipment and bench tops using soap and water. Dispose of all used contaminated disposables as hazardous waste per below.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW REQUIRED

As they deem necessary, the PI/supervisor should insert here any prior approval or review needed, before an individual can do the operation.

9. DESIGNATED AREA

As they deem necessary, the PI/supervisor should insert here any information about whether a special use-area is designated for this material/process.

Work should be completed in a laboratory fume hood given the volatility and flammability of most solvents.

10. SAFETY DATA SHEETS and OTHER REFERENCES

Insert where SDS for chemicals used in the lab are located

Prudent Practices in the Laboratory, 2011, see Secs. 4.D and 6.F for flammable liquids
http://www.nap.edu/openbook.php?record_id=12654&page=R15

11. LAB-SPECIFIC INFORMATION (required) (Examples of appropriate content)

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

GASES UNDER PRESSURE

(EXCLUDING TOXIC AND HIGHLY TOXIC GASES)

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

The purpose of this standard operating procedure is to acquaint you with the proper and safe handling, use, storage and disposal of compressed gases. However, the following gases are **excluded** from this SOP:

- those that considered toxic, or highly toxic

The common toxic and highly toxic gases are listed in APPENDIX A. Given their high hazard and special regulations that apply to their use, these materials should have their OWN GAS-SPECIFIC SOP, rather than this generic gas SOP. Contact the EHS Department for assistance. In some cases, the volume or concentration of toxic/highly toxic gas may allow less rigorous control measures.

This SOP would typically apply to inert gases like nitrogen, argon and helium, flammable gases like hydrogen, methane, propane, plus oxygen (oxidizer; fluorine and chlorine are also strong oxidizers, but because of their high toxicity should have their own SOP).

Chemicals in this category present hazards based on one, or more of these characteristics:

- the pressurized nature of their storage and use
- flammability
- oxidizing ability
- high toxicity (as stated above these do not fall under this SOP, but should be addressed separately given their extreme hazard)

All chemicals in this band are considered generally hazardous and the band is general

- gases which are contained in a receptacle at a pressure of 29 p.s.i. (200 kPa) or more at 20 ºC
- gases which are liquefied or liquefied and refrigerated

The Globally Harmonized System of Chemical Classification symbol and hazard codes for compressed gases are:

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the New Jersey Institute of Technology (NJIT) Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

3. ENGINEERING/VENTILATION CONTROLS

Basic pressurized gas control measures are noted here. For further information, see Sec. 7D of Prudent Practices in the Laboratory by the National Research Council. Gas vendors are another good source of information on gas equipment and handling.

- In general, it is preferable to perform all work with hazardous chemicals in a fume hood. Sash height should be kept as low as possible to avoid the escape of vapors, gases and particulates.
- Supplemental equipment such as blast shields should be used when working with chemicals or processes that may result in explosions or pressure releases.
- Consider the use of a glove box, toxic gas cabinet or other local exhaust in order to further contain hazards as appropriate. Gas cabinets may be required for some toxic gas applications.

For further information on engineering controls see the following pages in Sec. II of the Chemical Hygiene Plan:

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

Storage Areas

- Store full and empty compressed gas cylinders separately to avoid confusion. Serious back flow can occur when an empty cylinder is attached to a pressurized system.
- Select a cool, dry, and well-ventilated area.
    - Cool areas minimize pressure increases that can result from heat or direct sunlight.
    - Dryness deters rust and corrosion.
    - Ventilation is essential in case of leaks.

    - Never store compressed gas cylinders (with the exception of compressed air) in environmental rooms (i.e., refrigerated cold rooms or warm rooms). These rooms are not well ventilated and could pose a serious safety concern should a cylinder fail.
- Arrange storage facilities to permit inventory rotation, using cylinders in order as received from the supplier.
- Do not store cylinders next to doors or in corridors where they could possibly obstruct emergency egress from the building.
- Designate an area to store empty cylinders for return to the supplier. An area on or adjacent to your building's loading dock is suitable.
- Separate oxidizers or other incompatibles (e.g., oxygen) from flammables by at least 20 feet, or by a non-combustible wall with a fire rating of at least one (1) hour.

Storage Guidelines

- Restrain cylinders - Restrain cylinders as follows:
    - Store cylinders upright and secure them to a substantial, fixed surface with restraints made of non-combustible material, preferably chain.
    - Position the restraint approximately 2/3 of the height of the cylinder from the floor to prevent tipping.
- Properly label the cylinders and storage area.
- Cap cylinders when not in use.
- Store cylinders away from non-compatibles.
- Store empty cylinders separately from full cylinders.
- Do not keep non-corrosive gases longer than 5 years from the last hydrostatic test date (usually stamped just below the neck of the cylinder) unless otherwise regulated.
- Return all cylinders to the vendor that appear unsafe or show signs of corrosion, dents, dings, pitting, bulging, etc.

- Review your cylinder inventory regularly.
    - Return cylinders to the vendor if they're no longer being used. This removes potential hazards and saves on cylinder rental fees (cylinders are typically rented or leased, rather than purchased) and possible reconditioning fees.
    - Note: Some vendors charge a reconditioning fee on each cylinder that is not returned within 2 years. This fee may be significant in relation to the actual cost of the gas.
- In addition to standard storage requirements listed above, employ special precautions for cylinders containing flammable, oxidizing, or corrosive gases (empty or full) as described below:
    - **Flammable gases**
        - Separate from cylinders containing oxidizing gases by a minimum distance of 20 feet or by a noncombustible partition with a rating of one (1) hour.
        - When approved gas storage cabinets are used, the cabinets must be equipped with fire sprinklers. (**Note:** Fire code piping and connection requirements may apply for your facility. Consult the EHS Chemical Hygiene Officer.

        - Never store flammable gas near ignition or heat sources, or unprotected electrical connections.
        - Keep quantities to a minimum. There may be circumstances where using a pure flammable gas may pose unacceptable risks. It may be necessary to purchase a reduced concentration mixture (e.g., 1% hydrogen and 99% argon).
        - If you need large volumes (more than 1 large cylinder), contact the EHS Chemical Hygiene Officer for guidance.
    - **Oxidizing gases**
        - Do not permit oil or grease to come in contact with compressed oxidizing gases – explosions may occur!
        - Separate oxidizers from cylinders containing flammable gases by a minimum distance of 20 feet or by a noncombustible partition with a fire rating of at least one (1) hour.
        - Never store oxidizers near flammable solvents, combustible materials, unprotected electrical connections, or ignition or heat sources. (**Note:** Fire code piping requirements may apply in your facility. Consult the EHS Chemical Hygiene Officer,)
    - **Corrosive gases**
        - Never store lecture bottles of corrosives longer than 6 months and cylinders more than 2 years. (e.g., ammonia, hydrogen chloride, chlorine, and methylamine). Cylinders containing corrosives degrade over time.

Operational Guidelines

- Know the hazard classification of particular gases you are working with and specific safety requirements as discussed above.
- Label both the cylinder and gas line with the name of the gas. Do not depend on color codes.
- Work in a well-ventilated area when using compressed gases.
- Use the correct regulator. Ensure that each gas in use has its own dedicated regulator. Never use adapters.
- Never permit a flame or spark to come in contact with any part of a compressed gas cylinder. Have flashback protectors installed on cylinders of flammable gases, such as oxy-acetylene torch units.
- Use a trap or suitable check valve when discharging gas into a liquid to prevent liquid from getting back into the cylinder or regulator.
- Lecture bottles use universal threads and valves, and some of them are interchangeable. This increases the risk of accidentally mixing incompatible materials.
- In addition to standard operational requirements listed above, employ special precautions for cylinders containing flammable, oxidizing, or corrosive gases (empty or full) as described below.
    - **Flammable gases**
        - Use flow restrictors to prevent a sudden large unexpected release.
        - Detection systems may be required.

- **Oxidizing gases**
    - Diligently clean regulators and tubing used with oxidizing gases to remove oil and other reducing agents.
- **Corrosive gases**
    - Inspect cylinder valves periodically for corrosion.
    - If a cylinder or valve is noticeably corroded, contact the gas vendor and follow their instructions.
    - Alert the vendor to any damage that might impair the integrity of the cylinder before the cylinder is returned.
    - Use caution if flow does not immediately start when a valve is opened slightly — there could be a plug in the valve.

Transporting Gas Cylinders

- Leave the valve protection cap in place until the cylinder has been secured against a wall or bench or placed in a cylinder stand, and is ready for use.
- Use a hand truck or other suitable device to transport cylinders, even for short distances. Secure the cylinder to the hand truck with a chain or strap.
    - Do not roll, drag, or slide containers.
    - Do not lift cylinders by cylinder caps.
- Before returning empty cylinders to the supplier:
    - Close the valve. Leave some positive pressure in the cylinder.
    - Replace any valve outlet and protective caps originally shipped with the cylinder.
    - Mark or label the cylinder "empty" and store it in a designated area for the supplier.
- Move any cylinders that have been left unattended into a secure location as soon as possible.

5. SPILL AND INCIDENT PROCEDURES

Hazard Specific Incident Practices:

In case of cylinder leaks that can't be stopped by tightening the valve gland or packing nut, do the following:

- For hazardous gases:
    - Leave the room, closing the door behind you.
    - Secure the room to prevent entry.
    - Sound the fire alarm, unless the gas leak is relatively slow and contained within a gas cabinet, or fume hood.
    - Call for emergency assistance. Dial 9-1-1, preferably from a cell phone. Tell the dispatcher the name of the gas.
- For non-hazardous gases:
    - Close the leaking valve.

- If it is still leaking, replace the cylinder cap and notify the EHS Department.

General Response Practices:

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE; decontaminate equipment and bench tops using sodium bicarbonate and water. Dispose of all used contaminated disposables as hazardous waste following the Waste Disposal Section.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

9. DESIGNATED USE AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA (SDS) SHEETS

Insert the location of SDS for chemicals used in the lab

11. LAB-SPECIFIC INFORMATION (required) *(Examples of appropriate content)*

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

APPENDIX A:

Hazardous Gas Classification Table

(Because of their acute toxicity and high level of regulatory oversight, the gases listed here should not use this generic SOP, but rather a gas-specific version – contact the EHS Department)

Gas and Formula	CAS and UN or NA No.	UBC Class[1]	IDLH[2]	LC50[3]	PEL[4]
Ammonia – NH_3	7664–41–7, UN1005	Corro-sive[5], flamma-ble	300 ppm	4000 ppm	50 ppm
Arsine – AsH_3	7784–42–1, UN2188	Highly toxic, flamma-ble	3 ppm	20 ppm	0.05 ppm
Boron Tribromide – Bbr_3	10294–33–4, UN2692	Toxic	50 ppm	380 ppm	1 ppm[4(C)]
Boron Trichloride – BCl_3	10294–34–5, UN1741	Corro-sive[5]	25 ppm[7]	2541 ppm	5 ppm
Boron Trifluoride – BF_3	7637–07–2, UN1008	Toxic	25 ppm	806 ppm	1 ppm[4(C)]
Bromine – Br_2	7726–95–6, UN1744	Highly toxic, corrosive, oxidizer	3 ppm	113 ppm	0.1 ppm
Carbon Monoxide – CO	630–08–0, UN1016	Flamma-ble[5]	1200 ppm	3760 ppm	50 ppm
Chlorine – Cl_2	7782–50–5, UN1017	Toxic, corrosive, oxidizer	10 ppm	293 ppm	1 ppm[4(C)]
Chlorine Dioxide – ClO_2	10049–04–4, NA9191	Toxic, oxidizer	5 ppm	250 ppm	0.1 ppm
Chlorine Trifluoride – ClF_3	7790–91–2, UN1749	Toxic, oxidizer	20 ppm	299 ppm	0.1 ppm[4(C)]
Diborane – B_2H_6	19278–45–7, UN1911	Highly toxic, flamma-ble	15 ppm	80 ppm	0.1 ppm
Dichlorosilane – SiH_2Cl_2 (HCl)	4109–96–0, UN2189	Toxic, corrosive, flamma-ble	50 ppm	314 ppm	5 ppm[4(C)]
Ethylene Oxide – C_2H_40	75–21–8, UN1040	Flamma-ble[5]	800 ppm	4350 ppm	1 ppm

Gas and Formula	CAS and UN or NA No.	UBC Class[1]	IDLH[2]	LC50[3]	PEL[4]
Fluorine – F_2	7782–41–4, UN1045	Highly toxic, oxidizer	25 ppm	185 ppm	0.1 ppm
Germane – GeH_4	7782–65–2, UN2192	Toxic, flamma-ble	6 ppm[7]	622 ppm	0.2 ppm[7]
Hydrogen Bromide – HBr	10035–10–6, UN1048	Corro-sive[6]	30 ppm	2860 ppm	3 ppm
Hydrogen Chloride – HCl	7647–01–0, UN1050	Corro-sive[6]	50 ppm	2810 ppm	5 ppm[4(C)]
Hydrogen Cyanide – HCN	74–90–8, UN1051	Highly toxic, flamma-ble	50 ppm	40 ppm	10 ppm
Hydrogen Fluoride – HF	7664–39–3, UN1052	Toxic	30 ppm	1300 ppm	3 ppm
Hydrogen Selenide – H_2Se	7783–07–5, UN2202	Highly toxic, flamma-ble	1 ppm	2 ppm	0.05 ppm
Hydrogen Sulfide – H_2S	7783–06–4, UN1053	Toxic, flamma-ble	100 ppm	712 ppm	20 ppm
Methyl Bromide – CH_3Br	74–83–9, UN1062	Toxic, flamma-ble	250 ppm	1007 ppm	20 ppm[4(C)]
Methylisocyanate – CH_3NCO	624–83–9, UN2480	Highly toxic, flamma-ble	3 ppm	22 ppm	0.02 ppm
Methyl Mercaptan – CH_3SH	74–93–1, UN1064	Toxic, flamma-ble	150 ppm	1350 ppm	10 ppm[4(C)]
Nickel Carbonyl – $Ni(CO)_4$	13463–39–3, UN1259	Highly toxic, flamma-ble	2 ppm	18 ppm	0.001 ppm
Nitric Oxide – NO	10102–43–9, UN1660	Highly toxic, oxidizer	100 ppm	115 ppm	25 ppm

Gas and Formula	CAS and UN or NA No.	UBC Class[1]	IDLH[2]	LC50[3]	PEL[4]
Nitrogen Dioxide – NO_2	10102–44–0, UN1067	Highly toxic, oxidizer	20 ppm	115 ppm	5 ppm[4(C)]
Phosgene – $COCl_2$	75–44–5, UN1076	Highly toxic	2 ppm	5 ppm	0.1 ppm
Phosphine – PH_3	7803–51–2, UN2199	Highly toxic, pyro-phoric	50 ppm	20 ppm	0.3 ppm
Phosphorus Oxychloride – $POCl_3$	10025–87–3, UN1810	Highly toxic	0.96 ppm[6]	96 ppm	0.1 ppm[7]
Phosphorus Pentafluoride – PF_5	7647–19–0, UN2198	Toxic, oxidizer	2.6 ppm[6]	260 ppm	3 ppm
Phosphorus Trichloride – PCl_3	7719–12–2, UN1809	Toxic, oxidizer	25 ppm	208 ppm	0.5 ppm
Selenium Hexafluoride – SeF_6	7783–79–1, UN2194	Highly toxic	2 ppm	50 ppm	0.05 ppm (as Se)
Silicon Tetrachloride – $SiCl_4$ (HCl)	10026–04–7, UN1818	Toxic, corrosive	50 ppm	750 ppm	5 ppm[4(C)]
Silicon Tetrafluoride – SiF_4 (HF)	7783–61–1, UN1859	Toxic	30 ppm	450 ppm	0.1 ppm
Stibine – SbH_3	7803–52–3, UN2676	Highly toxic, flamma-ble	5 ppm	20 ppm	0.1 ppm
Sulfur Dioxide – SO_2	7446–09–5, UN1079	Corro-sive[6]	100 ppm	2520 ppm	5 ppm
Sulfuryl Fluoride – SO_2F_2	2699–79–8, UN2191	Corro-sive[6]	200 ppm	3020 ppm	5 ppm
Tellurium Hexafluoride – TeF_6	7783–80–4, UN2195	Highly toxic	1 ppm	25 ppm	0.02 ppm (as Te)
Titanium Tetrachloride – $TiCl_4$	7550–45–0, UN1838	Highly toxic, corrosive	1.3 ppm	119 ppm	—
Tungsten Hexafluoride – WF_6 (HF)	7783–82–6, UN2196	Toxic, corrosive	30 ppm	217 ppm	0.1 ppm

Footnotes:

1. UBC (Uniform Building Code) Class. **Gases listed as either toxic or highly toxic should not use this SOP, but develop a gas-specific SOP**
2. **IDLH (Immediately Dangerous to Life and Health)** values published in 1994 by the National Institute for Occupational Safety and Health (NIOSH).
3. **LC50 data (Lethal concentration 50%):** Lowest reported value, 1 hour adjusted, taken from Dept. of Transportation, Compressed Gas Association, Registry of Toxic Effects of Chemical Substances.
4. **PEL (Permissible Exposure Limit)** values published by Occupational Safety & Health Administration (OSHA). OSHA values used if available; otherwise, Threshold Limit Values (TLV) from ACGIH. (C) = TLV-ceiling limit, an exposure limit not to be exceeded under any circumstances.
5. When used as a refrigerant, Uniform Building Code Class does not apply.
6. IDLH determined by 0.01 of LC50.
7. OSHA PEL

STRONG OXIDIZING AGENTS

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Oxidizing materials are liquids or solids that readily give off oxygen or other oxidizing substances (such as bromine, chlorine, or fluorine). **They are materials that react chemically to oxidize combustible (burnable) materials; this means that oxygen combines chemically with the other material in a way that increases the chance of a fire or explosion.** This reaction may be spontaneous at either room temperature or may occur under slight heating. Oxidizing liquids and solids can be severe fire and explosion hazards. The most common strong oxidizers in campus laboratories are nitric acid and perchloric acid.

Outside a lab where nitric acid (strong oxidizer) reacted with organics to cause explosion

2. HAZARDOUS CHEMICAL(S) OR CLASS OF HAZARDOUS CHEMICAL(S)

The National Fire Protection Association (NFPA) "Code for the Storage of Liquid and Solid Oxidizers" provides many examples of typical oxidizing materials.

NFPA Class 1 Oxidizers - Slightly increase the burning rate of combustible materials. Do not cause spontaneous ignition when they come in contact with them. Examples:

- Aluminum nitrate
- Ammonium persulfate
- Barium peroxide
- Hydrogen peroxide solutions (8% to 27.5% by weight)
- Magnesium nitrate
- m-Chloroperoxybenzoic acid

- Nitric acid (40% concentration or less)
- Peracetic acid
- Perchloric acid solutions (less than 50% by weight)
- Potassium dichromate
- Potassium nitrate
- Silver nitrate
- Sodium dichloroisocyanurate dihydrate
- Sodium dichromate
- Sodium nitrate
- Sodium nitrite
- Sodium perborate (and its monohydrate)
- Sodium persulfate
- Strontium nitrate
- Strontium peroxide
- Trichloroisocyanuric acid
- Zinc peroxide

NFPA Class 2 Oxidizers - Increase the burning rate of combustible materials moderately with which they come in contact. May cause spontaneous ignition when in contact with a combustible material. Examples:

- Calcium chlorate
- Calcium hypochlorite (50% or less by weight)
- Chromic acid (chromium trioxide)
- 1,3-dichloro-5,5-dimethylhydantoin
- Hydrogen peroxide (27.5 to 52% by weight)
- Magnesium perchlorate
- Nitric acid (concentration greater than 40% but less than 86%)
- Potassium permanganate
- Sodium permanganate
- Sodium chlorite (40% or less by weight)
- Sodium perchlorate (and its monohydrate)
- Sodium peroxide

NFPA Class 3 Oxidizers - Severely increase the burning rate of combustible materials with which they come in contact. Will cause sustained and vigorous decomposition if contaminated with a combustible material or if exposed to sufficient heat. Examples:

1. Ammonium dichromate
2. Hydrogen peroxide (52 to 91% by weight)
3. Nitric acid, fuming (concentration greater than 86%)

4. Perchloric acid solutions (60 to 72% by weight)
5. Potassium bromate
6. Potassium chlorate
7. Potassium dichloroisocyanurate
8. Sodium chlorate
9. Sodium chlorite (greater than 40% by weight)
10. Sodium dichloroisocyanurate

NFPA Class 4 Oxidizers - Can explode when in contact with certain contaminants. Can explode if exposed to slight heat, shock, or friction. Will increase the burning rate of combustibles. Can cause combustibles to ignite spontaneously. Examples:

- Ammonium perchlorate (particle size greater than 15 microns)
- Ammonium permanganate
- Hydrogen peroxide (greater than 91% by weight)
- Perchloric acid solutions (greater than 72.5% by weight)
- Tetranitromethane

The other classification scheme for oxidizers is the Globally Harmonized System (GHS) which identifies 3 classes of solid/liquid oxidizers. Newer chemical containers will have this general symbol for oxidizers:

3. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the New Jersey Institute of Technology (NJIT) Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

4. ENGINEERING/VENTILATION CONTROLS

All chemicals should be transferred and used in an annually certified laboratory chemical fume hood with the sash at the certified position or lower. The hood flow alarm should be checked to be operating correctly prior to using the hood.

The following is a general plan for all strong oxidizers:

Always use strong oxidizers in a certified chemical fume hood to minimize the potential for the spread of a fire if one should occur. It is recommended to avoid the use of Class 4 oxidizers. If no alternative can be found, then operations MUST be carried out in a fume hood with the addition of a blast shield. No part of the body (for example, hands) should ever be directly exposed to these materials when they are mixed with other chemicals.

Perchloric acid has a notorious history of causing unanticipated explosions. Perchloric acid can form explosive salts almost anywhere, including in the exhaust ducts of fume hoods and even laboratory benches where other materials have been spilled in the past. Many perchlorate salts are shock sensitive and can lay dormant for very long periods.

For these reasons, it is imperative that perchloric acid only be used in a designated fume hood. In some cases, to avoid an explosive condition, this hood must be a special type with a built-in water wash-down feature.

Spills should be immediately and thoroughly cleaned up. This fume hood shall be prominently marked for use with perchloric acid. The EHS Department should be contacted for proper signage and approvals.

5. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

The following administrative controls must be followed:

- Never work alone with serious hazards . At least one other person must be present in the vicinity when any work involving strong oxidizers is carried out.
- Eliminate or substitute a less hazardous material when possible.
- Design your experiment to use the least amount of material possible to achieve the desired result.
- It is better to do multiple transfers of small volumes than attempt to handle larger quantities. Finely divided solids must be transferred under an inert atmosphere in a glove box. Liquids may be safely transferred without a glovebox by employing certain syringe techniques and equipment. Before transferring, make sure that the material is at room temperature.
- Consult with the campus Chemical Hygiene Officer if work involves large quantities.

It is essential that all strong oxidizers be stored separately from all chemicals with which they may react. Ensure secondary containment and segregation of incompatible chemicals. Also, follow any substance-specific storage guidance provided in Safety Data Sheet (SDS) documentation.

Wash thoroughly after handling. Do not ingest or inhale nor get in eyes, skin or clothing.

Store in a tightly closed, labeled container and in a cool, dry well-ventilated area. Segregate from incompatible materials. Secondary containers must be labeled clearly. Follow any substance-specific storage guidance provided in Safety Data Sheet documentation.

6. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW REQUIRED

Any prior approval or prior review of lab protocols should be inserted here by the Faculty/PI as they deem necessary.

9. DESIGNATED AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA SHEETS (SDS)

Insert the location of the SDS for the chemicals used in the lab

11. LAB-SPECIFIC INFORMATION (required) (Examples of appropriate content)

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

CRYOGENS (LIQUID NITROGEN, LIQUID HELIUM, DRY ICE)

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

These materials – liquid nitrogen, liquid helium and dry ice - are extremely cold (-100°C to -270°C) and, upon contact, can instantly freeze other materials. Serious tissue damage may occur upon exposure.

Evaporating liquid nitrogen or sublimating dry ice (carbon dioxide) will displace the air within a non-ventilated space possibly leading to **suffocation**. Generally, labs have adequate ventilation to prevent this, but do not work in a confined space with these materials. Note that individuals have died when working in a non-ventilated lab "cold room" where large quantities of dry ice were stored. The OSHA ceiling *Permissible Exposure Limit* for carbon dioxide is 30,000 ppm.

Be aware of ice that can plug or disable pressure-relief devices. Ensure adequate pressure relief mechanisms are functional, i.e., never use tight-fitting stoppers or closures without pressure-relief devices.

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Special insulated gloves for working with cryogens should be employed. See the PPE information under Section 2 of the New Jersey Institute of technology (NJIT) Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

3. ENGINEERING/VENTILATION CONTROLS

Always work in a well-ventilated area with cryogens to prevent oxygen displacement. Even with dry ice there has been a lab fatality when an individual worked in a "cold room" that did not have any ventilation provided. For this reason, liquid cryogens should also not be transported on an occupied pubic elevator.

For further information see these pages in Section 2 of the NJIT CHP*:*

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

- Do not move an **over-pressurized container**. Evacuate and seal area, call EHS or dial 911.
- Avoid trapping cryogenic liquids between closed sections of an apparatus.
- **Dewar flasks** or other glassware devices should be taped on the outside or provided with shatterproof protection to minimize flying glass particles in case of implosion. Dewar flasks should be vented with a bored or notched stopper.
- Cool cryogenic containers slowly to reduce thermal shock and flashing of the material.
- When utilizing cold baths (cryogen + organic solvent), use in a hood with a catch pan. Be aware of increased fire hazard. Be prepared for **vigorous solvent boiling** upon initial addition of solvent.
- Avoid **condensing oxygen** (blue in color) and/or its contact with organic material when using liquid nitrogen. Flush cold traps with nitrogen or keep under vacuum to avoid condensation of oxygen from air within the trap. Condensed oxygen when contacted with organic materials can cause a powerful explosion.
- To avoid condensing oxygen from the air with liquid nitrogen/helium, check glassware and valves for cracks and other defects before beginning experimental work. Verify that systems assumed to be under vacuum are so by checking vacuum gauges regularly. You should be on the lookout for the possibility of condensed air within the apparatus.
- Storage of liquid nitrogen: use only approved low temperature containers. Make sure liquid nitrogen containers are vented to prevent pressure buildup. You must use extreme care when working with liquid nitrogen. Liquid nitrogen should not be stored in sealed containers, as tremendous pressure could result and an explosion is likely.
- **Liquid helium** requires specialized handling techniques and equipment due to over-pressurization hazards and icing.

5. SPILL AND INCIDENT PROCEDURES

Flood the area (skin and eyes) immediately with large quantities of cool water. See a doctor immediately if the skin is blistered or if the liquid nitrogen came in contact with your eyes.

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. WASTE DISPOSAL

Not applicable to cryogens – let evaporate. However, low-temperature baths such as those made from dry ice and acetone, do need to have the solvent disposed of properly. Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

7. PRIOR APPROVAL/REVIEW REQUIRED

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

8. DESIGNATED AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

9. SAFETY DATA SHEETS (SDS) and OTHER REFERENCES

Insert the location where SDS are kept for chemicals used in the lab

Prudent Practices in the Laboratory (National Research Council): Liquefied Gases and Cryogenic Liquids

10. LAB-SPECIFIC INFORMATION (required) (Examples of appropriate content)

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

2. ADVANCED

ADVANCED FLAMMABLE and COMBUSTIBLE LIQUIDS

CARCINOGENS, REPRODUCTIVE TOXINS and ACUTE TOXINS

ORGANIC PEROXIDES and SELF-REACTIVE CHEMICALS

PEROXIDE-FORMING CHEMICALS

METAL CARBONYLS

POTENTIALLY EXPLOSIVE CHEMICALS (PEC)

HIGHLY TOXIC and PYROPHORIC COMPRESSED GASES

PYROPHORIC SOLIDS

PYROPHORIC ORGANOLITHIUM REAGENTS

ADVANCED FLAMMABLE and COMBUSTIBLE LIQUIDS HANDLING

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

This Standard Operating Procedure (SOP) is for work in which flammable/combustible liquids are used in operations that can generate static electricity which can act as an ignition source. This includes the pumping or pouring of solvents between metal containers. As described below, those operations require grounding and/or bonding of the containers to prevent a fire/explosion.

If your operations would not involve static electricity generation, then a different SOP template in the New Jersey Institute of Technology (NJIT) SOP Library can be used: BASIC FLAMMABLE AND COMBUSTIBLE LIQUIDS HANDLING

(See also these related NJIT SOP's: *"Peroxide-Forming Chemicals"*)

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Flammable and combustible organic solvents are amongst the most dangerous chemicals in the lab. A measure of how ignitable a particular solvent is the **flashpoint ;** defined as the lowest temperature at which a material can form an ignitable mixture with air and produce a flame when a source of ignition is present. **The lower the flashpoint, the more easily the liquid can be ignited.** Most common organic solvents in the lab are readily ignited, with the exception of chlorinated solvents like dichloromethane which require more extreme conditions to burn.

Flammable liquids (flash point < 100ºF) are divided into three classes:

Class	Flash Point	Boiling Point	Examples
IA	Below 73°F	Below 100 °F	Ethyl Ether
IB	Below 73 °F	At or above 100 °F	Acetone, Benzene, Toluene
IC	At or above 73°F and below 100°F		Isopropanol, Xylene

Combustible liquids (flash point > 100ºF) are divided into three classes:

Class	Flash Point	Examples
II	100-139 °F	Acetic acid, cyclohexane, and mineral spirits
IIIA	140-199 °F	Cyclohexanol, formic acid and nitrobenzene
IIIB	200 °F or above	Formalin and vegetable oil

A particular organic solvent may have other hazards beyond their flammability. For example, benzene is recognized carcinogen. Check the Safety Data Sheet for the particular solvents in use.

The international symbol (Globally Harmonized System) for flammable liquids/gases/solids is:

Diethyl ether initiated fire

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the NJIT CHP regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

In general, workers who use flammable liquids will be issued a free fire-resistant lab coat.

3. ENGINEERING/VENTILATION CONTROLS

All chemicals should be transferred and used in an annually certified laboratory chemical fume hood with the sash at the certified position or lower. The hood flow indicator should be checked to be operating correctly prior to using the hood. For further information see the following pages in Section 2 of the NJIT CHP*:*

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

- Safety Shielding: Shielding is required any time there is a significant risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of flammable liquids which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.
- Special Ventilation: Manipulation of flammable liquids outside of a fume hood may require special ventilation controls in order to minimize exposure and reduce the fire risk. Fume hoods provide the best protection against exposure to flammable liquids in the laboratory and are the preferred ventilation control device. If your research does not permit the handing of large quantities of flammable liquids in your fume hood, contact EH&S to review the adequacy of all special ventilation.

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

Use in an area that is properly equipped with a certified eye wash and safety shower that is available within ten seconds of travel.

Store in a tightly closed, labeled container and in a cool, dry, well-ventilated area. Segregate from incompatible materials. Repackaged chemicals must be labeled clearly. For example, squirt bottles and acid/base cleaning baths. Follow any substance-specific storage guidance provided in Safety Data Sheet documentation.

- **Flammable Liquid Storage Cabinets**
  - ✓ One or more Flammable Liquid Storage Cabinets **(FLSC)** are required for laboratories which store, use or handle more than 10 gallons of flammable or combustible liquids.
  - ✓ Containers of flammable liquids that are one gallon and larger must be stored in a flammable-liquids storage cabinet.
  - ✓ The storage of flammable and combustible liquids in a laboratory, shop, or building area must be kept to the minimum needed for research and/or operations. FLSC are not intended for the storage of highly toxic materials, acids, bases, compressed gases, or pyrophoric chemicals.
  - ✓ In most NJIT laboratories, flammable liquids storage is provided under the chemical fume hood. These cabinets are clearly marked “Flammable Storage” and are often ventilated via a stainless steel hose into the fume hood exhaust duct. Flammable liquids storage cabinets are constructed to limit the internal temperature when exposed to fire. When additional storage is needed, NFPA-approved FLSC may be purchased. All containers of flammable liquids must be stored in a FLSC when not in use. The following requirements apply:

    General Requirements

    - Cabinets shall be marked “Flammable - Keep Fire Away”
    - Cabinets should be kept in good condition. Doors that do not close and latch must be repaired or the cabinet must be replaced.
  - ✓ Flammable liquids storage cabinets are equipped with a grounding system that can be connected to a building ground. If you are pouring from a container in the storage cabinet and if the container being poured into is conductive then a bonding strap must be attached between them as explained in PROCEDURES TO AVOID STATIC ELECTRICITY.

FLSC involved in fire

- **Transferring/Dispensing**

STATIC ELECTRICITY HAZARDS IN THE LABORATORY

The flow of flammable and combustible liquids can cause the buildup of static electricity. When enough of a charge is built up a spark can result and potentially cause a fire or explosion. The likelihood of this happening is dependent upon how well the liquid conducts electricity, the flash point, and the capacity to generate static electricity.

Static electricity can be generated when liquid is transferred from one metal container to another. Liquids have the ability to generate static electricity when they move in contact with other materials during pouring, pumping, or agitating. The buildup of this static electricity can cause a spark to form where the solvent exits the container. This could result in a fire or explosion.

PROCEDURES TO AVOID STATIC ELECTRICITY

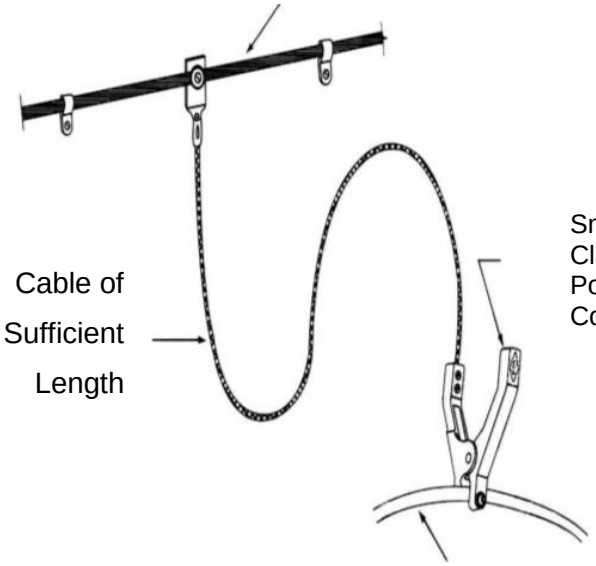
To avoid the buildup of static electricity that may cause a spark, it is important to bond and ground metal containers, particularly for larger quantities, e.g. 55 or 5 gallon drums. **Bonding** eliminates the electrical potential between two containers, therefore eliminating the likelihood of sparks. A bonding wire is connected to two conductive objects as seen in the drums pictured below.

Bonding wires between drums

Grounding eliminates the difference in static potential charge between the conductive object and ground. Grounding is accomplished by connecting the conductive object directly to the earth, usually using cold water copper pipes, building steel, or a grounding bus/bar.

Bonding and grounding require good electrical connections. Remove any dirt, paint or rust, ensuring **metal to metal** contact.

Building Static Grounding "Bus"
(Mounted on Wall)



Bonding and Grounding wires come in a variety of styles and lengths. They can be purchased through Fisher Scientific:, Justrite Manufacturing: and through Lab Safety Supply:

Hand Clamp

'C' Clamp and Alligator Clip

Static hazards may also exist in non-metallic plastic or glass containers that cannot be grounded. Static may be generated by the free fall and turbulence of the liquid being poured. To minimize this hazard, pour as slowly as possible and use a grounded nozzle extension that allows filling the container from the bottom.

DISPENSING FLAMMABLE LIQUIDS FROM 5 GALLON PAILS

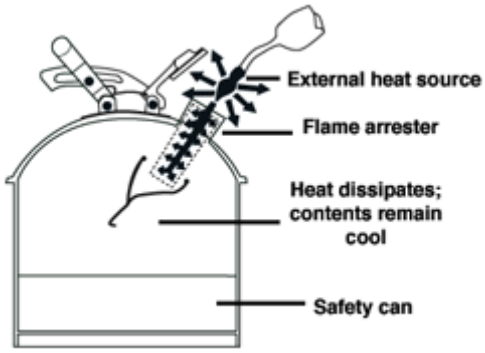
Manual dispensing pumps for 5-gallon pails/cans are available. These pumps are specifically designed to dispense liquids into small laboratory-size bottles without spilling. If you are pouring into a conductive container, a bonding wire should be attached from the 5-gallon pail to the container being filled. The 5-gallon pail should be grounded.

The dispenser shown in the picture below can be purchased through Fisher Scientific.The metal strap in the picture hooks over the bottom of the pail and secures the dispenser while pumping.

Two adapters are provided with the dispensing pump from Fisher (grey and black). Use the appropriate adapter to achieve the correct seal with the solvent container you have. Some solvent containers have a grey fitting at the opening, and others have a black one.

DISPENSING FLAMMABLES FROM SAFETY CANS

Safety cans have self-closing air tight lids and a flame arrestor that protects the contents from an external ignition source. Bonding and grounding is still required on safety cans since static electricity generation is possible. The nozzle provides a bonding path to a receiving metallic vessel.



If either of the containers is non-metallic (non-conductive) it is still important to follow the limited velocity and grounded nozzle extension information given previously.

Safety cans do not offer protection from heat when exposed to fire and should be stored in a flammable liquids storage cabinet when not in use.

- **Labeling**
  - ✓ All flammable liquids must be clearly labeled with the correct chemical name.
  - ✓ Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.
  - ✓ The label on any containers of flammable liquids should say “Flammable” and should include any other hazard information, such as “Corrosive” or “Toxic”, as applicable. Example: lab squirt bottles, or acid/base baths.

- **Heating/Open flame**
  - ✓ Do not permanently store flammable liquids in chemical fume hoods or allow containers of flammable liquids in proximity to heating mantles, hot plates, or torches.
  - ✓ With the exception of vacuum drying ovens, laboratory ovens rarely have any means of preventing the discharge of material volatilized within them. Thus it should be assumed that these substances will escape into the laboratory atmosphere, but may also be present in sufficient concentration to form explosive mixtures within the oven itself. Venting the oven to an exhausted system will reduce this hazard.
  - ✓ Drying ovens should not be used to dry glassware that has been rinsed with organic solvents until all of the solvent has had the opportunity to drain or evaporate at room temperature.

5. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE, decontaminate equipment and bench tops using soap and water. Dispose of all used contaminated disposables as hazardous waste per below.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW REQUIRED

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

9. DESIGNATED AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

Work should be completed in a laboratory fume hood given the volatility and flammability of most solvents.

10. SAFETY DATA SHEETS and OTHER REFERENCES

Insert location where SDS for the lab can be found

Prudent Practices in the Laboratory, 2011, see Secs. 4.D and 6.F for flammable liquids http://www.nap.edu/openbook.php?record_id=12654&page=R15

11. LAB-SPECIFIC PROTOCOL (required)

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, frequency done, scale, temperature, etc.

CARCINOGENS, REPRODUCTIVE TOXINS AND ACUTE TOXINS

Also Known as OSHA "Particularly Hazardous Substances"

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this Standard Operating Procedure (SOP), add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

This SOP deals with three classes of related materials:

- reproductive toxins
- acute toxins
- select carcinogens

Although the mechanism/target of their toxicity may vary, they are similar in that they generally don't present a physical hazard (fire, explosion, high reactivity). Their primary hazard is their long-term or acute toxicity - most commonly via inhalation or skin contact. Therefore, the engineering controls and personal protective equipment used to protect an individual are generally the same for these substances. These materials are denoted by OSHA as **Particularly Hazardous Substances (PHS)** under the Chemical Hygiene Plan safety standard. The individual *Safety Data Sheet* for a particular material should always be consulted before beginning work.

Labelling

Reproductive hazards and carcinogens are now identified by the United Nations **Globally Harmonized System of Classification and Labeling of Chemicals (GHS).** Newer chemical containers manufactured after the implementation of GHS will have this symbol

Newer containers of *acute toxins* are identified under GHS by one of these two symbols:

or

Definitions and Hazards of PHS

- **Select Carcinogens** are a category of chemicals where the available evidence strongly indicates that the substances cause human carcinogenicity. A "select carcinogen" meets one of the following criteria.
    - It is regulated by OSHA as a carcinogen
    - It meets certain OSHA definitions of carcinogenicity as used by the National Toxicology Program or the International Agency for Research on Cancer.

  Contact the EHS Department for more information about these materials, and for assistance in developing any further required standard operating procedures.
- **Reproductive Toxins** are chemicals that affect the reproductive capabilities including causing chromosomal damage (mutations), adverse effects on fetal development (teratogenesis), infertility, gestation/pregnancy, lactation, genetic effects, general reproductive performance, and can affect both women and men. But, note that chemicals can have more than one associated hazard.
- **Acute Toxins** are chemicals that pose a high/acute level of immediate health risk to individuals by skin contact, inhalation or ingestion.

Working with PHS

All of the above classes of materials have in common the fact that direct contact must be avoided. Careful handling and stringent controls are essential in order to minimize risk to researchers and the environment. Therefore, the requirements outlined in the following sections must be followed rigorously.

Note that this standard operating procedure describes the baseline requirements for handling these classes of compounds. There are many cases where specific chemical entities require additional or modified handling procedures. Some examples of this are chemicals that have:

- unique properties (e.g. cyanide salts, where the risk of exposure varies greatly over a range of pH),
- multiple hazards related to them (e.g. azide salts, which have toxicity profiles similar to cyanide, but have the added hazard of being potentially explosive),
- extreme levels of a particular hazard (e.g. methyl mercury, which can penetrate the skin very quickly and cause death in extremely small doses).

These chemicals should have their own chemical specific standard operating procedure.

Additional information about working with hazardous chemicals can be found in Prudent Practices in the Laboratory, National Research Council, 2011 Chapters 4-6.

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the New Jersey Institute of Technology (NJIT) Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria

- respirator use, etc.

At minimum, complete protection of the eyes and skin is essential.

3. ENGINEERING/VENTILATION CONTROLS

Particularly Hazardous Substances should *always* be used in a fume hood, glove box, or in totally-sealed containers. For further information see these pages in Section 2 of the NJIT CHP:

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

- Never work alone with extremely hazardous materials.
- Eliminate or substitute for a less hazardous material when possible.
- Design your experiment to use the least amount of material possible to achieve the desired result.
- Do not exceed the scale or deviate from the experimental parameters which may be outlined in the **lab-specific information** section below without the approval of the PI.
- Perform adequate hazard analysis and risk assessment before beginning the experiment, as described in in Prudent Practices in the Laboratory, National Research Council, 2011 Chapters 4-6.
- All hazardous materials must be labeled with their identity as well as all applicable warning statements. Manufacturer labels will contain all the necessary information. However, if material is repackaged or synthesized in the laboratory, please follow the protocols described in the CHEMICAL LABELLING section of the NJIT CHP.

5. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE; decontaminate equipment and bench tops using sodium bicarbonate and water. Dispose of all used contaminated disposables as hazardous waste following the Waste Disposal Section.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

9. DESIGNATED USE AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA SHEETS

Insert location where SDS for the lab can be found

Prudent Practices in the Laboratory, 2011, see Chapters 4–6.

11. LAB-SPECIFIC INFORMATION (required) *(Examples of appropriate content)*

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

ORGANIC PEROXIDES AND SELF-REACTIVE CHEMICALS

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☒ Hazardous Chemical ☐ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

(See also the "Peroxide-forming Chemicals" SOP in the New Jersey Institute of Technology (NJIT) SOP template library)

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Chemicals in this class are thermally unstable and may undergo exothermic self-accelerating decomposition. In addition, they may also be explosive, burn rapidly, be sensitive to impact or friction, or react dangerously with other substances. All chemicals in this band are considered highly hazardous.

Organic peroxides can be obtained in two ways:

1. Purchased or synthesized as such, example: benzoyl peroxide, or
2. Occur spontaneously when certain chemicals are stored for prolonged periods, concentrated through distillation, evaporation, or air exposure, and also as a result of polymerization.

This SOP only deals with organic peroxides and other self-reactive materials that are purchased or synthesized. Organic peroxides that spontaneously form (ethers for example), are addressed in a separate NJIT SOP template titled: "*Peroxide-forming Chemicals".*

The Globally Harmonized Chemical Classification System (GHS) hazard codes and OSHA definitions for these types of materials are identified below:

Hazard Level	GHS Category	GHS H-Code	OSHA Definitions
Highly Hazardous	Organic Peroxides (Types A,B,C,D,E,F)	H240, H241, H242	Organic Peroxide
	Self-Reactive Substances (Types A,B,C,D,E,F)	H240, H241, H242	Unstable (reactive)
Generally Hazardous	All chemicals in this band are considered highly hazardous.		

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the NJIT Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria

- respirator use, etc.

3. ENGINEERING/VENTILATION CONTROLS

In addition to the practices described below, follow procedures as specified in the lab-specific and special handling/use sections of this SOP.

General practices:

- In general, it is preferable to perform all work with hazardous chemicals in a fume hood. Sash height should be kept as low as possible to avoid the escape of vapors, gases and particulates.
- Supplemental equipment such as blast shields should be used when working with chemicals or processes that may result in explosions or pressure releases.
- Consider the use of a glove box, toxic gas cabinet or other local exhaust in order to further contain hazards as appropriate.

For further information see these pages in Section 2 of the NJIT CHP:

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

General Practices:

- Be sure to review the Safety Data Sheet (SDS) for all chemicals to be used in the experiment.
- Do not work alone with these high hazard substances. At least one other person must be present in the same laboratory when any work involving hazardous chemicals is being done.
- Eliminate or substitute for a less hazardous material when possible. Or purchase organic peroxides that contain stabilizing diluents.
- Design your experiment to use the least amount of material possible to achieve the desired result.
- Verify your experimental set-up and procedure prior to use. Be familiar with the Safety Data Sheets for all chemicals in use. Assess the hazards to ensure that appropriate controls are in place to minimize risk and address emergency shut-down procedures as appropriate.
- Consult with the Faculty/PI if the work involves procedure scale-up or other large quantities or there are any questions regarding appropriate safety procedures.

Hazard Class-Specific Practices:

- All work with organic peroxide chemicals <u>must</u> be carried out in a fume hood with the addition of a blast shield. Portable blast shields are available for purchase.
- Avoid heat, flames, sparks, and other sources of ignition. Avoid shock or friction. Protect from physical damage.
- Use containers and tools/supplies/equipment made from non-metal materials and which are compatible with the peroxides used. Keep them very clean to avoid contamination.

- Glass containers with screw-cap lids or glass stoppers may not be acceptable for some organic peroxides, especially those sensitive to friction and grinding.
- Do not store organic peroxides that give off gas as they decompose in a tightly sealed, non-vented container. The buildup of gas pressure could rupture it. These peroxides are shipped in containers with specially vented caps. Use no other type of cap for containers of these organic peroxides. The vent caps relieve the normal buildup of gas pressure that could shatter an un-vented container. Check vent caps regularly to ensure that they are working properly. Keep vented containers in an upright position.
- If a water-based formulation freezes, do not chip or grind it to break up lumps of material, or heat it to thaw it out. Follow the chemical supplier's advice.
- Dilute organic peroxides strictly in according to the chemical supplier's advice. Using the wrong solvent or a contaminated solvent could cause an explosion. For example, methyl ethyl ketone peroxide and cyclohexanone peroxide may explode if they are mixed with acetone, a common solvent. Using reclaimed solvents of uncertain composition can also be hazardous. They may contain dangerous concentrations of contaminants that are incompatible with the organic peroxide.
- Filtering friction-or shock-sensitive chemicals with materials and devices that produce heat, such as sintered glass filters, can also be hazardous. If the reactivity is not known but must be done, conduct these activities as if the organic peroxide is an explosive.
- Do not let combustible solids such as paper towels and lab coats become contaminated with organic peroxides. Should this happen, immediately soak and rinse with water to remove the organic peroxide.
- Additional information regarding the safe handling and use of oxidizers can be found at: Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (section 6.G. Working with Highly Reactive or Explosive Chemicals - http://www.nap.edu/openbook.php?record_id=4911&page=51

5. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE; decontaminate equipment and bench tops using sodium bicarbonate and water. Dispose of all used contaminated disposables as hazardous waste following the Waste Disposal Section.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

9. DESIGNATED USE AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA SHEETS

Insert the location of SDS for chemicals used in the lab

11. LAB-SPECIFIC INFORMATION (required) *(*Examples *of appropriate content)*

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

PEROXIDE-FORMING CHEMICALS

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Organic peroxides are among the most hazardous substances handled in the chemical laboratory. They are generally low-power explosives that are sensitive to shock, sparks, or other accidental ignition. They are far more shock-sensitive than most primary explosives such as TNT.

Organic peroxides can be obtained in two ways:

1. purchased as such, e.g. benzoyl peroxide, or
2. occur spontaneously when certain chemicals (see below) are stored for prolonged periods, concentrated through distillation, evaporation, or air exposure, and also as a result of polymerization.

This SOP only deals with the peroxides that can form in the lab. Organic peroxides that are purchased are addressed in a separate NJIT SOP template titled: *Organic Peroxides and Self-Reactive Chemicals*.

Organic peroxides are organic compounds containing the peroxide functional group (R-O-O-R'), where R = an organic group. These materials are sensitive to oxygen, heat, friction, impact, light, and strong oxidizing and reducing agents.

Peroxide forming chemicals are compounds that undergo auto-oxidation to form organic hydroperoxides and/or peroxides when exposed to the oxygen in air. Especially dangerous are **ether** bottles that have evaporated to dryness. A peroxide present as a contaminant in a reagent or solvent can be very hazardous and can change the course of a planned reaction. Auto-oxidation of organic materials (solvents and other liquids are most frequently of primary concern) proceeds by a free-radical chain mechanism. For the substrate R—H, the chain is initiated by ultraviolet light.

The unusual stability problems of this class of compounds make them a serious fire and explosion hazard that requires careful management.

2. HAZARDOUS CHEMICALS/CLASS OF HAZARDOUS CHEMICALS

The following are examples of specific compounds that are prone to forming peroxides:

Acetal	Diisopropyl ether	Sodium amide
Butadiene	Dioxane	Styrene

Cumene	Dimethyl ether	Tetrahydrofuran
Cyclohexene	Divinyl acetylene	Tetrahydronaphthalene
Cyclooctene	Ethyl ether	Tetralin
Decahydronaphthalene	Ethylene glycol dimethyl ether	Vinyl acetate
Decalin	Isopropyl ether	Vinyl actylene
Diacetylene	Methyl acetylene	Vinyl chloride
Dicyclopentadiene	Methylcyclopentane	Vinyl ethers
Diethylene glycol	Potassium metal	Vinylidene chloride

Most of the above specific examples fall into these chemical structure types:

- Ethers, especially cyclic ethers and those containing primary and secondary alkyl groups (never distill an ether before it has been shown to be free of peroxide)
- Aldehydes
- Compounds containing benzylic hydrogen
- Compounds containing allylic hydrogens (C=C-H), including most alkenes; vinyl, and vinylidene compounds
- Compounds containing a tertiary C-H group (e.g., decalin and 2,5-dimethyl hexane)

3. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the New Jersey Institute of Technology (NJIT) Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

4. ENGINEERING/VENTILATION CONTROLS

- Use at least one of the following engineering controls:
    - Fume hood: Work inside a certified chemical fume hood at all times.
    - Glove box: When inert or dry atmospheres are required.
    - Portable explosion shield: May also be required to control the risk of explosion.
    - Gas cabinet: If the material is classified as a compressed gas.
- Use bonding and grounding equipment to minimizing the likelihood of an ignition from static electricity during the transfer of all Class I flammable liquids – see the *Flammable Liquids* SOP template in the NJIT SOP library.

- Know where your safety equipment is located (i.e., fire extinguisher, eye wash/safety shower, and first aid kit).
- Have the appropriate fire extinguisher available.

For further information see these pages in Section 2 of the NJIT CHP:

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

5. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

- At least one other person should be present in the same laboratory, or nearby, when any work involving peroxide forming chemicals is carried out.
- Eliminate or substitute a less hazardous material when possible.
- Design your experiment to use the smallest amount of material possible to achieve the desired result.
- Verify your experimental set-up and procedure prior to use.
- Ensure all equipment is appropriate for the task.
- Avoid inadvertent incompatibles:
    - Heat sources, open flames and oxidizers
    - Consult with the campus Chemical Hygiene Officer if work involves large quantities.
- Conduct distillation, extraction or crystallization, and other processes that concentrate the organic peroxides only when it is explicitly known safe to do so.

Diethyl ether must be used in a fume hood. THF-containing mobile phase must be prepared in the fume hood but may be used outside of the fume hood on HPLC equipment so long as the mobile phase supply container is covered. Refrigeration of diethyl ether is not recommended. Reduced temperature can impede the peroxide-scavenging ability of added preservatives and may actually increase peroxide formation. Reduced temperature may also decrease the solubility of any solid peroxides that have formed, thereby increasing the hazard.

STORAGE:

- Purchase and use the minimum amount of material necessary to perform your research.
- Label peroxide-forming materials clearly and promptly with the date upon receipt or synthesis. Dispose of old materials when past their expiration date. For many ethers this is usually in the **6 to 12 months** range.
- The presence of peroxides in some cases is indicated by the appearance of a **precipitate or oily layer** in the container.
- Store all peroxide forming materials inside of a flammable cabinet
- Review your inventory frequently to prevent peroxide-forming chemicals from becoming unsafe.
- Test materials for peroxide formation before using, particularly if the material is to be concentrated via distillation/evaporation. See test methods below.

- Do not handle old or expired peroxide-forming materials that are discovered. Inform your Principal Investigator immediately and dispose of the item as a hazardous waste.
- Ether solvents: Ether solvents stored in solvent drying cartridge manifolds can be excluded since these are kept air-free under a positive pressure of inert gas. The dangers associated with ether solvents depend on and can be exacerbated by these factors:
    - Exposure to air (oxygen)
    - Exposure to light
    - Temperature
    - Friction
    - Shock
    - Concentration
    - Chemical structure
    - Distillation that removes stabilizers
    - Slow evaporation of volatile ethers over time
    - Impurities

Peroxide Detection Tests

From Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, 2011. Sec. 6.G.3.2: The following tests will detect most (but not all) peroxy compounds and all hyperperoxides. Results of peroxide detection tests must be indicated on the container/tag with test date, test results/method, and initials of the authorized person conducting the test. NOTE: These tests should not be used for testing materials potentially contaminated with inorganic peroxides (i.e., potassium).

Option 1. Add 1-3 ml of the liquid to be tested to an equal volume of acetic acid, add a few drops of 5% potassium iodide (KI) solution and shake. The appearance of a yellow to brown color indicates the presence of peroxides.

Option 2. Addition of 1 ml of a freshly prepared 10% KI and 10 ml of an organic solution in a 25 ml glass cylinder should produce a yellow color if peroxides are present.

Option 3. Add 0.5 ml of the liquid to be tested to a mixture of 1 ml of 10% KI solution and 0.5 ml of dilute hydrochloric acid to which a few drops of starch solution have been added just before the test. The presence of a blue-black color within a minute indicates the presence of peroxides.

Option 4. Peroxide test strips that turn an indicative color in the presence of peroxides. Take care to follow manufacturer instructions for effective detection. In general, the strips must be air dried until the solvent evaporates and then exposed to moisture for proper operation.

6. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

7. DECONTAMINATION

If there are incidental drips of peroxidizable solvent on the fume hood work surface, secure ignition sources and lower the sash to allow for evaporation. If bench paper becomes contaminated, it must be removed, replaced and disposed of as hazardous waste.

8. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

9. PRIOR APPROVAL/REVIEW REQUIRED

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed before an individual can do the operation.

The Faculty/PI must be notified and approval must be obtained if diethyl ether will be heated above room temperature or if the solvent volume will be reduced under reduced pressure (rotary evaporation technique). This is a very hazardous process, and concentration of the diethyl ether could cause crystals of potentially explosive ethereal peroxides to form. Consult with the Faculty/PI for alternative methods for reducing solvent volume.

10. DESIGNATED AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

Work should be completed in a laboratory fume hood.

11. SAFETY DATA SHEETS (SDS)

Insert the location of SDS for chemicals used in the lab

Review R.J. Kelly's paper *Review of Safety Guidelines for Peroxidizable Organic Chemicals* (Journal of Chemical Health and Safety; Sept/Oct 1996).

12. LAB-SPECIFIC INFORMATION (required) (Examples of appropriate content)

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

METAL CARBONYLS

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☒ Hazardous Chemical ☐ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Metal carbonyls are very toxic. The extreme toxicity of metal carbonyls is due to the release of carbon monoxide (both in storage and once inside the body), to the toxicity inherent to the metal center, and to the reactivity of each individual metal carbonyl complex. Nickel carbonyl is one of the strongest known inhalation poisons. Due to the generally high volatility of lower molecular weight metal carbonyls exposure due to inhalation is a notable risk and may be fatal if inhaled. Other forms of exposure are skin permeation, as well as accidental ingestion. Metal Carbonyls may be fatal through both skin absorption and ingestion. Some metal carbonyls are air reactive chemicals which can be flammable, pyrophoric, and/or form explosive mixtures in air. Additionally, they are heat and light sensitive. The international symbol (GHS system) for metal carbonyls is:

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Given the severe and immediate effects of metal carbonyls, the OSHA regulatory requirements and the New Jersey Institute of technology (NJIT) policy, it is essential that proper PPE always be employed.

See the PPE information under Section 2 of the NJIT Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

At minimum, complete protection of the eyes and skin is essential.

3. ENGINEERING/VENTILATION CONTROLS

In general, metal carbonyls should always be used in a properly functioning fume hood.

For further information see these pages in Section 2 of the NJIT CHP:

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

Precautions for safe handling: Avoid contact with skin and eyes. Avoid inhalation of vapor or mist. Use explosion-proof equipment. Keep away from sources of ignition/sparks. Take measures to prevent the build-up of electrostatic charge.

Conditions for safe storage: Store in cool place. Keep container tightly closed in a dry and well-ventilated place. Toxic carbon monoxide can be released during storage and could be fatal without adequate ventilation. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Recommended storage temperature: 2 - 8 °C (*always store inside a refrigerator that is approved for flammable chemical storage*). Heat, air & light sensitive. Handle and store under inert gas. Always follow the specific storage information provided by the supplier.

5. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Using proper personal protective equipment as outlined above, decontaminate equipment and bench tops using soap and water and properly dispose of all chemical and contaminated disposables as hazardous waste following the guidelines below.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW REQUIRED

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed before an individual can do the operation.

9. DESIGNATED AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA SHEETS (SDS)

Insert the location where the SDS for chemicals used in the lab are located.

11. LAB-SPECIFIC INFORMATION (required) *(Examples of appropriate content)*

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

POTENTIALLY EXPLOSIVE CHEMICALS (PEC)

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

PECs are chemicals (or combinations thereof) that may cause a sudden release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. Materials having these general properties are termed "explosive" throughout this document in the commonly-used sense of the word. However, the technical definition of an "explosive" is a material that meets certain criteria for the speed of the chemical reaction. "Deflagration" is another term sometimes used for "explosive" reactions of slower speed. "Unstable reactive" is another term used to describe some of these materials.

This SOP describes how to safely handle these types of chemical compounds in a general sense. SOP's covering specific chemicals/chemical classes in greater detail should be appended to this SOP if their use is routine in the laboratory in question.

Explosive chemicals can release tremendous amounts of destructive energy rapidly. If not handled properly, these chemicals can pose a serious threat to the health and safety of laboratory personnel, emergency responders, building occupants, chemical waste handlers, etc.

There are two classes of explosive chemicals:

- Known explosive chemicals that are designed and produced for use as an explosive (e.g., TNT, explosive bolts, bullets, blasting caps, and fireworks).
- Potentially explosive chemicals (PECs). Most chemicals that are used in research and teaching laboratories are stable and non-explosive at the time of purchase. Over time, some chemicals can oxidize, become contaminated, dry out, or otherwise destabilize to become PECs (e.g., isopropyl ether, sodium amide, and picric acid).

The Globally Harmonized System symbol (GHS system) for an explosive material is:

SOP templates for some specific PEC's are available in the NJIT SOP library, including peroxide-forming chemicals, perchloric acid, azides, diazomethane, etc. If these chemicals, or others, are used routinely in the laboratory, an SOP addressing the specific details of handling these materials is advised.

Potentially Explosive Lab Chemicals

Acetyl peroxide
Acetylene
Ammonium nitrate
Ammonium perchlorate
Ammonium picrate
Ba/Pb/Hg azide (heavy metal azides)
Li/K/Na azide
Organic azides
Bromopropyne
Butanone peroxide
Cumene peroxide
Diazodinitrophenol
Dinitrophenol
Dinitrophenylhydrazine
Dinitroresorcinol
Dipicryl amine
Dipicryl sulphide
Dodecanoyl peroxide
Ethylene oxide
Lauric peroxide
MEK peroxide
Mercury fulminate, Silver fulminate
Nitrocellulose
Nitrogen trifluoride
Nitrogen triiodide
Nitroglycerine
Nitroguanidine
Nitromethane
Nitrourea
Picramide
Picric acid (trinitrophenol) Picryl chloride
Picryl sulphonic acid
Propargyl bromide (neat)
Sodium dinitrophenate
Succinic peroxide
Tetranitroaniline
Trinitroaniline
Trinitroanisole
Trinitrobenzene
Trinitrobenzenesulphonic acid
Trinitrobenzoic acid
Trinitrocresol
Trinitronaphthalene
Trinitrophenol (picric acid)
Trinitroresorcinol
Trinitrotoluene
Urea nitrate

Potentially Explosive Compound Classes

Acetylene (-C=C-)
Acyl hypohalites (RCO-OX)
Azide Organic (R-N3)
Azide Metal (M-N3)
Azo (-N=N-)
Diazo (=N=N)
Diazosulphide (-N=N-S-N=N-)
Diazonium salts (R-N2+)
Fulminate (-CNO)
Halogen Amine (=N-X)
Nitrate (-ONO2)
Nitro (-NO2)

Aromatic or Aliphatic Nitramine (=N-NO2) (-NH-NO2)

Nitrite (-ONO)

Nitroso (-NO)

Ozonides

Peracids (-CO-O-O-H)

Peroxide (-O-O-)

Hydroperoxide (-O-O-H)

Metal peroxide (M-O-O-M)

Explosive Salts

Bromate salts (BrO3-)

Chlorate salts (ClO3-)

Chlorite salts (Cl02-)

Perchlorate salts (Cl04-)

Picrate salts (2,4,6-trinitrophenoxide)

Picramate salts (2-amino-4,6-dinitrophe-noxide)

Hypohalite salts (XO-)

Iodate salts (IO3-)

Chemicals That May Rupture their Container Due to Over-pressurization

Aluminum chloride
Aluminum lithium hydride
Ammonia solution
Ammonium hydroxide
Ammonium persulfate
Anisyl chloride
Aqua regia
Benzenesulphonyl chloride
Bleach
Bleaching powder
Calcium carbide
Calcium hydride
Calcium hypochlorite
Chloroform
Chromic acid
Cumene hydroperoxide
Cyclohexne
Diethyl pyrocarbonate
Dimethylamine
Formic Acid
Hydrogen peroxide
Lauroyl peroxide
Lithium aluminum hydride
Lithium hydride
Nitric acid
Nitrosoguanidine
Peracetic acid
Phenol
Phosphorus trichloride
Potassium Persulphate
Silicon tetrachloride
Sodium borohydride
Sodium dithionite
Sodium hydride
Sodium hydrosulphite
Sodium hypochlorite
Sodium peroxide
Sodium persulfate
Thionyl chloride
Urea peroxide
Zinc

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the New Jersey Institute of Technology (NJIT) Chemical hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

However, note that beyond the normal PPE (lab coat, safety glasses), the use of face shields and heavy leather gloves is advised when handling genuinely explosive materials.

3. ENGINEERING/VENTILATION CONTROLS

- Heavy transparent plastic safety shielding shall be used for any operation having the potential for explosion, including the following situations: Convenient portable weighted safety shields can be purchased from a variety of scientific equipment suppliers, including Fisher Scientific and Sigma-Aldrich.
    - When a reaction is attempted for the first time (small quantities of reactants should be used to minimize hazards);
    - When a familiar reaction is carried out on a larger than usual scale (i.e., 5-10 times more material); or
    - When operations are carried out under non-ambient conditions.
- Shields must be placed so that all personnel in the area are protected from hazard.
- All operations involving PECs and dilutions should be carried out in a certified fume hood to keep airborne level below recommended exposure limits. Sash should be kept in down position to act as additional shielding, but note that a hood sash is not a good substitute for a genuine safety shield.
- Chemical fume hoods used as containment areas for particularly hazardous chemicals must have a face velocity of 100 lfm, averaged over the face of the hood and must be certified annually by the Facilities Department.
- Laboratory rooms must be at negative pressure with respect to the corridors and external environment. The laboratory/room door must be kept closed at all times.
- The experimental set-up should be designed such that the reaction vessel can easily be immersed in a cold bath or other cooling device in case of a run-away exothermic reaction.

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

General Practices:

- Be sure to review the Safety Data Sheet (SDS) for all chemicals to be used in the experiment. General information on working with PECs can also be found in Prudent Practices in the Laboratory, see Secs. 4.D.3 and 6.G

- A risk assessment should be carried out before new work with PECs is begun. Discussing the risks with Faculty/PI is required.
- Do not work alone with these high hazard substances. At least one other person must be present in the same laboratory when any work involving hazardous chemicals is being done.
- Eliminate or substitute for a less hazardous material when possible.
- Design your experiment to use the least amount of material possible to achieve the desired result. **Consult with your Faculty/PI if the work involves procedure scale-up or other deviations from the Faculty/PI-approved protocol/procedure, or if there are any questions regarding appropriate safety procedures.**
- Verify your experimental set-up and procedure prior to use. Be familiar with the Safety Data Sheets for all chemicals in use. Assess the hazards to ensure that appropriate controls are in place to minimize risk and address emergency shut-down procedures as appropriate.
- Areas in which longer-term experiments containing PEC's should be labeled as "EXPLOSION RISK"

Explosion risk

Hazard Class-Specific Practices:

It is important that chemical users track and dispose of chemicals before they become a problem. Proper inventory management systems can help mitigate risk to personnel and avert higher than normal disposal costs.

- Identify all explosive and potentially explosive chemicals in your inventory. Never store unlabeled chemicals. Before they can be shipped to a disposal site, unknown chemicals require special testing to determine which hazardous properties they possess.
- Record the opening date and the date that the chemical should be discarded on the label of chemicals that may degrade to become potentially explosive.
- Keep explosive chemicals away from all ignition sources such as open flames, hot surfaces, spark sources, and direct sunlight.
- Consider designating a special area for explosive chemical use.
- Periodically check containers of chemicals that could become over-pressurized, like highly concentrated formic acid. Note: Release the pressure by unscrewing the cap, using protective heavy-duty gloves, chemically resistant coveralls, safety glasses, face shield, and a safety glass screen between you and the container.
- Make sure everyone who uses chemicals that are explosive or could become potentially explosive are thoroughly trained in safe storage methods, conditions to avoid (e.g., contamination), the hazards of the chemical, and disposal procedures.
- Chemically reactive substances are stored in designated cabinets in secondary containment and segregated away from incompatibles.

Note: Most explosions occur while purifying or distilling mixtures. Therefore, use extreme caution before concentrating or purifying any mixture that may contain an explosive chemical (e.g. a peroxide forming chemical or perchlorate).

5. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE; decontaminate equipment and bench tops using sodium bicarbonate and water. Dispose of all used contaminated disposables as hazardous waste following the Waste Disposal Section.

7. WASTE DISPOSAL

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

9. DESIGNATED USE AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA SHEETS and OTHER REFERENCES

Insert location where SDS for the lab can be found

Prudent Practices in the Laboratory, 2011, see Secs. 4.D.3 and 6.G for flammable liquids http://www.nap.edu/openbook.php?record_id=12654&page=R15

11. LAB-SPECIFIC INFORMATION (required) *(*Examples *of appropriate content)*

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

HIGHLY TOXIC AND PYROPHORIC COMPRESSED GASES

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Highly toxic and pyrophoric gases are among the most hazardous materials that could be used on campus. Common examples are given below. Due to their extreme hazard they are highly regulated under the Fire Code and/or the Department of Homeland Security. In some circumstances complex and expensive gas detection and alarm systems are required. These mitigations are required under when the volume of gas exceeds a particularly threshold for a building or floor.

Because of these complex issues, a generic Standard Operating Procedure template is **not** provided by the EHS Department for these materials. If a research group wants to use such materials, please contact the EHS Department to discuss the appropriate mitigations.

2. COMMON HIGHLY HAZARDOUS GASES (more examples in App. A. of "Gases Under Pressure" SOP)

- Arsine
- Boron trichloride
- Boron trifluoride
- Carbonyl sulfide
- Chlorine
- Cyanogen
- Fluorine
- Germane
- Hydrogen cyanide
- Hydrogen fluoride
- Hydrogen selenide
- Hydrogen sulfide
- Methyl bromide
- Methyl mercaptan
- Nickel carbonyl
- Nitric oxide
- Nitrogen dioxide
- Nitrous oxide
- Phosgene
- Phosphine
- Sila

PYROPHORIC SOLIDS

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

See also the "Pyrophoric Organolithium Reagents" SOP in the New Jersey Institute of Technology (NJIT) SOP library.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

Researchers should not use pyrophoric reagents until they have read and fully understood these safe operating procedures. However, reading these procedures does not substitute for hands-on training. New users of pyrophoric reagents must work under the close supervision of an experienced user.

In general these materials ignite spontaneously when exposed to air. They also tend to be associated with flammable solvents. Other common hazards include corrosivity, water reactivity, peroxide formation, and toxicity.

A variety of solids are pyrophoric (spontaneously ignite in air) including (but not necessarily limited to):

- Finely divided metals (bismuth, calcium, hafnium, iron, magnesium, titanium, uranium, zirconium)
- Alkali metals (lithium, sodium, potassium, especially sodium potassium alloy – NaK, and even more dangerous are cesium and rubidium)
- Low valent metals (titanium dichloride)
- Nonmetals (white phosphorous)
- Metal hydrides (potassium hydride, sodium hydride, lithium aluminum hydride, uranium trihydride)
- Nonmetal hydrides (arsine, boranes, germane, phosphine, silane, sodium borohydride) (Most but not all of these are actually gases.)
- Partially or fully alkylated derivatives of metal and nonmetal hydrides (diethylaluminium hydride,
- diisobutylaluminum hydride, dichloro(methyl)silane) (Usually in liquid form or in solution.)
- Alkylated metals (butyllithium, triethylboron, trimethylaluminum) (Usually in liquid form or in solution.)
- Alkylated metal alkoxides or halides (dimethylaluminum chloride, diethylethoxyaluminium)
- Metal carbonyls (dicobalt octacarbonyl, nickel carbonyl)

- Used hydrogenation catalysts, e.g. Raney Ni, are especially hazardous due to adsorbed hydrogen
- Copper fuel cell catalysts, e.g. Cu/ZnO/Al2O3 Methanetellurol (CH3TeH)
- Finely divided Iron sulfides (FeS, FeS2, Fe3S4), Potassium sulfide (K2S), Aluminum phosphide (AlP)

The international symbol (GHS system) for a pyrophoric is:

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Given the severe and immediate effects of acids on the eyes and skin, the OSHA regulatory requirements and the NJIT policy, it is essential that proper PPE always be employed.

See the PPE information under Section 2 of the NJIT Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria
- respirator use, etc.

Safety eyewear and a flame-resistant lab coat are required at a minimum.

3. ENGINEERING/VENTILATION CONTROLS

In general, pyrophorics should always be used in a properly functioning fume hood.

For further information see these pages in Section 2 of the NJIT CHP:

- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

Eyewash

Suitable facilities for quick drenching or flushing of the eyes should be within 10 seconds travel time for immediate emergency use. Bottle type eyewash stations are not acceptable.

Safety Shower

A safety shower should be available within 10 seconds travel time from where pyrophoric chemicals are used. These can also be used in the event of a clothing fire.

Fume Hood

Many pyrophoric chemicals release noxious or flammable gases and should be handled in a laboratory hood. In addition, some pyrophoric materials are stored under kerosene (or other flammable solvent), therefore the use of a fume hood (or glove box) is required to prevent the release of flammable vapors into the laboratory.

Fire Extinguisher

- A Class C dry chemical fire extinguisher must be available within 10 seconds travel time from where pyrophoric chemicals are used.
- Know the location of the nearest Class D fire extinguisher.
- A container of powdered lime (calcium oxide, CaO) should be kept within arm's length when working with a pyrophoric material.

Glove (Dry) Box

Glove boxes are an excellent device to control pyrophoric chemicals when inert or dry atmospheres are required

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

Before working with pyrophoric reagents, read the relevant Safety Data Sheets (SDS) and understand the hazards. The SDS must be reviewed before using an unfamiliar chemical and periodically as a reminder.

Set up your work in a laboratory fume hood or glove box and ALWAYS wear the appropriate PPE.

Handling Pyrophoric Solid Reagents

- Pyrophoric solids are ideally used in a sealed glove box flushed with inert gas.
- Many pyrophoric solids are sold as solutions, or dispersions in mineral oil or are covered with hydrocarbon solvents to facilitate use.
- Mildly pyrophoric solids (such as lithium aluminum hydride and sodium hydride) may be handled in the air for brief periods of time, but the containers must be flushed with inert gas before storage.

Transferring and Weighing Pyrophoric Solid Reagents

- Gather all necessary experimental equipment first to avoid prolonged exposure of pyrophoric solids to air.
- Weighing alkali metals: Cut desired piece of alkali metal under packing oil using a knife. Using tweezers, transfer to adjacent flask containing toluene or heptane to rinse off oil. Use tweezers again to transfer to a weighed flask of toluene and measure weight to determine mass of metal. Use tweezers again to transfer to desired reaction flask.
- **Avoid** low boiling rinses such as ether and pentane that tend to condense water upon evaporation.

Specific Recommendations for Working with Pyrophoric Solid Reagents

- Lithium Aluminum Hydride reacts violently with water and has a significant heat of solvation. Therefore **do not** add solvent to dry LiAlH4. Instead, slowly add LiAlH4 to anhydrous solvent in the reaction flask. The initial small amount of LiAlH4 will react with any trace amounts of water.
- Potassium metal is considerably more reactive than lithium or sodium.
- Potassium metal oxidizes to potassium oxide (K2O), potassium peroxide (K2O2), and potassium superoxide (KO2). The yellow peroxides are shock-sensitive and can explode when handled or cut. Therefore dispose of potassium metal as hazardous waste if old or if a significant amount of yellow crust is visible.
- The mineral oil of potassium hydride or sodium hydride dispersions can be rinsed off using a light hydrocarbon solvent such as hexane. This is easily accomplished in a glove box or can be done in a hood UNDER CAREFULLY CONTROLLED CONDITIONS. Weigh out desired amount of dispersion and seal in a flask under nitrogen. Add dry hexane via syringe, swirl, and let metal hydride settle. Slowly syringe off hexane and then carefully discard into a separate flask containing isopropanol. Repeat rinse procedure.
- AVOID low boiling rinses such as ether and pentane that tend to condense water upon evaporation.
- Sodium amalgam, Na(Hg), (or potassium amalgam) is prepared by dissolving sodium into liquid mercury. This highly exothermic process produces the intermetallic compound NaHg2 with enough heat to cause local boiling of the mercury. Thus it must be performed in a hood under dry nitrogen gas. The grey solid produced has the reducing potential of sodium, but is more air stable.

Storage

- Store pyrophoric chemicals under an inert atmosphere or under kerosene as directed by the manufacturer's instructions
- Avoid storage areas with heat/flames, oxidizers and water sources

5. SPILL AND INCIDENT PROCEDURES

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE; decontaminate equipment and bench tops using sodium bicarbonate and water. Dispose of all used contaminated disposables as hazardous waste following the Waste Disposal Section.

7. WASTE DISPOSAL

Unless the material is still in the original vendor's container, pyrophorics generally need to be "quenched" before giving to the EHS Department for disposal.

Disposal of Pyrophoric Solid Reagents by Quenching

- Small amounts of unused or unwanted pyrophoric materials must be destroyed by careful quenching of the residue. Transfer the materials to an appropriate reaction flask for hydrolysis and/or neutralization. Dilute significantly with an unreactive solvent such as heptane or toluene and place the flask in an ice water cooling bath. Slowly add isopropanol to quench pyrophoric materials. Upon completion, add methanol as a more reactive quenching agent to ensure completion. Finally, add water dropwise to make sure there are no pockets of reactive materials. Dispose of as hazardous waste.
- Alternatively, reactive substances can be quenched by slowly adding the dilute solution to dry ice, then adding a mildly reactive quenching agent such as methanol.
- AVOID low boiling diluents such as ether and pentane that tend to condense water upon evaporation.
- Do not leave containers with residues of pyrophoric materials open to the atmosphere due to uncontrolled ignition.

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

9. DESIGNATED USE AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA SHEETS

Insert the location of SDS for chemicals used in the lab

11. LAB-SPECIFIC INFORMATION (required) (*Examples* of appropriate content)

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

PYROPHORIC ORGANOLITHIUM REAGENTS

STANDARD OPERATING PROCEDURE (SOP) TEMPLATE

Type of SOP: ☐ Process ☐ Hazardous Chemical ☒ Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section ("Lab-Specific Information") is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

See also the "Pyrophoric Solids" SOP in the New Jersey Institute of Technology (NJIT) SOP library.

Department: _____ Building: _____ Room #:_____

Principal Investigator: _____ Phone #: _____

Prepared By: _____ Email: _____ Date: _____

1. HAZARD OVERVIEW

This procedure will cover the storage, transfer and use of organolithium reagents including (but not necessarily limited to):

Alkyls –

- Methyl-d3-lithium, as complex with lithium iodide solution 0.5 M in diethyl ether
- Methyllithium lithium bromide complex solution
- Methyllithium solution purum, ~5% in diethyl ether (~1.6M)
- Methyllithium solution purum, ~1 M in cumene/THF
- Methyllithium solution 3.0 M in diethoxymethane
- Methyllithium solution 1.6 M in diethyl ether
- Ethyllithium solution 0.5 M in benzene/cyclohexane (9:1)
- Isopropyllithium solution 0.7 M in pentane
- Butyllithium solution 2.0 M in cyclohexane
- Butyllithium solution purum, ~2.7 M in heptane
- Butyllithium solution 10.0 M in hexanes
- Butyllithium solution 2.5 M in hexanes
- Butyllithium solution 1.6 M in hexanes
- Butyllithium solution 2.0 M in pentane
- Butyllithium solution ~1.6 M in hexanes
- Butyllithium solution technical, ~2.5 M in toluene
- Isobutyllithium solution technical, ~16% in heptane (~1.7 M)
- sec-Butyllithium solution 1.4 M in cyclohexane

- tert-Butyllithium solution purum, 1.6-3.2 M in heptane
- tert-Butyllithium solution 1.7 M in pentane
- (Trimethylsilyl)methyllithium solution 1.0 M in pentane
- (Trimethylsilyl)methyllithium solution technical, ~1 M in pentane
- Hexyllithium solution 2.3 M in hexane
- 2-(Ethylhexyl)lithium solution 30-35 wt. % in heptane

Alkynyls –

- Lithium acetylide, ethylenediamine complex 90%
- Lithium acetylide, ethylenediamine complex 25 wt. % slurry in toluene
- Lithium (trimethylsilyl)acetylide solution 0.5 M in tetrahydrofuran
- Lithium phenylacetylide solution 1.0 M in tetrahydrofuran

Aryls –

- Phenyllithium solution 1.8 M in di-n-butyl ether

Others –

- 2-Thienyllithium solution 1.0 M in tetrahydrofuran
- Lithium tetramethylcyclopentadienide
- Lithium pentamethylcyclopentadienide

The international symbol (GHS system) for a Pyrophoric Organolithium Reagents is:

In general these materials are pyrophoric; they ignite spontaneously when exposed to air. This is the primary hazard and reagents must be handled so as to rigorously exclude air/moisture. They all tend to be toxic and come dissolved in a flammable solvent. Other common hazards include corrosivity, teratogenicity, water reactivity, peroxide formation, along with damage to the liver, kidneys, and central nervous system.

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

See the PPE information under Section 2 of the NJIT Chemical Hygiene Plan (CHP) regarding:

- the PPE Policy (what PPE is needed and when/where to use)
- obtaining your PPE
- glove selection criteria

- respirator use, etc.

In addition:

- Gloves must be worn when handling pyrophoric chemicals. Nitrile gloves should be adequate for handling most of these in general laboratory settings, but they are combustible. Be sure to use adequate protection to prevent skin exposures. Sigma-Aldrich recommends the use of nitrile gloves underneath neoprene gloves.
- Flame-resistant gloves are also available for purchase, but are generally not used due to their poor dexterity when doing delicate chemical transfer work.
- *A lab coat or apron* (not made from easily ignited material like nylon or polyester) *must be worn*. Special fire-resistant lab coats are more expensive, but recommended for labs using these reagents routinely.

3. ENGINEERING/VENTILATION CONTROLS

Eyewash

- Suitable facilities for quick drenching or flushing of the eyes should be within 10 seconds travel time for immediate emergency use. Bottle type eyewash stations are not acceptable.

Safety Shower

- A safety shower should be available within 10 seconds travel time where pyrophoric chemicals are used. These can be used in the event of a clothing fire.

Fume Hood

- Many pyrophoric chemicals release noxious or flammable gases and should be handled in a laboratory hood. In addition, some pyrophoric materials are stored under kerosene (or other flammable solvent), therefore the use of a fume hood (or glove box) is required to prevent the release of flammable vapors into the laboratory.

Glove (Dry) Box

- Glove boxes are an excellent device to control pyrophoric chemicals when inert or dry atmospheres are required.

Fire Extinguisher

- A Class C dry chemical fire extinguisher must be available within 10 seconds travel time from where pyrophoric chemicals are used.
- Know the location of the nearest Class D fire extinguisher.
- A container of powdered lime (calcium oxide, CaO) should be kept within arm's length when working with a pyrophoric material.

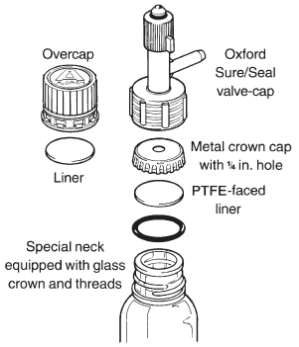


Fig. 1A Sure/Seal Components

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

Before working with pyrophoric reagents, read the relevant Safety Data Sheets (SDS) and understand the hazards. The SDS must be reviewed before using an unfamiliar chemical and periodically as a reminder. Pyrophorics users must be thoroughly-trained in proper lab technique and working alone with pyrophorics is strongly discouraged.

Set up your work in a laboratory fume hood or glove box and ALWAYS wear the appropriate personal protective equipment. Minimize the quantity of pyrophoric reagents used and stored.

The use of smaller syringes is encouraged. If handling more than 20 ml of sample - one should use a cannula for transfer or use a 20 ml syringe repeatedly.

IMPORTANT STEPS TO FOLLOW

Handling Pyrophoric Reagents

- By using proper syringe techniques, these reagents can be handled easily in the laboratory.

The Aldrich[3]Sure/Seal™ Packaging System

The Sure/Seal packaging system (**Fig. 1A)** provides a convenient method for storing and dispensing air-sensitive reagents. The reagent can be dispensed using a syringe or double-tipped needle (16, 18 or 20 gauge) inserted through the hole in the metal cap. When inserting a needle through a septum, a layer of silicone or hydrocarbon grease on the septum will help. Upon withdrawal of the needle, the small hole that remains in the PTFE liner will not cause the reagent to deteriorate under normal circumstances. However, it is recommended that the plastic cap be replaced after each use and in particular for long-term storage.

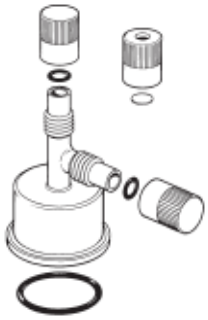


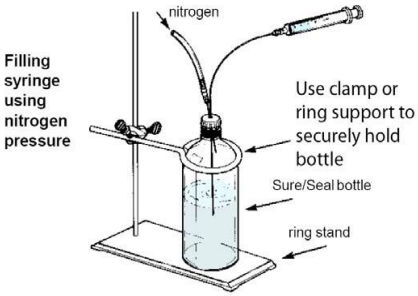
Fig. 1B Sure/Seal septum-inlet transfer adapter

For extended storage of unused reagents, use the solid plastic cap, or equip the bottle with an Oxford Sure/Seal valve cap, or transfer the reagent to a suitable storage vessel.

The Sure/Seal septum-inlet transfer adapter (**Fig. 1B)** can be used when repeated dispensing is necessary. The adapter protects the contents of the bottles from air and moisture.

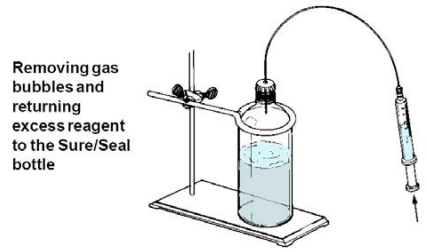
Transferring Pyrophoric Reagents with Syringe

- In a fume hood or glove box, clamp the reagent bottle to prevent it from moving Clamp/secure the receiving vessel too.
- After flushing the syringe with inert gas, depress the plunger and insert the syringe into the Sure/Seal bottle with the tip of the needle below the level of the liquid.
- Secure the syringe so if the plunger blows out of the body it, and the contents will not impact anyone (aim it toward the back of the containment)



pressure

- Insert a needle from an inert gas source carefully keeping the tip of the needle above the level of the liquid
- Gently open the inert gas flow control valve to slowly add nitrogen gas into the Sure/Seal bottle.
- This will allow the liquid to slowly fill the syringe (up to 100mL) as shown in **Fig. 2A**. Pulling the plunger causes gas bubbles.
- Let nitrogen pressure push the plunger to reduce bubbles. Excess reagent and entrained bubbles are then forced back into the reagent bottle as shown in **Fig. 2B**.
- The desired volume of reagent in the syringe is quickly transferred to the reaction apparatus by puncturing a rubber septum as illustrated in **Fig. 2C**



turning excess reagent to the Sure/Seal bottle

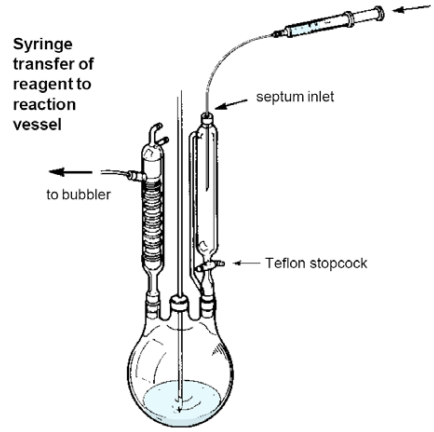


Fig. 2C Syringe transfer of reagent to reaction vessel

Transferring Pyrophoric Reagents with a Double-Tipped Needle

- The double-tipped needle technique is recommended when transferring 50 mL or more.
- Pressurize the Sure/Seal bottle with nitrogen and then insert the double-tipped needle through the septum into the headspace above the reagent. Nitrogen will pass through the needle. Insert the other end through the septum at the calibrated addition funnel on the reaction apparatus. Push the needle into the liquid in the Sure/Seal reagent bottle and transfer the desired volume. Then withdraw the needle to above the liquid level. Allow nitrogen to flush the needle. Remove the needle first from the reaction apparatus and then from the reagent bottle. **(Fig. 3A)**

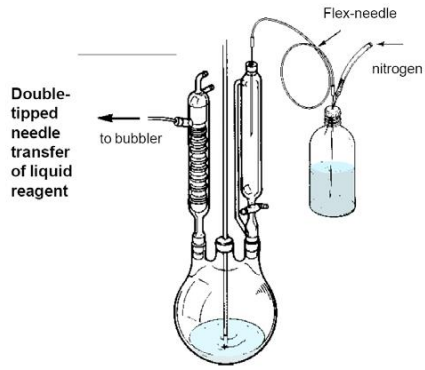


Fig. 3A Double-tipped needle transfer of liquid reagent

- For an exact measured transfer, convey from the Sure/Seal bottle to a dry nitrogen flushed graduated cylinder fitted with a double-inlet adapter **(Fig. 3B)**. Transfer the desired quantity and then remove the needle from the Sure/Seal bottle and insert it through the septum on the reaction apparatus. Apply nitrogen pressure as before and the measured quantity of reagent is added to the reaction flask.
- To control flow rate, fit a Luer lock syringe valve between two long needles as shown in **(Fig. 3C)**.

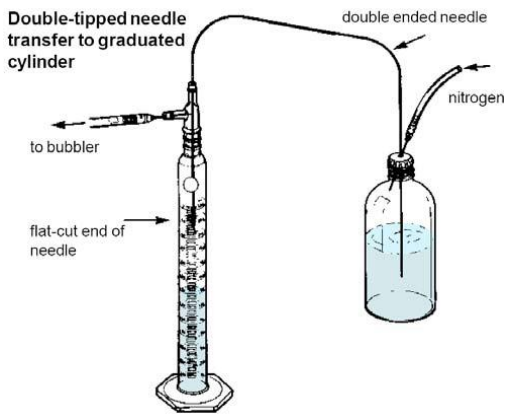


Fig. 3B Double-tipped needle transfer to graduated cylinder

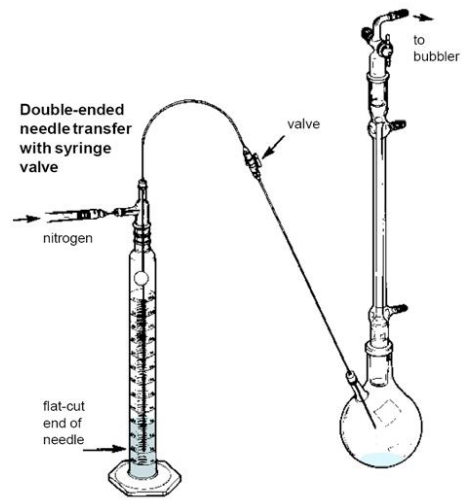


Fig. 3C Double-ended needle transfer with syringe valve

Storage

- Pyrophoric chemicals should be stored under an atmosphere of inert gas or under kerosene as appropriate.
- Avoid areas with heat/flames, oxidizers, and water sources.
- Containers carrying pyrophoric materials must be clearly labeled with the correct chemical name and hazard warning.
- For storage prepare a storage vessel with a septum filled with an inert gas
  - Select a septum that fits snugly into the neck of the vessel
  - Dry any new empty containers thoroughly
  - Insert septum into neck in a way that prevents atmosphere from entering the clean dry (or reagent filled) flask.
  - Insert a needle to vent the flask and quickly inject inert gas through a second needle to maintain a blanket of dry inert gas above the reactive reagent.
  - Once the vessel is fully purged with inert gas, remove the vent needle then the gas line.
- For long-term storage, the septum should be secured with a copper wire (figure 4A).
- For extra protection a second same-sized septa (sans holes) can be placed over the first (figure 4b).
- Use parafilm around the outer septa and (obviously) remove the parafilm and outer septa before accessing the reagent through the primary septa

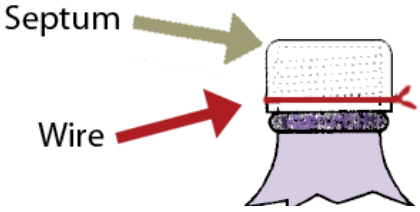


Fig. 4A Septa wired to vessel

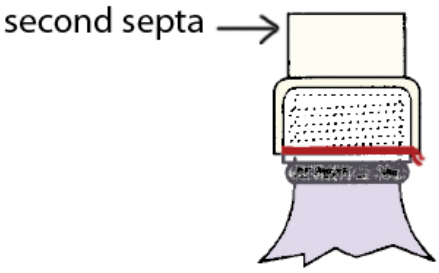


Fig. 4B For long-term storage, use a second septa

5. SPILL AND INCIDENT PROCEDURES

Spill

- Powdered lime should be used to completely smother and cover any spill that occurs.
- A container of powdered lime should be kept within arm's length when working *with a pyrophoric material.*
- *If anyone is exposed, or on fire, wash with copious amounts of water.*
- *The recommended fire extinguisher is a standard dry powder (ABC) type. Class D extinguishers are recommended for combustible solid metal fires (e.g, sodium,* LAH), but not for organolithium reagents.
- Call 9-1-1 for emergency assistance

See directions under the Emergency Response – Spills and Exposures section of the NJIT CHP for the proper procedures during a spill or chemical exposure.

6. DECONTAMINATION

Wear proper PPE; decontaminate equipment and bench tops using sodium bicarbonate and water. Dispose of all used contaminated disposables as hazardous waste following the Waste Disposal Section.

7. WASTE DISPOSAL

Disposal of Pyrophoric Reagents

- A container with any residue of pyrophoric materials should never be left open to the atmosphere.
- Any unused or unwanted pyrophoric materials must be destroyed by transferring the materials to an appropriate reaction flask for hydrolysis and/or neutralization with adequate cooling.
- The essentially empty container should be rinsed three times with an inert dry solvent; this rinse solvent must also be neutralized or hydrolyzed.
- After the container is triple-rinsed, it should be left open in back of a hood or atmosphere at a safe location for at least a week. After the week, the container should then be rinsed 3 times again.

Disposal of Pyrophoric Contaminated Materials

- All materials that are contaminated with pyrophoric chemicals should be disposed of as hazardous waste.
- Alert the EHS Department for any wastes contaminated by pyrophoric chemicals.
- The contaminated waste should not be left overnight in the open laboratory but must be properly contained to prevent fires.

Unless the material is still in the original vendor's container, pyrophorics generally need to be "quenched" before giving to EH&S for disposal.

Follow the practices and procedures in the NJIT Laboratory Waste Management Program to properly dispose of this waste.

As they deem necessary, the Faculty/PI should insert here any specific waste procedures or information for these substances.

8. PRIOR APPROVAL/REVIEW

As they deem necessary, the Faculty/PI should insert here any prior approval or review needed, before an individual can do the operation.

9. DESIGNATED USE AREA

As they deem necessary, the Faculty/PI should insert here any information about whether a special use-area is designated for this material/process.

10. SAFETY DATA SHEETS

Insert the location of SDS for chemicals used in the lab

11. LAB-SPECIFIC INFORMATION (required) *(Examples of appropriate content)*

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.

APPENDIX F

Laboratory SOP for the Use of Particularly Hazardous Materials or Substances

New Jersey Institute of Technology
Laboratory Standard Operating Procedure
(For the Use of Particularly Hazardous Materials or Substances)

EHS has to approve the use of all particularly hazardous substances. For a detailed definition of Particularly Hazardous Substances please visit EHS website.

Department: _____ Building: _____ Room #: _____

Principal Investigator: _____ Contact #: _____ Prepared By: _____ Date: _____

1. Substance Information

Substance #	*Chemical Name*	*CAS Number*	*Location*	*Estimated Rate of Use (e.g., grams/month)*	*Frequency of Manipulation (Daily/Weekly/Monthly)*	*SDS Reviewed and Available*	*Hazard Type*
1						☐	
2						☐	
3						☐	
4						☐	
5						☐	
6						☐	
7						☐	
8						☐	
9						☐	
10						☐	

- Do any of these materials have a low LD-50 or PEL (LD-50 ≤ 200 mg/kg or a PEL ≤ 10 ppm or 25 mg/m^3) that requires enhanced safety precautions?

❑ No
❑ Yes (Please explain in the box below for each substance)

2. Hazards

A. PHYSICAL HAZARDS (CHECK ALL THAT APPLY)

Physical Hazards/Substance #	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Flammable	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Corrosive	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Reactive	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Atmospheric/Temperature	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unstable[1]	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Substance #	***Known Incompatibilities***
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

[1] Decomposes, forms peroxides, polymerizes, shelf-life concerns

B. HEALTH HAZARDS

Substance #	Applicable Significant Routes of Exposure	Sensitizer	Medical Consultation Needed	Antidote On Hand
1	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐
2	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐
3	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐
4	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐
5	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐
6	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐
7	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐
8	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐
9	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐
10	☐Inhalation ☐Skin Absorption ☐ Injection	☐	☐	☐

If medical consultation is needed or there is an antidote is available for a substance, please describe below: Ex: (Calcium Gluconate for Hydrofluoric Acid)

3. Workplace Controls

A. VENTILATION/CONTAINMENT

Substance #	Hood Required	Hood Operates 80 – 120 ft/min	Bio Safety Cabinet Required	Bio Cabinet Certified within 1 year	Glovebox Required	Vented Gas Cabinet Required	Other Ventilated Equipment[2]
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

B. SAFETY EQUIPMENT

Prior to performing this procedure, the following safety equipment must be accessible and ready for use: (ex. chemical fume hood, biological safety cabinet, laminar flow hood, emergency eye wash, safety shower, chemical spill kit, etc.)

[2] e.g. PCR hood, elephant trunk exhaust duct

C. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Substance #	*Safety glasses*	*Chemical splash goggles*	*Face Shield*	*Gloves (type)*	*Lab coat*	*Apron*	*Respirator*[3]	*SCBA*	*Other*
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

If other, (please describe for each substance):

Special personal protective equipment needed (e.g., acid resistant gloves) ❑Yes ❑ No

****Particularly hazardous substances*** might require specialized personal protective equipment (PPE). Please describe any specialized PPE required for laboratory safety.* (ex. Acid resistant gloves, chemical splash goggles, full face shield, moisture resistant Tyvek, chemical splash apron, flame resistant lab coat, etc.)

[3] *Respirators and SCBA require EHS approval*

4. Procedure

- How the material will be used for each substance below: (Attach experimental protocol if needed)

- Vacuum system used: ❑ Yes ❑ No
- If yes, describe method for trapping effluents:

5. Storage/Designated Area

A. Building _____ B. Room _____ C. Describe the area where substance(s) will be used and the method of posting as a designated area. Please indicate where the material is stored.

Substance #	Area where substance(s) will be used and the method of posting as a designated area	Substance Storage Location in the Lab
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

D. Storage Method

Substance #	Refrigerator/ Freezer	Hood	Double Containment	Vented Cabinet	Gas Cylinder	Flammable Liquid Storage Cabinet	Enhanced Security Required	Other
1	☐	☐	☐	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	☐	☐	☐	☐
3	☐	☐	☐	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐	☐	☐	☐
5	☐	☐	☐	☐	☐	☐	☐	☐
6	☐	☐	☐	☐	☐	☐	☐	☐
7	☐	☐	☐	☐	☐	☐	☐	☐
8	☐	☐	☐	☐	☐	☐	☐	☐
9	☐	☐	☐	☐	☐	☐	☐	☐
10	☐	☐	☐	☐	☐	☐	☐	☐

❑ Other (please describe): _____

❑ Enhanced security required (please describe): (For example, toxins of Biological origin, e.g., tetrodotoxin, needs to be secured in a locked cabinet, or locked refrigerator)

_____

6. Spills and Decontamination

Substance #	materials needed for spill control and decontamination	Spill Control Materials available	Personnel trained For Using Spill Kits	Special PPE Required (e.g., Tyvek) - Describe	Decontamination Method
1		☐	☐	☐|	
2		☐	☐	☐|	
3		☐	☐	☐|	
4		☐	☐	☐|	
5		☐	☐	☐|	
6		☐	☐	☐|	
7		☐	☐	☐|	
8		☐	☐	☐|	
9		☐	☐	☐|	
10		☐	☐	☐|	

A. In the event of a spill of hazardous materials, follow these procedures for each decontamination:

7. Training (please list names and training dates in the table below)

Name	*Title*	*Hazard Communication Training (EHS)*	*General Lab Safety Training (EHS)*	*Bio Safety Training (EHS)*	*Protocol-Specific Hands-On Training (Lab)*	*Other Required Training*

8. Waste Disposal

Substance #	*Dispose as hazardous waste*	*Decontamination prior to disposal*	*Decontamination Method (If applicable)*	*New waste accumulation area to be established*
1	☐	☐		☐
2	☐	☐		☐
3	☐	☐		☐
4	☐	☐		☐
5	☐	☐		☐
6	☐	☐		☐
7	☐	☐		☐
8	☐	☐		☐
9	☐	☐		☐
10	☐	☐		☐

Please describe other waste disposal requirements for each item if needed:

9. Authorization

Based on the information provided, prior experience, and records, the individual(s) has demonstrated satisfactory understanding of the hazards associated with the listed substance. Safe-handling methods were established to minimize potential risk to health and property. The individual is authorized to use the material as described in this form.

_____ _____

EHS Authorization Signature Principal Investigator/Supervisor

_____

Department Chair

Please submit this form to EHS, the lab principal investigator, and department chair.

Particularly hazardous substances should not be used until prior approval is granted.

APPENDIX G

Particularly Hazardous Substances

Particularly Hazardous Substances - Known Carcinogens	
Chemical	**CAS #**
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)	13909-09-6
1,3-Butadiene	106-99-0
1,4-Butanediol dimethanesulfonate (Busulfan)	55-98-1
2,3,7,8-Tetrachlorodibenzo-para-dioxin (TCDD)	1746-01-6
2-Naphthylamine	91-59-8
3,3'-Dichlorobenzidine	91-94-1
3,3'-Dimethoxybenzidine (ortho-Dianisidine)	119-90-4
3,3'-Dimethoxybenzidine dihydrochloride(ortho-Dianisidine dihydrochloride)	20325-40-0
4-Aminobiphenyl (4-aminodiphenyl)	92-67-1
Aflatoxins	----
Analgesic Mixtures Containing Phenacetin (Phenacetin and Analgesic Mixtures Containing Phenacetin)	---
Aristolochic Acids	---
Arsenic and Inorganic Arsenic Compounds	7440-38-2
Arsenic pentafluoride gas	784-36-3
Asbestos	1332-21-4
Azathioprine	446-86-6
Benzene	71-43-2
Benzidine [and its salts]	92-87-5
Benzidine and Dyes Metabolized to Benzidine	---
Beryllium and beryllium compounds	---
Betel quid with tobacco	---
Bis (chloromethyl) ether	542-88-1
Bis(2-chloroethyl)ether	111-44-4
Cadmium	7440-43-9
Cadmium and cadmium compounds	---
Chlorambucil	305-03-3
Chloromethyl methyl ether	107-30-2
Chromium (hexavalent)	---
Ciclosporin (Cyclosporin A; Cyclosporine)	59865-13-3;79217-60-0
Coal Tars and Coal-Tar Pitches	---
Coke Oven Emissions	---
Conjugated estrogens	---
Diethylstilbestrol	56-53-1
Epstein-Barr Virus	---

Erionite	12510-42-8
Ethylene oxide	75-21-8
Formaldehyde	50-00-0
Hepatitis B Virus	---
Hepatitis C Virus	---
Human Immunodeficiency Virus Type 1	---
Human Papillomaviruses: Some Genital-Mucosal Types	---
Human T-Cell Lymphotrophic Virus Type 1	---
Kaposi Sarcoma–Associated Herpesvirus	---
Melphalan	148-82-3
Merkel Cell Polyomavirus	---
Methoxsalen with Ultraviolet A Therapy	---
Mineral Oils: Untreated and Mildly Treated	---
Mustard Gas	505-60-2
N,N'-Diacetylbenzidine	613-35-4
Nickel and certain nickel compounds	---
Nickel carbonyl	13463-39-3
Nickel subsulfide	12035-72-2
ortho-Toluidine	95-53-4
ortho-Toluidine hydrochloride	636-21-5
o-Toluidine	---
para-Toluidine	106-49-0
p-Chloro-o-toluidine	95-69-2
Phenacetin	62-44-2
Silica, crystalline	---
Soots	---
Strong Inorganic Acid Mists Containing Sulfuric Acid	---
Tamoxifen	---
Thorium Dioxide	1314-20-1
Trichloroethylene	79-01-6
Tris (1-aziridinyl) phosphine sulfide (Thiotepa)	52-24-4
Vinyl chloride	75-01-4

Particularly Hazardous Substances - Anticipated Carcinogens	
Chemical	**CAS #**
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)	13909-09-6
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea	13010-47-4
1,1,2,2-Tetrachloroethane	79-34-5
1,1-Dichloroethane	75-34-3
1,1-Dimethylhydrazine (UDMH)	57-14-7
1,2,3-Trichloropropane	---
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8
1,2-Dibromoethane	---
1,2-Dichloropropane	78-87-5
1,2-Diethylhydrazine	1615-80-1
1,2-Dimethylhydrazine	540-73-8
1,3-Dichloropropene	542-75-6
1,3-Propane sultone	1120-71-4
1,4-Dichloro-2-butene	764-41-0
1,4-Dioxane	---
1,6-Dinitropyrene	42397-64-8
1,8-Dinitropyrene	42397-65-9
1-[5-Nitrofurfurylidene)-amino]-2-imidazolidinone	555-84-0
1-Amino-2,4-dibromoanthraquinone	---
1-Amino-2-methylanthraquinone	82-28-0
1-Bromopropane	---
1-Naphthylamine	124-32-7
1-Nitropyrene	5522-43-0
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole	3570-75-0
2,2-Bis(bromomethyl)-1,3-propanediol (Technical Grade)	---
2,3-Dibromo-1-propanol	---
2,4,6-Trichlorophenol	88-06-2
2,4-Diaminoanisole	615-05-4
2,4-Diaminoanisole sulfate	39156-41-7
2,4-Diaminotoluene	95-80-7
2,4-Dinitrotoluene	121-14-2
2,6-Xylidine (2,6-Dimethylaniline)	87-62-7
2-Acetylaminofluorene	53-96-3
2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (see Heterocyclic Amines [Selected])	---
2-Amino-3,4-dimethylimidazo[4,5-f]quinoline (see Heterocyclic Amines [Selected])	---
2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline (see Heterocyclic Amines [Selected])	---
2-Amino-3-methylimidazo[4,5-f]quinoline (see Heterocyclic Amines [Selected])	---
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole	712-68-5
2-Aminoanthraquinone	117-79-3
2-Aminopyridine	462-08-8

2-Ethoxy ethanol	110-80-5
2-Ethoxyethyl acetate	111-15-9
2-Ethyhexanol	104-76-7
2-Fluoroethanol	371-62-0
2-Methoxyethanol	109-86-4
2-Methoxyethyl acetate	110-49-6
2-Methyl-1-nitroanthraquinone	129-15-7
2-Methylaziridine (Propyleneimine)	75-55-8
2-Nitrofluorene	607-57-8
2-Nitropropane	79-46-9
3-(N-Nitrosomethylamino)propionitrile	60153-49-3
3,3'-Dichloro-4,4'-diaminodiphenyl ether	28434-86-8
3,3'-Dichlorobenzidine	91-94-1
3,3'-Dimethoxybenzidine (ortho-Dianisidine)	119-90-4
3,3′-Dimethylbenzidine (see 3,3′-Dimethylbenzidine and Dyes Metabolized to 3,3′-Dimethylbenzidine)	---
3-Amino-9-ethylcarbazole hydrochloride	6109-97-3
3-Chloro-2-methylpropene	563-47-3
3-Methylcholanthrene	56-49-5
4-(N-Nitrosomethylamino)-1-(3-pyridyl)1-butanone	64091-91-4
4,4´ - Thiodianiline	139-65-1
4,4'-Diaminodiphenyl ether (4,4'-Oxydianiline)	101-80-4
4,4'-Methylene bis(2-chloroaniline)	101-14-4
4,4'-Methylene bis(2-methylaniline)	838-88-0
4,4'-Methylene bis(N,N-dimethyl)benzenamine	101-61-1
4,4'-Methylenedianiline	01-77-9
4,4'-Methylenedianiline dihydrochloride	13552-44-8
4,4′-Methylenebis(2-chloroaniline)	---
4-Chloro-ortho-phenylenediamine	95-83-0
4-Dimethylaminoazobenzene	---
4-Nitrobiphenyl	93-93-3
4-Nitropyrene	57835-92-4
4-Vinyl-1-cyclohexene diepoxide (Vinyl cyclohexene dioxide)	106-87-6
5-(Morpholinomethyl)-3-[(5-nitro-furfurylidene)-amino]-2 oxalolidinone	139-91-3
5-Methoxypsoralen with ultraviolet A therapy	484-20-8
5-Methylchrysene	369-72-43
5-Nitroacenaphthene	602-87-9
5-Nitro-o-anisidine	99-59-2
6-Nitrochrysene	2043937
7H-Dibenzo[c,g]carbazole	194-59-2
8-Methoxypsoralen with ultraviolet A therapy	298-81-7
A-alpha-C (2-Amino-9H-pyrido{2,3-b]indole)	26148-68-5
Acetaldehyde	76-07-0

Acetamide	60-35-5
Acetochlor	34256-82-1
Acifluorfen	62476-59-9
Acrolein	107-02-8
Acrylamide	79-06-1
Acrylonitrile	107-13-1
Actinomycin D	50-76-0
Adriamycin (Doxorubicin hydrochloride)	23214-92-8
AF-2; [2-(2-furyl)-3-(5-nitro-2-furyl)]acrylamide	3588-53-7
Aflotoxins	---
Alachlor	15972-60-8
Aldrin	309-00-2
Allyl chloride	107-05-1
Aluminum chloride	7446-70-0
Amitrole	61-82-5
Anesthetic gases	---
Antimony oxide (Antimony trioxide)	130-96-4
Aramite	140-57-8
Arsine gas	7784-42-1
Auramine	492-80-8
Azacitidine	320-67-2
Azaserine	115-02-6
Azobenzene	103-33-3
Benz[a]anthracene	56-55-3
Benzo [a] pyrene	50-32-8
Benzo [b] fluoranthene	205-99-2
Benzo [j] fluoranthene	205-82-3
Benzo [k] fluoranthene	207-08-9
Benzo(a)pyrene	50-32-8
Benzo[b]fluoranthene	---
Benzofuran	271-89-6
Benzotrichloride	98-07-7
Benzyl chloride	100-44-7
Benzyl violet 4B	1694-09-3
beta-Propiolactone	57-57-8
Bischloroethyl nitrosourea (BCNU) (Carmustine)	154-93-8
Bitumens, extracts of steam-refined and air-refined	---
Boron trifluoride	2095581
Bracken fern	---
Bromine	7726-95-6
Bromodichloromethane	75-27-4
Bromoform	75-25-2

Butylated hydroxyanisole	25013-16-5
C. I. Acid Red 114	6459-94-5
C. I. Basic Red 9 monohydrochloride	569-61-9
Captafol	191906
Captan	133-06-2
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Carbon-black extracts	---
Cellosolve	110-80-5
Ceramic fibers	---
Chloramphenicol	56-75-7
Chlordane	57-74-9
Chlordecone (Kepone)	143-50-0
Chlordimeform	115-28-6
Chlorendic acid	115-28-6
Chlorinated paraffins	108171-26-2
Chlorine gas	7782-50-5
Chlorine trifluoride	7790-91-2
Chlorodibromethane	124-48-1
Chloroethane (Ethyl chloride)	75-00-3
Chloroform	67-66-3
Chloroprene	126-99-8
Chlorothalonil	1897-45-6
Chlorozotocin	54749-90-5
Chorine dioxide	10049-04-4
Chromium trioxide	1333-82-0
Chrysene	18-01-9
Cinnamyl anthranilate	87-29-6
Cisplatin	15663-27-1
Citrus Red No. 2	6358-53-8
Cobalt [II] oxide	1307-96-6
Cobalt and Cobalt Compounds That Release Cobalt IonsIn Vivo	
Cobalt metal powder	7440-48-4
Cobalt–Tungsten Carbide: Powders and Hard Metals	---
Creosotes	---
Cumene	---
Cupferron	135-20-6
Cyanogen chloride	506-77-4
Cycasin	14901-08-7
Cyclophosphamide (anhydrous)	50-18-0
Cyclophosphamide (hydrated)	6055-19-2
D&C Orange No. 17	46-83-1

D&C Red No. 19	81-88-9
D&C Red No. 8	2092-56-0
D&C Red No. 9	1190723
Dacarbazine	891986
Daminozide	1596-84-5
Danthron	---
Dantron (Chrysazin; 1,8-Dihydroxyanthraquinone)	117-10-2
Daunomycin	20830-81-3
DBCP (1,2-dibromo-3-chloropropane)	96-12-8
DDD (Dichlorodiphenyldichloroethane)	72-54-8
DDE (Dichlorodiphenyldichloroethylene)	72-55-9
DDT (Dichlorodiphenyltrichloroethane)	50-29-3
DDVP (Dichlorvos)	62-73-7
Decaborane	17702-41-9
Di(2-ethylhexyl)phthalate	117-81-7
Diaminotoluene (mixed)	---
Diazoaminobenzene	---
Diazomethane gas	334-88-3
Dibenz[a,h]acridine	226-36-8
Dibenz[a,h]anthracene	53-70-3
Dibenz[a,j]acridine	224-42-0
Dibenzo[a,e]pyrene	192-65-4
Dibenzo[a,h]pyrene	189-64-0
Dibenzo[a,I]pyrene	189-55-9
Dibenzo[a,l]pyrene	191-30-0
Diborane gas	19287-45-7
Dichloroacetylene	79-36-7
Dieldrin	60-57-1
Dienestrol	84-17-3
Diepoxybutane	1464-53-5
Diesel engine exhaust	---
Diethyl sulfate	64-67-5
Diethylnitrosamine	55-18-5
Diglycidyl resorcinol ether (DGRE)	101-90-6
Dihydrosafrole	94-58-6
Dimethyl formamide	68-12-2
Dimethyl mercury	593-74-8
Dimethyl sulfate	77-78-1
Dimethyl sulfide	75-18-3
Dimethylcarbamoyl chloride	79-44-7
Dimethylvinyl chloride	513-37-1
Dinitrooctyl phenol	63149-81-5

Diphenylhydantoin (Phenytoin)	57-41-0
Diphenylhydantoin (Phenytoin), sodium salt	630-93-3
Direct Black 38 (technical grade)	1937-37-7
Direct Blue 6 (technical grade)	2602-46-2
Direct Brown 95 (technical grade)	16071-86-6
Di-sec-octyl-phthalate	117-81-7
Disperse Blue 1	2475-45-8
Dithane	111-54-6
Epichlorohydrin	106-89-8
Estradiol 17ß	50-28-2
Estrone	53-16-7
Ethinylestradiol	57-63-6
Ethyl acrylate	140-88-5
Ethyl methanesulfonate	62-50-0
Ethyl-4-4'-dichlorobenzilate	510-15-6
Ethylene chlorohydrin	107-07-3
Ethylene dibromide	106-93-4
Ethylene dichloride (1,2-Dichloroethane)	107-06-2
Ethylene fluorohydrin	371-62-0
Ethylene glycol monoethyl ether	110-80-5
Ethylene glycol monomethyl ether	109-86-4
Ethylene thiourea	96-45-7
Ethyleneimine	151-56-4
Fluorine gas	7681-49-4
Folpet	133-07-3
Furazolidone	67-45-8
Furmecyclox	60568-05-0
Glu-P-1 (2-Amino-6-methyldipyrido[1,2-a:3’,2’- d]imidazole)	67730-11-4
Glycidaldehyde	765-34-4
Glycidol	556-52-5
Glycol ethers	---
Griseofulvin	126-07-8
Gyromitrin (Acetaldehyde methylformylhydrazone)	16568-02-8
Halothane	151-67-7
HC Blue 1	2784-94-3
Heptachlor	76-44-8
Heptachlor epoxide	1024-57-3
Hexachlorobenzene	118-74-1
Hexachlorocyclohexane (technical grade)	---
Hexachlorodibenzodioxin	34465-46-8
Hexachloroethane	67-72-1
Hexafluoroacetone	684-16-2

Hexamethylene diiosocyanate	822-06-0
Hexamethylphosphoramide	680-31-9
Hydrazine	302-01-2
Hydrazine sulfate	10034-93-2
Hydrazobenzene (1,2-Diphenylhydrazine)	122-66-7
Hydrogen Cyanide	74-90-8
Hydrogen Fluoride	7664-39-3
Indeno [1,2,3-cd]pyrene	193-39-5
Iodine (inhalation only)	7553-56-2
IQ (2-Amino-3-methylimidazp[4,5-f]quinoline)	76180-96-6
Iron dextran complex	9004-66-4
Iron pentacarbonyl	13463-40-6
Isoprene	---
Isopropyl formate	625-55-8
Isosafrole	120-58-1
Karathane	131-72-6
Lactofen	77501-63-4
Lasiocarpine	303-34-4
Lead (inorganic compounds)	7439-92-1
Lead acetate	301-04-2
Lead phosphate	7446-27-7
Lead subacetate	1335-32-6
Lindane	---
Mancozeb	2234562
Maneb	12427-38-2
Me-A-alpha-C (2-Amino-3-methyl-9H-pyrido[2,3-b]indole)	68005-83-7
Medroxyprogesterone acetate	71-58-9
Merphalan	531-76-0
Mestranol	72-33-3
Methacryloyl chloride	920-46-7
Methyl acrylonitrile	126-98-7
Methyl cellosolve	109-86-4
Methyl chloride	74-87-3
Methyl chloroformate	79-22-1
Methyl fluoroacetate	453-18-9
Methyl fluorosulfate	421-20-5
Methyl mercury and other organic forms	---
Methyl methanesulfonate	66-27-3
Methyl trichlorosilane	75-79-6
Methyl vinyl ketone	78-94-4
Methylazoxymethanol	590-96-5
Methylazoxymethanol acetate	592-62-1

Methylene biphenyl isocyanate	101-68-9
Methyleugenol	---
Methylhydrazine and its salts	13552-44-8
Methylthiouracil	560-4-2
Metiram	9005-42-2
Metronidazole	443-48-1
Michler's ketone	90-94-8
Mirex	2385-85-5
Mitomycin C	50-07-7
Monocrotaline	315-22-0
N,N,-Bis(2-chloroethyl)-2-naphthylamine (Chlornapazine)	494-03-1
N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide	531-82-8
Nafenopin	3771-19-5
Naphthalene	---
Nickel and certain nickel compounds	---
Ninitrooctyl phenol	63149-81-5
Niridazole	61-47-4
Nitrilotriacetic acid	139-13-9
Nitrilotriacetric acid, trisodium salt monohydrate	18662-53-8
Nitrobenzene	---
Nitrofen (technical grade)	1836-75-5
Nitrofurazone	59-87-0
Nitrogen dioxide	10102-44-0
Nitrogen mustard (Mechlorethamine)	51-75-2
Nitrogen mustard hydrochloride (Mechlorethamine hydrochloride)	55-86-7
Nitrogen mustard N-oxide	126-85-2
Nitrogen mustard N-oxide hydrochloride	302-70-5
Nitrogen tetroxide	10544-72-6
Nitrogen trioxide	10544-73-7
Nitrous Oxide	---
N-Methyl-2-pyrrolidone	872-50-4
N-Methyl-N'-nitro-N-nitrosoguanidine	70-25-7
N-Methylolacrylamide	924-42-5
N-Nitrosamines	---
N-Nitrosodiethanolamine	1116-54-7
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
N-Nitrosodi-n-butylamine	924-16-3
N-Nitrosodi-n-propylamine	621-64-7
N-Nitrosodiphenylamine	86-30-6
N-Nitrosomethylethylamine	10595-95-6
N-Nitrosomethylvinylamine	4549-40-0

N-Nitrosomorpholine	59-89-2
N-Nitroso-N-ethylurea	759-73-9
N-Nitroso-N-methylurea	684-93-5
N-Nitroso-N-methylurethane	615-53-2
N-Nitrosonornicotine	16543-55-8
N-Nitrosopiperidine	100-75-4
N-Nitrosopyrrolidine	930-55-2
N-Nitrososarcosine	13256-22-9
Norethisterone (Norethindrone)	68-22-4
o-Aminoazotoluene	---
Ochratoxin A	303-47-9
o-Nitroanisole	---
o-Phenylphenate, sodium	132-27-4
ortho-Aminoazotoluene	97-56-3
ortho-Anisidine	90-04-0
ortho-Anisidine hydrochloride	134-29-2
ortho-Toluidine hydrochloride	636-21-5
Osmium tetroxide	20816-12-0
Oxadiazon	19666-30-9
Oxygen difluoride gas	7783-41-7
Oxymetholone	434-07-1
Ozone	10028-15-6
p-a, a, a-Tetrachlorotoluene	5216-25-1
p-Aminoazobenzene	60-09-3
Panfuran S	---
para-Cresidine	120-71-8
p-Chloro-o-toluidine	95-69-2
p-Dichlorobenzene	106-46-7
Pentachlorophenol	87-86-5
Phenacetin	62-44-2
Phenazopyridine	94-78-0
Phenazopyridine hydrochloride	136-40-3
Phenesterin	601472
Phenobarbital	50-06-6
Phenolphthalein	---
Phenoxybenzamine	59-96-1
Phenoxybenzamine hydrochloride	63-92-3
Phenyl glycidyl ether	22-60-1
Phenylhydrazine and its salts	---
Phosgene	75-44-5
Phosphine gas	1498-40-4
Phosphorus oxychloride	10025-87-3

Phosphorus pentafluoride gas	7641-19-0
Phosphorus trichloride	2125683
p-Nitrosodiphenylamine	156-10-5
Polybrominated biphenyls	---
Polygeenan	53973-98-1
Ponceau 3R	608016
Ponceau MX	3761-53-3
Potassium bromate	2139594
Procarbazine	671-16-9
Procarbazine hydrochloride	366-70-1
Progesterone	57-83-0
Propylene glycol monomethyl ether	107-98-2
Propylene glycol monomethyl ether acetate	108-65-6
Propylene oxide	75-56-9
Propylthiouracil	51-52-5
Reserpine	50-55-5
RH-7592	---
Riddelliine	---
Saccharin	81-07-2
Saccharin, sodium	128-44-9
Safrole	94-59-7
Selenium sulfide	7446-34-6
Sodium azide	26628-22-8
Sodium cyanide (and other cyanide salts)	143-33-9
Streptozotocin	18883-66-4
Styrene oxide	96-09-3
Sulfallate	95-06-7
Systhane/RH-3866	88671-89-0
Talc´ containing asbestiform fibers	---
Testosterone and its esters	58-22-0
Tetrachloroethylene (Perchloroethylene)	127-18-4
Tetrafluoroethylene	---
Tetranitromethane	509-14-8
Thioacetamide	62-55-5
Thiourea	62-56-6
TOK (herbicide)	1836-75-5
Toluene diisocyanate	26471-62-5
Toxaphene (Polychorinated camphenes)	8001-35-2
Trasulfan	299-75-2
Trichlormethine (Trimustine hydrochloride)	817-09-4
Trimethyltin chloride	1066-45-1
Triphenyltin hydroxide	76-87-9

Tris (2,3-dibromopropyl) phosphate	126-72-7
Tris (2-chloroethyl) phosphate	115-96-8
Tris (aziridinyl)-para-benzoquinone (Triaziquone)	68-76-8
Trp-P-1 (Tryptophan-P-1)	62450-06-0
Trp-P-2 (Tryptophan-P-2)	62450-07-1
Trypan blue (commercial grade)	72-57-1
Uracil mustard	66-75-1
Urethane (Ethyl carbamate)	51-79-6
vbeta-Butyrolactone	3068-88-0
Vinyl bromide	593-60-2
Vinyl Fluoride	---
Vinyl trichloride (1,1,2-Trichloroethane)	79-00-5
Zineb	12122-67-7

High Acute Toxicity Substances	
Chemical	**CAS #**
2-Aminopyridine	462-08-8
2-Fluoroethanol	371-62-0
Acrolein	107-02-8
Arsenic pentafluoride gas	784-36-3
Arsine gas	7784-42-1
Benzyl chloride	100-44-7
Boron trifluoride	2095581
Bromine	7726-95-6
Chlorine gas	7782-50-5
Chlorine trifluoride	7790-91-2
Chorine dioxide	10049-04-4
Cyanogen chloride	506-77-4
Cyclophosphamide (anhydrous)	50-18-0
Decaborane	17702-41-9
Diazomethane gas	334-88-3
Diborane gas	19287-45-7
Dimethyl mercury	593-74-8
Nickel carbonyl	13463-39-3

Reproductive Toxins	
Chemical	**CAS #**
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8
2-Ethoxy ethanol	110-80-5
2-Ethoxyethyl acetate	111-15-9
2-Ethyhexanol	104-76-7
2-Methoxyethanol	109-86-4
2-Methoxyethyl acetate	110-49-6
Acetaldehyde	76-07-0
Aflatoxins	-
Aluminum chloride	7446-70-0
Anesthetic gases	-
Arsenic	7440-38-2
Benzene	71-43-2
Benzo [a] pyrene	50-32-8
Cadmium	7440-43-9
Cadmium and cadmium compounds	-
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Cellosolve	110-80-5
Chloroform	67-66-3
Chloroprene	126-99-8
Chromium trioxide	1333-82-0
DBCP (1,2-dibromo-3-chloropropane)	96-12-8
Dimethyl formamide	68-12-2
Dinitrooctyl phenol	63149-81-5
Di-sec-octyl-phthalate	117-81-7
Dithane	111-54-6
Epichlorohydrin	106-89-8
Ethylene dibromide	106-93-4
Ethylene glycol monoethyl ether	110-80-5
Ethylene glycol monomethyl ether	109-86-4
Ethylene oxide	75-21-8
Ethylene thiourea	96-45-7
Formaldehyde	50-00-0
Glycol ethers	-
Halothane	151-67-7
Hexafluoroacetone	684-16-2
Hexamethylphosphoramide	680-31-9
Hormones	-
Hydrazine	302-01-2
Karathane	131-72-6

Lead (inorganic compounds)	7439-92-1
Methyl cellosolve	109-86-4
Methyl chloride	74-87-3
Ninitrooctyl phenol	63149-81-5
N-Methyl-2-pyrrolidone	872-50-4
Propylene glycol monomethyl ether	107-98-2
Propylene glycol monomethyl ether acetate	108-65-6
Propylene oxide	75-56-9
RH-7592	-
Systhane/RH-3866	88671-89-0
TOK (herbicide)	1836-75-5
Trichloroethylene	79-01-6
Vinyl chloride	75-01-4

Highly Hazardous Chemicals, Toxics and Reactives[1]		
CHEMICAL	CAS	Threshold Quantity (Pounds)
Acetaldehyde	75-07-0	2500
Acrolein (2-Popenal)	107-02-8	150
Acrylyl Chlorde	814-68-6	250
Allyl Chlorid	107-05-1	1000
Allylamine	107-11-9	1000
Alkylaluminum	Varies	5000
Ammonia, Anhydrous	7664-41-7	10000
Ammonia solutions (greater than 44% ammonia by weight)	7664-41-7	15000
Ammonium Perchlorate	7790-98-9	7500
Ammonium Permanganate	7787-36-2	7500
Arsine (also called Arsenic Hydride)	7784-42-1	100
Bis(Chloromethyl) Ether	542-88-1	100
Boron Trichloride	10294-34-5	2500
Boron Trifluoride	7637-07-2	250
Bromine	7726-95-6	1500
Bromine Chloride	13863-41-7	1500
Bromine Pentafluoride	7789-30-2	2500
Bromine Trifluoride	7787-71-5	15000
3-Bromopropyne (also called Propargyl Bromide)	106-96-7	100
Butyl Hydroperoxide (Tertiary)	75-91-2	5000
Butyl Perbenzoate (Tertiary)	614-45-9	7500
Carbonyl Chloride (see Phosgene)	75-44-5	100
Carbonyl Fluoride	353-50-4	2500
Cellulose Nitrate (concentration greater than 12.6% nitrogen	9004-70-0	2500
Chlorine	7782-50-5	1500
Chlorine Dioxide	10049-04-4	1000
Chlorine Pentrafluoride	13637-63-3	1000
Chlorine Trifluoride	7790-91-2	1000
Chlorodiethylaluminum (also called Diethylaluminum Chloride)	96-10-6	5000
1-Chloro-2,4-Dinitrobenzene	97-00-7	5000
Chloromethyl Methyl Ether	107-30-2	500
Chloropicrin	76-06-2	500
Chloropicrin and Methy Bromide mixture	None	1500
Chloropicrin and Methyl Chloride mixture	None	1500
Cumene Hydroperoxide	80-15-9	5000
Cyanogen	460-19-5	2500
Cyanogen Chloride	506-77-4	500

Cyanuric Fluoride	675-14-9	100
Diacetyl Peroxide (concentration greater than 70%)	110-22-5	5000
Diazomethane	334-88-3	500
Dibenzoyl Peroxide	94-36-0	7500
Diborane	19287-45-7	100
Dibutyl Peroxide (Tertiary)	110-05-4	5000
Dichloro Acetylene	7572-29-4	250
Dichlorosilane	4109-96-0	2500
Diethylzinc	557-20-0	10000
Diisopropyl Peroxydicarbonate	105-64-6	7500
Dilauroyl Peroxide	105-74-8	7500
Dimethyldichlorosilane	75-78-5	1000
Dimethylhydrazine, 1,1-	57-14-7	1000
Dimethylamine, Anhydrous	124-40-3	2500
2,4-Dinitroaniline	97-02-9	5000
Ethyl Methyl Ketone Peroxide (also Methyl Ethyl Ketone greater than 60%)	1338-23-4	5000
Ethyl Nitrite	109-95-5	5000
Ethylamine	75-04-7	7500
Ethylene Fluorohydrin	371-62-0	100
Ethylene Oxide	75-21-8	5000
Ethyleneimine	151-56-4	1000
Fluorine	7782-41-4	1000
Formaldehyde (Formalin)	50-00-0	1000
Furan	110-00-9	500
Hexafluoroacetone	684-16-2	5000
Hydrochloric Acid, Anhydrous	7647-01-0	5000
Hydrofluoric Acid, Anhydrous	7664-39-3	1000
Hydrogen Bromide	10035-10-6	5000
Hydrogen Chloride	7647-01-0	5000
Hydrogen Cyanide, Anhydrous	74-90-8	1000
Hydrogen Fluoride	7664-39-3	1000
Hydrogen Peroxide (52% by weight or greater)	7722-84-1	7500
Hydrogen Selenide	7783-07-5	150
Hydrogen Sulfide	7783-06-4	1500
Hydroxylamine	7803-49-8	2500
Iron, Pentacarbonyl	13463-40-6	250
Isopropylamine	75-31-0	5000
Ketene	463-51-4	100
Methacrylaldehyde	78-85-3	1000
Methacryloyl Chloride	920-46-7	150
Methacryloyloxyethyl Isocyanate	30674-80-7	100

Methyl Acrylonitrile	126-98-7	250
Methylamine, Anhydrous	74-89-5	1000
Methyl Bromide	74-83-9	2500
Methyl Chloride	74-87-3	15000
Methyl Chloroformate	79-22-1	500
Methyl Ethyl Ketone Peroxide (concentration greater than 60%)	1338-23-4	5000
Methyl Fluoroacetate	453-18-9	100
Methyl Fluorosulfate	421-20-5	100
Methyl Hydrazine	60-34-4	100
Methyl Iodide	74-88-4	7500
Methyl Isocyanate	624-83-9	250
Methyl Mercaptan	74-93-1	5000
Methyl Vinyl Ketone	79-84-4	100
Methyltrichlorosilane	75-79-6	500
Nickel Carbonly (Nickel Tetracarbonyl)	13463-39-3	150
Nitric Acid (94.5% by weight or greater)	7697-37-2	500
Nitric Oxide	10102-43-9	250
Nitroaniline (para Nitroaniline)	100-01-6	5000
Nitromethane	75-52-5	2500
Nitrogen Dioxide	10102-44-0	250
Nitrogen Oxides (NO; NO(2); N2O4; N2O3)	10102-44-0	250
Nitrogen Tetroxide (also called Nitrogen Peroxide)	10544-72-6	250
Nitrogen Trifluoride	7783-54-2	5000
Nitrogen Trioxide	10544-73-7	250
Oleum (65% to 80% by weight; also called Fuming Sulfuric Acid)	8014-95-7	1000
Osmium Tetroxide	20816-12-0	100
Oxygen Difluoride (Fluorine Monoxide)	7783-41-7	100
Ozone	10028-15-6	100
Pentaborane	19624-22-7	100
Peracetic Acid (concentration greater 60% Acetic Acid; also called Peroxyacetic Acid)	79-21-0	1000
Perchloric Acid (concentration greater than 60% by weight)	7601-90-3	5000
Perchloromethyl Mercaptan	594-42-3	150
Perchloryl Fluoride	7616-94-6	5000
Peroxyacetic Acid (concentration greater than 60% Acetic Acid; also called Peracetic Acid)	79-21-0	1000
Phosgene (also called Carbonyl Chloride)	75-44-5	100
Phosphine (Hydrogen Phosphide)	7803-51-2	100
Phosphorus Oxychloride (also called Phosphoryl Chloride)	10025-87-3	1000
Phosphorus Trichloride	7719-12-2	1000
Phosphoryl Chloride (also called Phosphorus Oxychloride)	10025-87-3	1000
Propargyl Bromide	106-96-7	100
Propyl Nitrate	627-3-4	2500

Sarin	107-44-8	100
Selenium Hexafluoride	7783-79-1	1000
Stibine (Antimony Hydride)	7803-52-3	500
Sulfur Dioxide (liquid)	7446-09-5	1000
Sulfur Pentafluoride	5714-22-7	250
Sulfur Tetrafluoride	7783-60-0	250
Sulfur Trioxide (also called Sulfuric Anhydride)	7446-11-9	1000
Sulfuric Anhydride (also called Sulfur Trioxide)	7446-11-9	1000
Tellurium Hexafluoride	7783-80-4	250
Tetrafluoroethylene	116-14-3	5000
Tetrafluorohydrazine	10036-47-2	5000
Tetramethyl Lead	75-74-1	1000
Thionyl Chloride	7719-09-7	250
Trichloro (chloromethyl) Silane	1558-25-4	100
Trichloro (dichlorophenyl) Silane	27137-85-5	2500
Trichlorosilane	10025-78-2	5000
Trifluorochloroethylene	79-38-9	10000
Trimethyoxysilane	2487-90-3	1500

[1] Occupational Safety and Health Standards (1910.119 App A)

APPENDIX H

OSHA 29 CFR 1910.1450 – The Laboratory Standard
"Occupational Exposure to Hazardous Chemicals in Laboratories"

1910.1450(a) Scope and application.

1910.1450(a)(1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

1910.1450(a)(2) Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

1910.1450(a)(2)(i) For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

1910.1450(a)(2)(ii) Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

1910.1450(a)(2)(iii) Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

1910.1450(a)(3) This section shall not apply to:

1910.1450(a)(3)(i) Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

1910.1450(a)(3)(ii) Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

1910.1450(a)(3)(ii)(A) Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

1910.1450(a)(3)(ii)(B) Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

1910.1450(b) Definitions—

"Action level" means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

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

"Carcinogen" (see "select carcinogen").

"Chemical Hygiene Officer" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations

on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

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

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

"Compressed gas" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding

104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1

deg. C); or

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

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

"Emergency" means 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 into the workplace.

"Employee" means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

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

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

(i) Aerosol, flammable means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) Gas, flammable means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) Liquid, flammable means any liquid having a flashpoint below 100 deg F (37.8 deg.
C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

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

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

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) – for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78).

(iv) Organic peroxides, which undergo auto accelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

"Hazardous chemical" means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

"Laboratory" means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

"Laboratory scale" means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

"Laboratory-type hood" means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

"Laboratory use of hazardous chemicals" means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

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

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

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

"Physical hazard" means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

"Protective" laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety

experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

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

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

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

"Unstable (reactive)" means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

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

1910.1450(c) Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

1910.1450(d) Employee exposure determination—

1910.1450(d)(1) Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

1910.1450(d)(2) Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

1910.1450(d)(3) Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

1910.1450(d)(4) Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

1910.1450(e) Chemical hygiene plan -- General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

1910.1450(e)(1) Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

1910.1450(e)(1)(i) Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

1910.1450(e)(1)(ii) Capable of keeping exposures below the limits specified in paragraph (c) of this section.

1910.1450(e)(2) The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

1910.1450(e)(3) The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

1910.1450(e)(3)(i) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

1910.1450(e)(3)(ii) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

1910.1450(e)(3)(iii) 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;

1910.1450(e)(3)(iv) Provisions for employee information and training as prescribed in paragraph (f) of this section;

1910.1450(e)(3)(v) The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

1910.1450(e)(3)(vi) Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

1910.1450(e)(3)(vii) 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; and

1910.1450(e)(3)(viii) Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

1910.1450(e)(3)(viii)(A) Establishment of a designated area;
1910.1450(e)(3)(viii)(B) Use of containment devices such as fume hoods or glove boxes;
1910.1450(e)(3)(viii)(C) Procedures for safe removal of contaminated waste; and
1910.1450(e)(3)(viii)(D) Decontamination procedures.
1910.1450(e)(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.
1910.1450(f) Employee information and training.
1910.1450(f)(1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.
1910.1450(f)(2) Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.
1910.1450(f)(3) Information. Employees shall be informed of:
1910.1450(f)(3)(i) The contents of this standard and its appendices which shall be made available to employees;
1910.1450(f)(3)(ii) The location and availability of the employer's Chemical Hygiene Plan;
1910.1450(f)(3)(iii) The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;
1910.1450(f)(3)(iv) Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and
1910.1450(f)(3)(v) The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.
1910.1450(f)(4) Training.
1910.1450(f)(4)(i) Employee training shall include:

1910.1450(f)(4)(i)(A) Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);
1910.1450(f)(4)(i)(B) The physical and health hazards of chemicals in the work area; and
1910.1450(f)(4)(i)(C) The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.
1910.1450(f)(4)(ii) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.
1910.1450(g) Medical consultation and medical examinations.

1910.1450(g)(1) The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

1910.1450(g)(1)(i) Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

1910.1450(g)(1)(ii) Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

1910.1450(g)(1)(iii) Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

1910.1450(g)(2) All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

1910.1450(g)(3) Information provided to the physician. The employer shall provide the following information to the physician:

1910.1450(g)(3)(i) The identity of the hazardous chemical(s) to which the employee may have been exposed;

1910.1450(g)(3)(ii) A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

1910.1450(g)(3)(iii) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

1910.1450(g)(4) Physician's written opinion.

1910.1450(g)(4)(i) For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

1910.1450(g)(4)(i)(A) Any recommendation for further medical follow-up;

1910.1450(g)(4)(i)(B) The results of the medical examination and any associated tests;

1910.1450(g)(4)(i)(C) Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

1910.1450(g)(4)(i)(D) A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

1910.1450(g)(4)(ii) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

1910.1450(h) Hazard identification.

1910.1450(h)(1) With respect to labels and material safety data sheets:

1910.1450(h)(1)(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

1910.1450(h)(1)(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

1910.1450(h)(2) The following provisions shall apply to chemical substances developed in the laboratory:

1910.1450(h)(2)(i) If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

1910.1450(h)(2)(ii) If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

1910.1450(h)(2)(iii) If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

1910.1450(i) Use of respirators. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

1910.1450(j) Recordkeeping.

1910.1450(j)(1) The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

1910.1450(j)(2) The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

1910.1450(k) Dates—

1910.1450(k)(1) Effective date. This section shall become effective May 1, 1990.

1910.1450(k)(2) Start-up dates.

1910.1450(k)(2)(i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

1910.1450(k)(2)(ii) Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

APPENDIX I
OSHA 1910 Subpart Z – Toxic and Hazardous Substances

A. Table Z-1 – Limits for Air Contaminants

Substance	CAS No. (c)	ppm (a)[1]	mg/m^3(b)[1]	Skin designation
Acetaldehyde	75-07-0	200	360	
Acetic acid	64-19-7	10	25	
Acetic anhydride	108-24-7	5	20	
Acetone	67-64-1	1000	2400	
Acetonitrile	75-05-8	40	70	
2-Acetylaminofluorine; see 1910.1014	53-96-3			
Acetylene dichloride; see 1,2-Dichloro-ethylene.				
Acetylene tetrabromide	79-27-6	1	14	
Acrolein	107-02-8	0.1	0.25	
Acrylamide	79-06-1		0.3	X
Acrylonitrile; see 1910.1045	107-13-1			
Aldrin	309-00-2		0.25	X
Allyl alcohol	107-18-6	2	5	X
Allyl chloride	107-05-1	1	3	
Allyl glycidyl ether (AGE)	106-92-3	(C)10	(C)45	
Allyl propyl disulfide	2179-59-1	2	12	
alpha-Alumina	1344-28-1			
Total dust			15	
Respirable fraction			5	
Aluminum, metal (as Al)	7429-90-5			
Total dust			15	
Respirable fraction			5	
4-Aminodiphenyl; see 1910.1011	92-67-1			
2-Aminoethanol; see Ethanolamine.				
2-Aminopyridine	504-29-0	0.5	2	
Ammonia	7664-41-7	50	35	
Ammonium sulfamate	7773-06-0			
Total dust			15	
Respirable fraction			5	
n-Amyl acetate	628-63-7	100	525	
sec-Amyl acetate	626-38-0	125	650	
Aniline and homologs	62-53-3	5	19	X
Anisidine (o-, p-isomers)	29191-52-4		0.5	X
Antimony and compounds (as Sb)	7440-36-0		0.5	
ANTU (alpha Naphthylthiourea)	86-88-4		0.3	

Arsenic, inorganic compounds (as As); see 1910.1018	7440-38-2			
Arsenic, organic compounds (as As)	7440-38-2		0.5	
Arsine	7784-42-1	0.05	0.2	
Asbestos; see 1910.1001	-4			
Azinphos-methyl	86-50-0		0.2	X
Barium, soluble compounds (as Ba)	7440-39-3		0.5	
Barium sulfate	7727-43-7			
Total dust			15	
Respirable fraction			5	
Benomyl	17804-35-2			
Total dust			15	
Respirable fraction			5	
Benzene; see 1910.1028	71-43-2			
See Table Z-2 for the limits applicable in the operations or sectors excluded in 1910.1028[d]				
Benzidine; see 1910.1010	92-87-5			
p-Benzoquinone; see Quinone.				
Benzo(a)pyrene; see Coal tar pitch vola-tiles.				
Benzoyl peroxide	94-36-0		5	
Benzyl chloride	100-44-7	1	5	
Beryllium and beryllium compounds (as Be); see 1910.1024 [8]	7440-41-7			
Biphenyl; see Diphenyl.				
Bismuth telluride, Undoped	1304-82-1			
Total dust			15	
Respirable fraction			5	
Boron oxide	1303-86-2			
Total dust			15	
Boron trifluoride	7/2/7637	(C)1	(C)3	
Bromine	7726-95-6	0.1	0.7	
Bromoform	75-25-2	0.5	5	X
Butadiene (1,3-Butadiene); See 29 CFR 1910.1051; 29 CFR 1910.19(l)	106-99-0	1 ppm/5 ppm STEL		
Butanethiol; see Butyl mercaptan.				
2-Butanone (Methyl ethyl ketone)	78-93-3	200	590	
2-Butoxyethanol	111-76-2	50	240	X
n-Butyl-acetate	123-86-4	150	710	
sec-Butyl acetate	105-46-4	200	950	
tert-Butyl acetate	540-88-5	200	950	
n-Butyl alcohol	71-36-3	100	300	

sec-Butyl alcohol	78-92-2	150	450	
tert-Butyl alcohol	75-65-0	100	300	
Butylamine	109-73-9	(C)5	(C)15	X
tert-Butyl chromate (as CrO_3); see 1910.1026[6]	1189-85-1			
n-Butyl glycidyl ether (BGE)	8/6/2426	50	270	
Butyl mercaptan	109-79-5	10	35	
p-tert-Butyltoluene	98-51-1	10	60	
Cadmium (as Cd); see 1910.1027	7440-43-9			
Calcium carbonate	1317-65-3			
Total dust			15	
Respirable fraction			5	
Calcium hydroxide	1305-62-0			
Total dust			15	
Respirable fraction			5	
Calcium oxide	1305-78-8		5	
Calcium silicate	1344-95-2			
Total dust			15	
Respirable fraction			5	
Calcium sulfate	7778-18-9			
Total dust			15	
Respirable fraction			5	
Camphor, synthetic	76-22-2		2	
Carbaryl (Sevin)	63-25-2		5	
Carbon black	1333-86-4		3.5	
Carbon dioxide	124-38-9	5000	9000	
Carbon disulfide	75-15-0		-2	
Carbon monoxide	630-08-0	50	55	
Carbon tetrachloride	56-23-5		-2	
Cellulose	9004-34-6			
Total dust			15	
Respirable fraction			5	
Chlordane	57-74-9		0.5	X
Chlorinated camphene	8001-35-2		0.5	X
Chlorinated diphenyl oxide	55720-99-5		0.5	
Chlorine	7782-50-5	(C)1	(C)3	
Chlorine dioxide	10049-04-4	0.1	0.3	
Chlorine trifluoride	7790-91-2	(C)0.1	(C)0.4	
Chloroacetaldehyde	107-20-0	(C)1	(C)3	
a-Chloroacetophenone (Phenacyl chloride)	532-27-4	0.05	0.3	
Chlorobenzene	108-90-7	75	350	

o-Chlorobenzylidene malononitrile	2698-41-1	0.05	0.4	
Chlorobromomethane	74-97-5	200	1050	
2-Chloro-1,3-butadiene; see beta-Chloroprene.				
Chlorodiphenyl (42% Chlorine) (PCB)	53469-21-9		1	X
Chlorodiphenyl (54% Chlorine) (PCB)	11097-69-1		0.5	X
1-Chloro-2,3-epoxypropane; see Epichlorohydrin.				
2-Chloroethanol; see Ethylene chlorohydrin.				
Chloroethylene; see Vinyl chloride.				
Chloroform (Trichloromethane)	67-66-3	(C)50	(C)240	
bis(Chloromethyl) ether; see 1910.1008	542-88-1			
Chloromethyl methyl ether; see 1910.1006	107-30-2			
1-Chloro-1-nitropropane	600-25-9	20	100	
Chloropicrin	76-06-2	0.1	0.7	
beta-Chloroprene	126-99-8	25	90	X
2-Chloro-6-(trichloromethyl) pyridine	1929-82-4			
Total dust			15	
Respirable fraction			5	
Chromium (II) compounds.				
(as Cr)	7440-47-3		0.5	
Chromium (III) compounds.				
(as Cr)	7440-47-3		0.5	
Chromium (VI) compounds; See 1910.1026[5]				
Chromium metal and insol. salts (as Cr)	7440-47-3		1	
Chrysene; see Coal tar pitch volatiles.				
Clopidol	2971-90-6			
Total dust			15	
Respirable fraction			5	
Coal dust (less than 5% SiO_2), respirable fraction			-3	
Coal dust (greater than or equal to 5% SiO_2), respirable fraction			-3	
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	65966-93-2		0.2	
Cobalt metal, dust, and fume (as Co)	7440-48-4		0.1	
Coke oven emissions; see 1910.1029.				
Copper	7440-50-8			
Fume (as Cu)			0.1	
Dusts and mists (as Cu)			1	

Cotton dust[e]; see 1910.1043			1	
Crag herbicide (Sesone)	136-78-7			
Total dust			15	
Respirable fraction			5	
Cresol, all isomers	1319-77-3	5	22	X
Crotonaldehyde	123-73-9;	2	6	
	4170-30-3			
Cumene	98-82-8	50	245	X
Cyanides (as CN)	-4		5	X
Cyclohexane	110-82-7	300	1050	
Cyclohexanol	108-93-0	50	200	
Cyclohexanone	108-94-1	50	200	
Cyclohexene	110-83-8	300	1015	
Cyclopentadiene	542-92-7	75	200	
2,4-D (Dichlorophenoxyacetic acid)	94-75-7		10	
Decaborane	17702-41-9	0.05	0.3	X
Demeton (Systox)	8065-48-3		0.1	X
Diacetone alcohol (4-Hydroxy-4-methyl-2-pentanone)	123-42-2	50	240	
1,2-Diaminoethane; see Ethylenedia-mine.				
Diazomethane	334-88-3	0.2	0.4	
Diborane	19287-45-7	0.1	0.1	
1,2-Dibromo-3-chloropropane (DBCP); see 1910.1044	96-12-8			
1,2-Dibromoethane; see Ethylene dibro-mide.				
Dibutyl phosphate	107-66-4	1	5	
Dibutyl phthalate	84-74-2		5	
o-Dichlorobenzene	95-50-1	(C)50	(C)300	
p-Dichlorobenzene	106-46-7	75	450	
3,′-Dichlorobenzidine; see 1910.1007	91-94-1			
Dichlorodifluoromethane	75-71-8	1000	4950	
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5		0.2	
Dichlorodiphenyltrichloroethane (DDT)	50-29-3		1	X
1,1-Dichloroethane	75-34-3	100	400	
1,2-Dichloroethane; see Ethylene dichlo-ride.				
1,2-Dichloroethylene	540-59-0	200	790	
Dichloroethyl ether	111-44-4	(C)15	(C)90	X
Dichloromethane; see Methylene chlo-ride.				
Dichloromonofluoromethane	75-43-4	1000	4200	
1,1-Dichloro-1-nitroethane	594-72-9	(C)10	(C)60	

1,2-Dichloropropane; see Propylene dichloride.				
Dichlorotetrafluoroethane	76-14-2	1000	7000	
Dichlorvos (DDVP)	62-73-7		1	X
Dicyclopentadienyl iron	102-54-5			
Total dust			15	
Respirable fraction			5	
Dieldrin	60-57-1		0.25	X
Diethylamine	109-89-7	25	75	
2-Diethylaminoethanol	100-37-8	10	50	X
Diethyl ether; see Ethyl ether.				
Difluorodibromomethane	75-61-6	100	860	
Diglycidyl ether (DGE)	7/5/2238	(C)0.5	(C)2.8	
Dihydroxybenzene; see Hydroquinone.				
Diisobutyl ketone	108-83-8	50	290	
Diisopropylamine	108-18-9	5	20	X
4-Dimethylaminoazobenzene; see 1910.1015	60-11-7			
Dimethoxymethane; see Methylal.				
Dimethyl acetamide	127-19-5	10	35	X
Dimethylamine	124-40-3	10	18	
Dimethylaminobenzene; see Xylidine				
Dimethylaniline (N,N-Dimethylaniline)	121-69-7	5	25	X
Dimethylbenzene; see Xylene.				
Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate	300-76-5		3	
Dimethylformamide	68-12-2	10	30	X
2,6-Dimethyl-4-heptanone; see Diisobutyl ketone.				
1,1-Dimethylhydrazine	57-14-7	0.5	1	X
Dimethylphthalate	131-11-3		5	
Dimethyl sulfate	77-78-1	1	5	X
Dinitrobenzene (all isomers)			1	X
(ortho)	528-29-0			
(meta)	99-65-0			
(para)	100-25-4			
Dinitro-o-cresol	534-52-1		0.2	X
Dinitrotoluene	25321-14-6		1.5	X
Dioxane (Diethylene dioxide)	123-91-1	100	360	X
Diphenyl (Biphenyl)	92-52-4	0.2	1	
Diphenylmethane diisocyanate; see Methylene bisphenyl isocyanate.				
Dipropylene glycol methyl ether	34590-94-8	100	600	X

Di-sec octyl phthalate (Di-(2-ethylhexyl) phthalate)	117-81-7		5	
Emery	12415-34-8			
Total dust			15	
Respirable fraction			5	
Endrin	72-20-8		0.1	X
Epichlorohydrin	106-89-8	5	19	X
EPN	2104-64-5		0.5	X
1,2-Epoxypropane; see Propylene oxide.				
2,3-Epoxy-1-propanol; see Glycidol.				
Ethanethiol; see Ethyl mercaptan.				
Ethanolamine	141-43-5	3	6	
2-Ethoxyethanol (Cellosolve)	110-80-5	200	740	X
2-Ethoxyethyl acetate (Cellosolve acetate)	111-15-9	100	540	X
Ethyl acetate	141-78-6	400	1400	
Ethyl acrylate	140-88-5	25	100	X
Ethyl alcohol (Ethanol)	64-17-5	1000	1900	
Ethylamine	75-04-7	10	18	
Ethyl amyl ketone (5-Methyl-3-heptanone)	541-85-5	25	130	
Ethyl benzene	100-41-4	100	435	
Ethyl bromide	74-96-4	200	890	
Ethyl butyl ketone (3-Heptanone)	106-35-4	50	230	
Ethyl chloride	75-00-3	1000	2600	
Ethyl ether	60-29-7	400	1200	
Ethyl formate	109-94-4	100	300	
Ethyl mercaptan	75-08-1	(C)10	(C)25	
Ethyl silicate	78-10-4	100	850	
Ethylene chlorohydrin	107-07-3	5	16	X
Ethylenediamine	107-15-3	10	25	
Ethylene dibromide	106-93-4		-2	
Ethylene dichloride (1,2-Dichloroethane)	107-06-2		-2	
Ethylene glycol dinitrate	628-96-6	(C)0.2	(C)1	X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate.				
Ethyleneimine; see 1910.1012	151-56-4			
Ethylene oxide; see 1910.1047	75-21-8			
Ethylidene chloride; see 1,1-Dichloroethane.				
N-Ethylmorpholine	100-74-3	20	94	X
Ferbam	14484-64-1			
Total dust			15	

Ferrovanadium dust	12604-58-9		1	
Fluorides (as F)	-4		2.5	
Fluorine	7782-41-4	0.1	0.2	
Fluorotrichloromethane (Trichlorofluoro-methane)	75-69-4	1000	5600	
Formaldehyde; see 1910.1048	50-00-0			
Formic acid	64-18-6	5	9	
Furfural	98-01-1	5	20	X
Furfuryl alcohol	98-00-0	50	200	
Grain dust (oat, wheat, barley)			10	
Glycerin (mist)	56-81-5			
Total dust			15	
Respirable fraction			5	
Glycidol	556-52-5	50	150	
Glycol monoethyl ether; see 2-Ethoxy-ethanol.				
Graphite, natural, respirable dust	7782-42-5		-3	
Graphite, synthetic				
Total dust			15	
Respirable fraction			5	
Guthion; see Azinphos methyl.				
Gypsum	13397-24-5			
Total dust			15	
Respirable fraction			5	
Hafnium	7440-58-6		0.5	
Heptachlor	76-44-8		0.5	X
Heptane (n-Heptane)	142-82-5	500	2000	
Hexachloroethane	67-72-1	1	10	X
Hexachloronaphthalene	1335-87-1		0.2	X
n-Hexane	110-54-3	500	1800	
2-Hexanone (Methyl n-butyl ketone)	591-78-6	100	410	
Hexone (Methyl isobutyl ketone)	108-10-1	100	410	
sec-Hexyl acetate	108-84-9	50	300	
Hydrazine	302-01-2	1	1.3	X
Hydrogen bromide	10035-10-6	3	10	
Hydrogen chloride	7647-01-0	(C)5	(C)7	
Hydrogen cyanide	74-90-8	10	11	X
Hydrogen fluoride (as F)	7664-39-3		-2	
Hydrogen peroxide	7722-84-1	1	1.4	
Hydrogen selenide (as Se)	7/5/7783	0.05	0.2	
Hydrogen sulfide	6/4/7783		-2	
Hydroquinone	123-31-9		2	

Iodine	7553-56-2	(C)0.1	(C)1	
Iron oxide fume	1309-37-1		10	
Isoamyl acetate	123-92-2	100	525	
Isoamyl alcohol (primary and secondary)	123-51-3	100	360	
Isobutyl acetate	110-19-0	150	700	
Isobutyl alcohol	78-83-1	100	300	
Isophorone	78-59-1	25	140	
Isopropyl acetate	108-21-4	250	950	
Isopropyl alcohol	67-63-0	400	980	
Isopropylamine	75-31-0	5	12	
Isopropyl ether	108-20-3	500	2100	
Isopropyl glycidyl ether (IGE)	4016-14-2	50	240	
Kaolin	1332-58-7			
Total dust			15	
Respirable fraction			5	
Ketene	463-51-4	0.5	0.9	
Lead, inorganic (as Pb); see 1910.1025	7439-92-1			
Limestone	1317-65-3			
Total dust			15	
Respirable fraction			5	
Lindane	58-89-9		0.5	X
Lithium hydride	7580-67-8		0.025	
L.P.G. (Liquefied petroleum gas)	68476-85-7	1000	1800	
Magnesite	546-93-0			
Total dust			15	
Respirable fraction			5	
Magnesium oxide fume	1309-48-4			
Total particulate			15	
Malathion	121-75-5			
Total dust			15	X
Maleic anhydride	108-31-6	0.25	1	
Manganese compounds (as Mn)	7439-96-5		(C)5	
Manganese fume (as Mn)	7439-96-5		(C)5	
Marble	1317-65-3			
Total dust			15	
Respirable fraction			5	
Mercury (aryl and inorganic) (as Hg)	7439-97-6		-2	
Mercury (organo) alkyl compounds (as Hg)	7439-97-6		-2	
Mercury (vapor) (as Hg)	7439-97-6		-2	
Mesityl oxide	141-79-7	25	100	
Methanethiol; see Methyl mercaptan.				

Methoxychlor	72-43-5			
Total dust			15	
2-Methoxyethanol (Methyl cellosolve)	109-86-4	25	80	X
2-Methoxyethyl acetate (Methyl cello-solve acetate)	110-49-6	25	120	X
Methyl acetate	79-20-9	200	610	
Methyl acetylene (Propyne)	74-99-7	1000	1650	
Methyl acetylene-propadiene mixture (MAPP)		1000	1800	
Methyl acrylate	96-33-3	10	35	X
Methylal (Dimethoxy-methane)	109-87-5	1000	3100	
Methyl alcohol	67-56-1	200	260	
Methylamine	74-89-5	10	12	
Methyl amyl alcohol; see Methyl isobutyl carbinol.				
Methyl n-amyl ketone	110-43-0	100	465	
Methyl bromide	74-83-9	(C)20	(C)80	X
Methyl butyl ketone; see 2-Hexanone.				
Methyl cellosolve; see 2-Methoxy-ethanol.				
Methyl cellosolve acetate; see 2-Methox-yethyl acetate.				
Methyl chloride	74-87-3		-2	
Methyl chloroform (1,1,1-Trichloro-ethane)	71-55-6	350	1900	
Methylcyclohexane	108-87-2	500	2000	
Methylcyclohexanol	25639-42-3	100	470	
o-Methylcyclohexanone	583-60-8	100	460	X
Methylene chloride	75-09-2		-2	
Methyl ethyl ketone (MEK); see 2-Buta-none.				
Methyl formate	107-31-3	100	250	
Methyl hydrazine (Monomethyl hydra-zine)	60-34-4	(C)0.2	(C)0.35	X
Methyl iodide	74-88-4	5	28	X
Methyl isoamyl ketone	110-12-3	100	475	
Methyl isobutyl carbinol	108-11-2	25	100	X
Methyl isobutyl ketone; see Hexone.				
Methyl isocyanate	624-83-9	0.02	0.05	X
Methyl mercaptan	74-93-1	(C)10	(C)20	
Methyl methacrylate	80-62-6	100	410	
Methyl propyl ketone; see 2-Pentanone.				
alpha-Methyl styrene	98-83-9	(C)100	(C)480	
Methylene bisphenyl isocyanate (MDI)	101-68-8	(C)0.02	(C)0.2	

Mica; see Silicates.				
Molybdenum (as Mo)	7439-98-7			
Soluble compounds			5	
Insoluble compounds.				
Total dust			15	
Monomethyl aniline	100-61-8	2	9	X
Monomethyl hydrazine; see Methyl hydrazine.				
Morpholine	110-91-8	20	70	X
Naphtha (Coal tar)	8030-30-6	100	400	
Naphthalene	91-20-3	10	50	
alpha-Naphthylamine; see 1910.1004	134-32-7			
beta-Naphthylamine; see 1910.1009	91-59-8			
Nickel carbonyl (as Ni)	13463-39-3	0.001	0.007	
Nickel, metal and insoluble compounds (as Ni)	7440-02-0		1	
Nickel, soluble compounds (as Ni)	7440-02-0		1	
Nicotine	54-11-5		0.5	X
Nitric acid	7697-37-2	2	5	
Nitric oxide	10102-43-9	25	30	
p-Nitroaniline	100-01-6	1	6	X
Nitrobenzene	98-95-3	1	5	X
p-Nitrochlorobenzene	100-00-5		1	X
4-Nitrodiphenyl; see 1910.1003	92-93-3			
Nitroethane	79-24-3	100	310	
Nitrogen dioxide	10102-44-0	(C)5	(C)9	
Nitrogen trifluoride	7783-54-2	10	29	
Nitroglycerin	55-63-0	(C)0.2	(C)2	X
Nitromethane	75-52-5	100	250	
1-Nitropropane	108-03-2	25	90	
2-Nitropropane	79-46-9	25	90	
N-Nitrosodimethylamine; see 1910.1016.				
Nitrotoluene (all isomers)		5	30	X
o-isomer	88-72-2			
m-isomer	99-08-1			
p-isomer	99-99-0			
Nitrotrichloromethane; see Chloropicrin.				
Octachloronaphthalene	2234-13-1		0.1	X
Octane	111-65-9	500	2350	
Oil mist, mineral	8012-95-1		5	
Osmium tetroxide (as Os)	20816-12-0		0.002	
Oxalic acid	144-62-7		1	

Oxygen difluoride	7783-41-7	0.05	0.1	
Ozone	10028-15-6	0.1	0.2	
Paraquat, respirable dust	4685-14-7;		0.5	X
	1910-42-5;			
	2074-50-2			
Parathion	56-38-2		0.1	X
Particulates not otherwise regulated (PNOR)[f].				
Total dust			15	
Respirable fraction			5	
PCB; see Chlorodiphenyl (42% and 54% chlorine).				
Pentaborane	19624-22-7	0.005	0.01	
Pentachloronaphthalene	1321-64-8		0.5	X
Pentachlorophenol	87-86-5		0.5	X
Pentaerythritol	115-77-5			
Total dust			15	
Respirable fraction			5	
Pentane	109-66-0	1000	2950	
2-Pentanone (Methyl propyl ketone)	107-87-9	200	700	
Perchloroethylene (Tetrachloroethylene)	127-18-4		-2	
Perchloromethyl mercaptan	594-42-3	0.1	0.8	
Perchloryl fluoride	7616-94-6	3	13.5	
Petroleum distillates (Naphtha) (Rubber Solvent)		500	2000	
Phenol	108-95-2	5	19	X
p-Phenylene diamine	106-50-3		0.1	X
Phenyl ether, vapor	101-84-8	1	7	
Phenyl ether-biphenyl mixture, vapor		1	7	
Phenylethylene; see Styrene.				
Phenyl glycidyl ether (PGE)	122-60-1	10	60	
Phenylhydrazine	100-63-0	5	22	X
Phosdrin (Mevinphos)	7786-34-7		0.1	X
Phosgene (Carbonyl chloride)	75-44-5	0.1	0.4	
Phosphine	7803-51-2	0.3	0.4	
Phosphoric acid	7664-38-2		1	
Phosphorus (yellow)	7723-14-0		0.1	
Phosphorus pentachloride	10026-13-8		1	
Phosphorus pentasulfide	1314-80-3		1	
Phosphorus trichloride	12/2/7719	0.5	3	
Phthalic anhydride	85-44-9	2	12	
Picloram	2/1/1918			

Total dust			15	
Respirable fraction			5	
Picric acid	88-89-1		0.1	X
Pindone (2-Pivalyl-1,3-indandione)	83-26-1		0.1	
Plaster of Paris	26499-65-0			
Total dust			15	
Respirable fraction			5	
Platinum (as Pt)	6/4/7440			
Metal				
Soluble salts			0.002	
Portland cement	65997-15-1			
Total dust			15	
Respirable fraction			5	
Propane	74-98-6	1000	1800	
beta-Propriolactone; see 1910.1013	57-57-8			
n-Propyl acetate	109-60-4	200	840	
n-Propyl alcohol	71-23-8	200	500	
n-Propyl nitrate	627-13-4	25	110	
Propylene dichloride	78-87-5	75	350	
Propylene imine	75-55-8	2	5	X
Propylene oxide	75-56-9	100	240	
Propyne; see Methyl acetylene.				
Pyrethrum	8003-34-7		5	
Pyridine	110-86-1	5	15	
Quinone	106-51-4	0.1	0.4	
RDX; see Cyclonite.				
Rhodium (as Rh), metal fume and insoluble compounds	7440-16-6		0.1	
Rhodium (as Rh), soluble compounds	7440-16-6		0.001	
Ronnel	299-84-3		15	
Rotenone	83-79-4		5	
Rouge				
Total dust			15	
Respirable fraction			5	
Selenium compounds (as Se)	7782-49-2		0.2	
Selenium hexafluoride (as Se)	7783-79-1	0.05	0.4	
Silica, amorphous, precipitated and gel	112926-00-8		-3	
Silica, amorphous, diatomaceous earth, containing less than 1% crystalline silica	61790-53-2		-3	
Silica, crystalline, respirable dust				
Cristobalite; see 1910.1053 [7]	14464-46-1			
Quartz; see 1910.1053 [7]	14808-60-7			

Tripoli (as quartz); see 1910.1053 [7]	1317-95-9			
Tridymite; see 1910.1053 [7]	15468-32-3			
Silica, fused, respirable dust	60676-86-0		-3	
Silicates (less than 1% crystalline silica)				
Mica (respirable dust)	12001-26-2		-3	
Soapstone, total dust			-3	
Soapstone, respirable dust			-3	
Talc (containing asbestos); use asbestos limit; see 29 CFR 1910.1001			-3	
Talc (containing no asbestos), respirable dust	14807-96-6		-3	
Tremolite, asbestiform; see 1910.1001.				
Silicon	7440-21-3			
Total dust			15	
Respirable fraction			5	
Silicon carbide	409-21-2			
Total dust			15	
Respirable fraction			5	
Silver, metal and soluble compounds (as Ag)	7440-22-4		0.01	
Soapstone; see Silicates.				
Sodium fluoroacetate	62-74-8		0.05	X
Sodium hydroxide	1310-73-2		2	
Starch	9005-25-8			
Total dust			15	
Respirable fraction			5	
Stibine	7803-52-3	0.1	0.5	
Stoddard solvent	8052-41-3	500	2900	
Strychnine	57-24-9		0.15	
Styrene	100-42-5		-2	
Sucrose	57-50-1			
Total dust			15	
Respirable fraction			5	
Sulfur dioxide	9/5/7446	5	13	
Sulfur hexafluoride	2551-62-4	1000	6000	
Sulfuric acid	7664-93-9		1	
Sulfur monochloride	10025-67-9	1	6	
Sulfur pentafluoride	5714-22-7	0.025	0.25	
Sulfuryl fluoride	2699-79-8	5	20	
Systox; see Demeton.				
2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	93-76-5		10	
Talc; see Silicates.				

Tantalum, metal and oxide dust	7440-25-7		5	
TEDP (Sulfotep)	3689-24-5		0.2	X
Tellurium and compounds (as Te)	13494-80-9		0.1	
Tellurium hexafluoride (as Te)	7783-80-4	0.02	0.2	
Temephos	3383-96-8			
Total dust			15	
Respirable fraction			5	
TEPP (Tetraethyl pyrophosphate)	107-49-3		0.05	X
Terphenyls	26140-60-3	(C)1	(C)9	
1,1,1,2-Tetrachloro-2,2-difluoroethane	76-11-9	500	4170	
1,1,2,2-Tetrachloro-1,2-difluoroethane	76-12-0	500	4170	
1,1,2,2-Tetrachloroethane	79-34-5	5	35	X
Tetrachloroethylene; see Perchloroethylene.				
Tetrachloromethane; see Carbon tetrachloride.				
Tetrachloronaphthalene	1335-88-2		2	X
Tetraethyl lead (as Pb)	78-00-2		0.075	X
Tetrahydrofuran	109-99-9	200	590	
Tetramethyl lead (as Pb)	75-74-1		0.075	X
Tetramethyl succinonitrile	3333-52-6	0.5	3	X
Tetranitromethane	509-14-8	1	8	
Tetryl (2,4,6-Trinitrophenylmethylnitramine)	479-45-8		1.5	X
Thallium, soluble compounds (as Tl)	7440-28-0		0.1	X
4,4′-Thiobis (6-tert, Butyl-m-cresol)	96-69-5			
Total dust			15	
Respirable fraction			5	
Thiram	137-26-8		5	
Tin, inorganic compounds (except oxides) (as Sn)	7440-31-5		2	
Tin, organic compounds (as Sn)	7440-31-5		0.1	
Titanium dioxide	13463-67-7			
Total dust			15	
Toluene	108-88-3		-2	
Toluene-2,4-diisocyanate (TDI)	584-84-9	(C)0.02	(C)0.14	
o-Toluidine	95-53-4	5	22	X
Toxaphene; see Chlorinated camphene.				
Tremolite; see Silicates.				
Tributyl phosphate	126-73-8		5	
1,1,1-Trichloroethane; see Methyl chloroform.				
1,1,2-Trichloroethane	79-00-5	10	45	X

Trichloroethylene	79-01-6		-2	
Trichloromethane; see Chloroform.				
Trichloronaphthalene	1321-65-9		5	X
1,2,3-Trichloropropane	96-18-4	50	300	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1000	7600	
Triethylamine	121-44-8	25	100	
Trifluorobromomethane	75-63-8	1000	6100	
2,4,6-Trinitrophenol; see Picric acid.				
2,4,6-Trinitrophenylmethylnitramine; see Tetryl.				
2,4,6-Trinitrotoluene (TNT)	118-96-7		1.5	X
Triorthocresyl phosphate	78-30-8		0.1	
Triphenyl phosphate	115-86-6		3	
Turpentine	8006-64-2	100	560	
Uranium (as U)	7440-61-1			
Soluble compounds			0.05	
Insoluble compounds			0.25	
Vanadium	1314-62-1			
Respirable dust (as V_2O_5)			(C)0.5	
Fume (as V_2O_5)			(C)0.1	
Vegetable oil mist				
Total dust			15	
Respirable fraction			5	
Vinyl benzene; see Styrene.				
Vinyl chloride; see 1910.1017	75-01-4			
Vinyl cyanide; see Acrylonitrile.				
Vinyl toluene	25013-15-4	100	480	
Warfarin	81-81-2		0.1	
Xylenes (o-, m-, p-isomers)	1330-20-7	100	435	
Xylidine	1300-73-8	5	25	X
Yttrium	7440-65-5		1	
Zinc chloride fume	7646-85-7		1	
Zinc oxide fume	1314-13-2		5	
Zinc oxide	1314-13-2			
Total dust			15	
Respirable fraction			5	
Zinc stearate	557-05-1			
Total dust			15	
Respirable fraction			5	
Zirconium compounds (as Zr)	7440-67-7		5	

[1] The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit. They are to be determined from breathing-zone air samples.

(a) Parts of vapor or gas per million parts of contaminated air by volume at 25 °C and 760 torr.

(b) Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.

(c) The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound, measured as the metal, the CAS number for the metal is given-not CAS numbers for the individual compounds.

(d) The final benzene standard in 1910.1028 applies to all occupational exposures to benzene except in some circumstances the distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures; for the excepted subsegments, the benzene limits in Table Z-2 apply. See 1910.1028 for specific circumstances.

(e) This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The timeweighted average applies to the cottom waste processing operations of waste recycling (sorting, blending, cleaning and willowing) and garnetting. See also 1910.1043 for cotton dust limits applicable to other sectors.

(f) All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the Particulates Not Otherwise Regulated (PNOR) limit which is the same as the inert or nuisance dust limit of Table Z-3.

[2] See Table Z-2.

[3] See Table Z-3.

[4] Varies with compound.

[5] See Table Z-2 for the exposure limit for any operations or sectors where the exposure limit in §1910.1026 is stayed or is otherwise not in effect.

[6] If the exposure limit in §1910.1026 is stayed or is otherwise not in effect, the exposure limit is a ceiling of 0.1 mg/m^3.

[7] See Table Z-3 for the exposure limit for any operations or sectors where the exposure limit in § 1910.1053 is stayed or is otherwise not in effect.

[8] See Table Z-2 for the exposure limits for any operations or sectors where the exposure limits in § 1910.1024 are stayed or otherwise not in effect.

B. Table Z-2

Substance	8-hour time weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift	
			Concentration	Maximum duration
Benzene[a] (Z37.40-1969)	10 ppm	25 ppm	50 ppm	10 minutes.
Beryllium and beryllium compounds (Z37.29—1970) [d]	2 µg/m^3	5 µg/m^3	25 µg/m^3	30 minutes.
Cadmium fume[b] (Z37.5-1970)	0.1 mg/m^3	0.3 mg/m^3		
Cadmium dust[b] (Z37.5-1970)	0.2 mg/m^3	0.6 mg/m^3		
Carbon disulfide (Z37.3-1968)	20 ppm	30 ppm	100 ppm	30 minutes.
Carbon tetrachloride (Z37.17-1967)	10 ppm	25 ppm	200 ppm	5 min. in any 4 hrs.
Chromic acid and chromates (Z37.7-1971) (as CrO_3)[c]		1 mg/10m^3		
Ethylene dibromide (Z37.31-1970)	20 ppm	30 ppm	50 ppm	5 minutes.
Ethylene dichloride (Z37.21-1969)	50 ppm	100 ppm	200 ppm	5 min. in any 3 hrs.
Fluoride as dust (Z37.28-1969)	2.5 mg/m^3			
Formaldehyde; see 1910.1048				
Hydrogen fluoride (Z37.28-1969)	3 ppm			
Hydrogen sulfide (Z37.2-1966)		20 ppm	50 ppm	10 mins. once, only if no other meas. exp. occurs.
Mercury (Z37.8-1971)		1 mg/10m^3		
Methyl chloride (Z37.18-1969)	100 ppm	200 ppm	300 ppm	5 mins. in any 3 hrs.
Methylene Chloride: See §1919.52.				
Organo (alkyl) mercury (Z37.30-1969)	0.01 mg/m^3	0.04 mg/m^3		
Styrene (Z37.15-1969)	100 ppm	200 ppm	600 ppm	5 mins. in any 3 hrs.
Tetrachloroethylene (Z37.22-1967)	100 ppm	200 ppm	300 ppm	5 mins. in any 3 hrs.
Toluene (Z37.12-1967)	200 ppm	300 ppm	500 ppm	10 minutes.
Trichloroethylene (Z37.19-1967)	100 ppm	200 ppm	300 ppm	5 mins. in any 2 hrs.

[a] This standard applies to the industry segments exempt from the 1 ppm 8-hour TWA and 5 ppm STEL of the benzene standard at 1910.1028.

[b] This standard applies to any operations or sectors for which the Cadmium standard, 1910.1027, is stayed or otherwise not in effect.

[c] This standard applies to any operations or sectors for which the exposure limit in the Chromium (VI) standard, §1910.1026, is stayed or is otherwise not in effect.

[d] This standard applies to any operations or sectors for which the exposure limits in the beryllium standard, § 1910.1024, are stayed or is otherwise not in effect.

C. Table Z-3 – Mineral Dusts

Substance	mppcf[a]	mg/m³
Silica:		
Crystalline		
Quartz (Respirable)[f]	250[b]	10 mg/m³ [e]
	-------	------
	%SiO_2 + 5	% SiO_2 + 2
Cristobalite: Use ½ the value calculated from the count or mass formulae for quartz.[f]		
Tridymite: Use ½ the value calculated from the formulae for quartz [f]		
Amorphous, including natural diatomaceous earth	20	80 mg/m³
		_____
		%SiO^2
Silicates (less than 1% crystalline silica):		
Mica	20	
Soapstone	20	
Talc (not containing asbestos)	20[c]	
Talc (containing asbestos) Use asbestos limit		
Tremolite, asbestiform (see 29 CFR 1910.1001)		
Portland cement	50	
Graphite (Natural)	15	
Coal Dust:		
Respirable fraction less than 5% SiO_2		2.4 mg/m³ [e]
		10 mg/m³ [e]
Respirable fraction greater than 5% SiO_2		_____
		%SiO_2 + 2
Inert or Nuisance Dust:[d]		
Respirable fraction	15	5 mg/m³
Total dust	50	15 mg/m³

Note-Conversion factors - mppcf × 35.3 = million particles per cubic meter = particles per c.c.

[a] Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.

[b] The percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

[c] Containing less than 1% quartz; if 1% quartz or more, use quartz limit.

[d] All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by this limit, which is the same as the Particulates Not Otherwise Regulated (PNOR) limit in Table Z-1.

[e] Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
3.5	50
5	25
10	0

The measurements under this note refer to the use of an AEC (now NRC) instrument. The respirable fraction of coal dust is determined with an MRE; the figure corresponding to that of 2.4 mg/m^3 in the table for coal dust is 4.5 mg/m^{3K}.

[f] This standard applies to any operations or sectors for which the respirable crystalline silica standard, 1910.1053, is stayed or is otherwise not in effect.

APPENDIX J
Pre-College Programs

NJIT New Jersey Institute of Technology	UNIVERSITY SAFETY ENVIRONMENTAL MANAGEMENT SYSTEM	**USEMS SOP #** **June 2016 Version 1**
PRE-COLLEGE SUMMER PROGRAMS		

Purpose and Scope

The New Jersey Institute of Technology (NJIT) is committed to providing a safe working environment for all employees, students, visitors, and guests. The purpose of the EHS Pre-College Summer Program SOP is to protect the health and safety of program participants and minimize the environmental risks potentially emanating from these programs. As minor aged students may be more susceptible to the health effects of certain potentially hazardous agents and are be less aware of potential risks and hazards present in laboratories and workshops, they therefore require heightened supervision and oversight by the Program Coordinators and Instructors.

Responsibilities

There are many departments that may be potentially involved in the Pre-College Summer Programs at NJIT; however, the implementation of this SOP is primarily the responsibility of the Environmental Health and Safety Department. Program Coordinators and Instructors have shared responsibility in the implementation of this SOP.

Primary Responsibility:

- **NJIT Environmental Health and Safety Department**: Determines compliance with regulations and policies concerning potentially hazardous materials, laboratory equipment, procedures and processes that will be utilized or encountered by participants in the Pre-College Summer Programs. Ensures that appropriate training, personal protective equipment, waste management guidance is provided to supervisors, counselors, instructors, and program participants as required by the particular program. Ensures that other potential environmental health and safety hazards or conditions are mitigated appropriately. Responds to and coordinates response to potential environmental health and safety questions, request for guidance and incidents that may occur during the course of a Pre-College Summer Program.

Affiliated Departments: In addition to the EHS Department, sponsoring NJIT departments will have second-tier responsibility for the implementation of this SOP, including:

- **NJIT Risk Management and Treasury**: Determines compliance with regulations and policies concerning minor aged students, volunteers, visitors and guests on the NJIT campus and ensures that appropriate health and safety procedures and insurance coverage is in place. Provides policy documents as required.

- **NJIT Public Safety**: Responds to and coordinates overall response to all incidents that may occur during the course of a Pre-College Summer Program.
- **NJIT Office of Research Compliance**: Assists with the implementation of certain organized PreCollege Summer Programs that are research-oriented. The Office of Research Compliance is responsible for maintaining up-to-date contact information and rosters of program participants, emergency contact information for parents and guardians, as well as instructions for emergency response.
- **Host Departments**: Host departments are to remain cognizant of ongoing activities within their departmental laboratories and classrooms throughout the summer programs. Host departments are to provide detailed academic program descriptions and assist EHS Department to identify potential hazardous activities and risks associate with their academic programs. Host departments may request training records, copies of approval forms, etc. for any of the summer programs taking place in their laboratory facilities. Host departments are to be notified of any incidents occurring as a result of the summer programs taking place in their departmental space.
- **NJIT Security, Identification, and Parking Systems**: Maintains roster of participating programs, departments and coordinators. Provides photo IDs to appropriate program participants, instructors, or counselors as required and arranges for guest parking when necessary.
- **Center for Pre-College Programs, Program Coordinators, Instructors, and Counselors**: Assists with the implementation of certain organized Pre-College Summer Programs that are non-research oriented. Program Coordinators, Instructors, and Counselors are to attend required health and safety training provided by the EHS Department and, in turn, are to provide a safety orientation to all program participants at the beginning of each program. Program Coordinators, Instructors, and Counselors are also responsible for maintaining up-to-date contact information and rosters of program participants, emergency contact information for parents and guardians, as well as instructions for emergency response. This is a joint responsibility managed in conjunction with EHS and Public Safety.
- **Program Participants**: Program Participants are required to attend necessary trainings and follow all written guidelines and policies supplied by the program hosts. Additionally, Program Participants are required to follow all written instructions provided by the Program Coordinators, as well as applicable regulations and guidelines described in this SOP.

Assessment, Prevention and Control Procedures

It is anticipated that participants in Pre-College Summer Programs hosted by NJIT will not handle hazardous materials. However, there may be occasions where program participants work in and share laboratory space where ongoing research involving the use of hazardous materials occurs. Also, more advanced researchoriented programs may involve the use of chemical reagents, laboratory equipment, and materials; adhering to the exclusions outlined in Attachment 1: NJIT Guidelines for Minors and Volunteers in Laboratory and Shops (**Research-Oriented Programs**). Please refer to Attachment 1, where specific hazardous materials are restricted for program participants and Diagram 1 which depicts the various steps involved in program assessment.

Non-Research programs are limited in scope and will not involve the use, storage, or disposal of hazardous materials. Because these programs are limited in scope and all participants will be engaged in identical projects, each program will complete one protocol review form. Please see Attachment 2: NJIT Guidelines for Minors and Volunteers in Laboratory and Shops (**Non-Research-Oriented Programs**).

Research Oriented and Non-Research Oriented Programs

Research Programs

- Research programs will be conducted in research laboratories where potentially hazardous materials are present
- Each participant in a research program is assigned a faculty mentor and graduate student supervisor; assigned a unique research project; and placed in an established research laboratory where existing mechanisms are in place for the storage, use, and disposal of potentially hazardous materials
- Each participant in a research program will attend a comprehensive laboratory safety training provided by EHS, and review all EHS handouts and Lab Safety Rules
- The faculty mentor will submit an EHS protocol review form for each program participant in a researchoriented program which will require the approval of the Director of EHS prior to allowing the participant to work in a laboratory or workshop.

Non-Research Programs

- Non-Research programs will be conducted in teaching laboratories that have been vacated and cleared by the host department for the summer months
- The EHS Department will ensure that each non-research program has clear instructions in terms of laboratory safety rules, appropriate laboratory attire and PPE, as well as waste disposal guidelines
- All participants in a non-research program will participate in a single project, follow the same protocol, that will not involve the use of any potentially hazardous materials
- Non-Research Program Directors, Program Coordinators, Instructors, and Counselors will attend health and safety training provided by the EHS Department, obtain EHS handouts and Lab Safety Rules, and, in turn, will provide a safety orientation to program participants at the beginning of each program
- Program Directors will submit a single EHS protocol review form for each summer program which must be approved by the Director of EHS

Regulatory Requirements

In terms of Environmental health and safety, the following regulations and guidelines may regulate the activities in NJIT **research laboratories**. Subsequently, these regulations and guidelines may influence PreCollege Summer Programs activities, especially those occurring in research laboratories:

- Employee Hazard Communication (29 CFR 1910.1200)
- NJ Worker and Community Right-to-Know (NJAC 8:59)

- Exposure to Hazardous Chemicals in Laboratories - the Laboratory Standard (29 CFR 1910.1450)
- Emergency Action Plan (29 CFR 1910.38)
- Personal Protective Equipment (29 CFR 1910.132-138
- Non Ionizing Radiation/LASERS (29 CFR 1926.54)
- Bloodborne Pathogen Standard (29 CFR 1910.1030)
- Biosafety in Microbiological and Biomedical Laboratories (BMBL) 5th Edition (HHS Publication (CDC) 21-1112, December 2009)
- The NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules
  (Department of Health and Human Services, National Institutes of Health, April, 2016)
- Standards for Protection Against Radiation (NRC 10 CFR Part 20) Program Specific Guidance About Academic Research and Development and Other Licenses of Limited Scope (NRC NUREG 1556 Vol
  7)
- Solid, Hazardous, Universal, Medical waste regulations

Training

As stated previously, it is anticipated that participants in Pre-College Summer Programs hosted by NJIT will not handle hazardous materials. Please see Attachment 1 for a list of prohibited materials. However, all program participants who will work or be present in an NJIT research laboratory will attend a laboratory safety training program that includes, at a minimum:

- Hazard Communication and Right-to-Know
- Chemical Hygiene
- Laboratory Waste Disposal
- Biosafety/Bloodborne Pathogens Awareness
- LASER Safety Awareness
- Radiation Safety Awareness
- Nanoparticle Safety Awareness
- Laboratory Emergency Response Procedures
- Shop Safety

Similarly, Program Directors, Program Coordinators, Instructors, and Counselors facilitating non-research programs, will attend a comprehensive health and safety training provided by the EHS Department that will include all the elements described above. Once trained, Program Directors, Program Coordinators, Instructors, and Counselors facilitating non-research programs, will provide a safety orientation to program participants at the beginning of each program session. Please see Attachment 3 for training outline and attachment 4 for the list of General Lab Safety Rules that are distributed at training.

Records and Documentation Retention

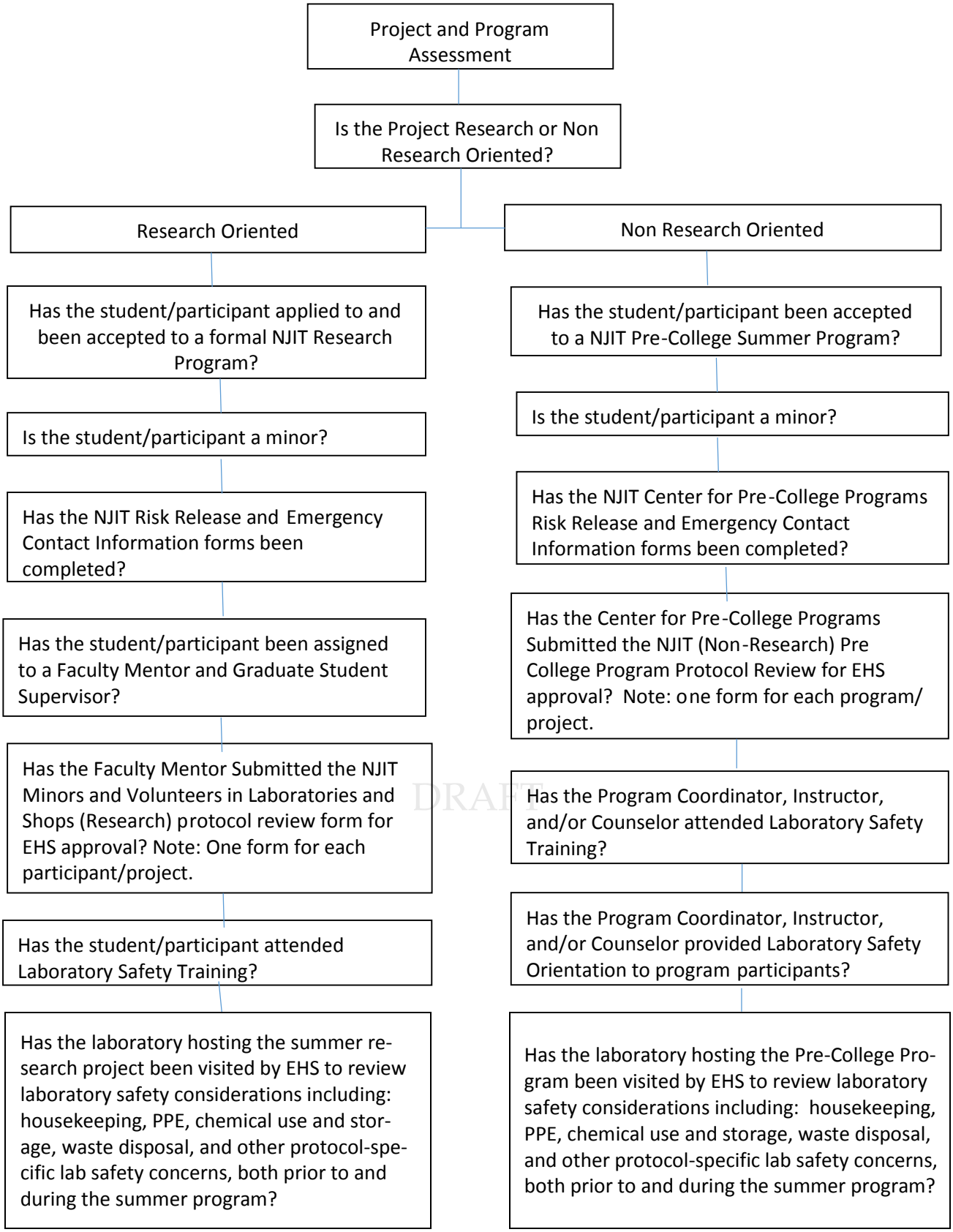
Documentation of training provided to the Pre-College Summer Programs as well as protocol review sheets and other records program-specific records will be maintained by the Environmental Health and Safety Department (EHS) for the duration of employment plus five years. Similar

records for those program participants, who are not NJIT employees, will be maintained for the same length of time as described above.

Pertinent USEMS SOP References

Hazard Communication and Right-to-Know
Chemical Hygiene
Laboratory Waste Disposal
Biosafety/Bloodborne Pathogens Awareness
LASER Safety Awareness
Radiation Safety Awareness
Nanoparticle Safety Awareness
Laboratory Emergency Response Procedures
Shop Safety

Diagram 1: Project and Program, Assessment



Laboratory-Specific SOPs

There will be several laboratories involved in the various Pre-College Summer Programs hosted at NJIT. Program participants will adhere to the written Laboratory-Specific SOP developed by the host laboratory and supervising Principal Investigator.

Regardless of host-laboratory particulars, each Research-Oriented Laboratory-Specific SOP will contain the following minimum elements:

- Hazard Evaluation ○ Review of chemical labels and SDSs to understand the nature of potential chemical, physical, biological or radiological hazards
- Engineering Controls ○ Review of the proper use of chemical fume hoods and other engineering controls
- Administrative and Work Practice Controls ○ Review of safe laboratory work practices
- Personal Protective Equipment (PPE) and Appropriate Laboratory Attire ○ Review of proper selection and use of protective eyewear, gloves and lab coat/aprons ○ In addition to PPE appropriate laboratory attire will be emphasized for summer programs,

  e.g., safety glasses; gloves; no open toe shoes, shorts; etc.
- Waste Disposal ○ Generally Pre-College Summer Program participants will not be responsible for waste disposal. Rather, this function will be handled by their Principal Investigator, or the hostlaboratory's designated safety coordinator. EHS will ensure that proper waste disposal guidelines, containers, labels, etc. will be provided to each program
- Emergency Response Procedures and Contact Information ○ Review of proper emergency response procedures and who to contact in the event of an emergency

Implementation

Administrative aspects of the summer programs are implemented by the various host departments, the Vice Provost for Research office, and the Center for Pre-College Programs. Once arrangements and start dates are confirmed, Program Coordinators contact the EHS Department to arrange for and schedule safety training. Prior to initiation of safety training, the EHS Department reviews program protocols and develops programappropriate training program. EHS Department then provides appropriate training for each group, individually or combined, as appropriate. During the course of the summer program, EHS staff will periodically visit the summer program locations to ensure compliance with SOPs and other program requirements.

Attachments:

I. NJIT Guidelines for Minors and Volunteers in Laboratory and Shops (Research Programs)

II. NJIT Guidelines for Minors and Volunteers in Laboratory and Shops (Non-Research Programs) III. Safety Training Outline

IV. NJIT General Lab Safety Rules

Attachment 1:
NJIT Environmental Health and Safety Department
Guidelines for Minors in Laboratories and Workshops
Research-Oriented Programs-Completed for Each Student
(Updated April 2016)

NJIT is committed to providing a safe and healthy work environment for all members of the university community as well as visitors and members of the general public.

Minors may be more susceptible to the health effects of certain toxic and hazardous agents; are less aware of potential risks and hazards present in laboratories and workshops; and require heightened supervision and oversight. Minors may only be allowed in NJIT laboratories and shops as part of an organized event, program, or tour. Minors may never be allowed in settings where research activities involving controlled substances, are being used or hazardous conditions (specified below) are being performed.

Principal Investigators, other faculty, and their designated staff shall adhere to the following guidelines for minors and volunteers working in their laboratory and shop facilities:

- The Principal Investigator must pre-notify the Department Chair that minors or volunteers will be working in their lab or shop.
- Prospective minors and volunteers must complete an application that provides appropriate individual information (address, phone, etc.), emergency contact information, as well as any medical concerns.
- All applicants must complete the Risk Management waiver forms and provide proof of medical coverage.
- Departments must ensure compliance with applicable labor laws for all minors.
- The minor or volunteer must attend training appropriate for the work activities they perform or that may be performed by others in their assigned laboratory or shop.
- Personal protective equipment shall be provided by the department and worn by the minor or volunteer as directed by the laboratory or shop director(s), EHS Department, or other NJIT guidelines.
- Minors shall never be permitted to work unsupervised a NJIT laboratory or shop.
- Minors shall be prohibited from the following work activities:
- Handle or manipulate organisms at Biological Safety Level 2 or higher
- Operate or work in laboratories with hazard class 3b or 4 open beam lasers
- Handle or manipulate Select Agents (as defined by the CDC)
- Handle or manipulate radioactive materials or ionizing radiation sources
- Handle or manipulate Particularly Hazardous Substance (as defined by OSHA) or Highly Hazardous Substances - including pyrophorics, explosives, large quantities of flammable materials, and highly toxic compounds - without prior approval from the department chair and EHS Perform research activities with live laboratory animals.
- Utilizing hazardous mechanical equipment (cutting, lathes, welding, etc.)
- Principal Investigators, other faculty, and their designated staff wishing to host and mentor minors or volunteers in their laboratory or shop must adhere to the criteria described above, complete the attached form, and submit for EHS approval PRIOR to project initiation.

Name of Principal Investigator of other faculty mentor:

Department: Department Chair:

Location of laboratory or shop where minor or volunteer is anticipated to work:

Name of Minor or Volunteer: Date of Birth:

Anticipated dates of work experience:

Title of project:

Brief project description:

List of any potentially hazardous materials (including chemical, biological, and radiological) that may be encountered by minor or volunteer during the conduct of the project:

List of laboratory or shop equipment that may be used by minor or volunteer during the conduct of the project:

List graduate student mentor, other faculty mentor, or staff mentor who may be responsible for supervising the minor or volunteer during the course of this project:

Have arrangements been made for appropriate safety training (both classroom training and hand's on training) prior to the minor or volunteer beginning their work experience? Please describe:

Please list personal protective equipment to be issued to the minor or volunteer for the duration of the project:

PI/Faculty acknowledgement of responsibility as described in these guidelines:

PI/Faculty Signature: Date:
EHS Approval: Date:

Attachment 2
NJIT Environmental Health and Safety Department
Guidelines for Minors and Volunteers in Laboratories and Shops
Non-Research Oriented Pre College Programs-Completed for Each Program
(Updated May 2016)

NJIT is committed to providing a safe and healthy work environment for all members of the university community as well as visitors and members of the general public.

Minors may be more susceptible to the health effects of certain toxic and hazardous agents; may be less aware of potential risks and hazards present in laboratories and shops; and may require heightened supervision and oversight. Minors may only be allowed in NJIT laboratories and shops as part of an organized Pre-College Summer Program administered under the auspices of the Center for Pre College Programs.

The Center for Pre College Programs and their designated staff shall adhere to the following guidelines for minors and volunteers working in NJIT laboratory and shop facilities:

- Arrangements must be made between the Center for Pre-college Programs and the host department regarding the proposed use of laboratory facilities for the summer program.
- Prospective minors and volunteers must complete a program application that provides appropriate individual information (address, phone, etc.), emergency contact information, as well as any medical concerns.
- All applicants must complete the Risk Management waiver forms and provide proof of medical coverage.
- Program supervisors, counselors, and instructors must attend health and safety training appropriate for the work activities they supervise or that may be performed by others in their assigned laboratory or shop. In turn, program supervisors, counselors, and instructors will provide training, supervision, and guidance to the program participants.
- Personal protective equipment shall be provided by the program and worn by the program participants as directed by the program directors, EHS Department, or other NJIT guidelines.
- Minors shall never be permitted to work unsupervised a NJIT laboratory or shop.
- Program participants will adhere to the NJIT laboratory safety guidelines that will be distributed during training sessions conducted at the beginning of the summer program.
- Minors shall be prohibited from the following work activities:
- Handle or manipulate organisms at Biological Safety Level 2 or higher
- Operate or work in laboratories with hazard class 3b or 4 open beam lasers
- Handle or manipulate Select Agents (as defined by the CDC)
- Handle or manipulate radioactive materials or ionizing radiation sources
- Handle or manipulate Particularly Hazardous Substance (as defined by OSHA) or Highly Hazardous Substances - including pyrophorics, explosives, large quantities of flammable materials, and highly toxic compounds - without prior approval from the department chair and EHS Perform research activities with live laboratory animals.
- Utilizing hazardous mechanical equipment (cutting, lathes, welding, etc.)
- Program Directors and their designated staff wishing to host minors or volunteers in their laboratory or shop must adhere to the criteria described above, complete the attached form, and submit for EHS approval PRIOR to project initiation. In the case on non-research oriented programs – one form should be completed for each program. Name of Pre College Summer Program and title of summer project:

Name of Program Director:

Name of Program Counselor(s), Supervisor(s), or Instructor(s):

Location of laboratory or shop where Pre College Summer Program will take place:

Please attach a list or roster of program participants:

Anticipated dates of program:

Brief project description:

List of any potentially hazardous materials (including chemical, biological, and radiological) that may be encountered by program participants during the conduct of the project:

List of laboratory or shop equipment that may be used by minor or volunteer during the conduct of the project:

List other staff members that may be responsible for supervising program participants during the course of this project:

Have arrangements been made for appropriate safety training prior to the initiation of the program? Please describe:

Have arrangements been made for appropriate disposal of any potential waste materials generated by the project? Please describe:

Please list personal protective equipment to be issued to the program participants for the duration of the project:

Program Director acknowledgement of responsibility as described in these guidelines:

Program Director Signature: Date:

EHS Approval: Date:

Attachment 3 Training Outline

1. Introduction to academic research laboratories
2. General description of potentially hazardous materials that may be present
3. Regulatory Review
    a. Right to Know
    b. Hazard Communication
    c. Occupational Exposure to Hazardous Chemicals in Laboratories
    d. Resource Conservation and Recovery Act
    e. Biological Safety and Bloodborne Pathogens
    f. Radiation Safety
4. Right to Know Hazard Communication-Main Elements
    a. Right to Know Survey
    b. Chemical Labeling
    c. Globally Harmonized System (GHS) for Chemical Labeling
    d. Elements of a Compliant Label, Including Signal Word, Precautionary Statement, Hazard Statement, and Pictograms
    e. Compliant Portable Chemical Labels
        i. Description of Chemical Hazards Expressed as Pictograms
            1. Health Hazards
            2. Flame
            3. Exclamation Mark
            4. Exploding Bomb
            5. Gas Under Pressure
            6. Corrosives
            7. Flame Over Circle 8. Skull and Crossbones
    f. Safety Data Sheets and Hazardous Substance Fact Sheets
    g. Employee Rights
    h. Laboratory Caution Signs
    i. Training Requirements
5. Occupational Exposure to Hazardous Chemicals in Laboratories-Main Elements
    a. Implementation of a Chemical Hygiene Plan
    b. Appoint a Chemical Hygiene Officer
    c. Establish Written Standard Operating Procedures for Laboratory Operations
    d. Provide Information and Training
    e. Provide Access to Medical Exams and Consultations
    f. Laboratory Safety Considerations
        i. Physical Hazards
            1. Heat/Cold
            2. Electrical Safety
            3. Compressed Gasses
            4. Laboratory Housekeeping ii. Chemical Storage
        iii. Chemical Segregation
        iv. Acute versus Chronic Toxicity
        v. Routes of Entry
        vi. Hierarchy of Controls
            1. Engineering Controls

2. Administrative and Work Practice Controls
3. Personal Protective Equipment/Proper Laboratory Attire vii. Emergency Equipment
1. Eye Wash
2. Safety Shower
3. Fire Extinguisher
4. First Aid Kit
5. Chemical Spill Kit

viii. Chemical Spill Response
1. Small/Minor Chemical Spill
2. Large Chemical Spill

6. Resource Conservation and Recovery Act (RCRA) and Laboratory Chemical Waste Disposal a. Waste Determination
   b. Generator Class
   c. Satellite Accumulation Area
   d. Waste Labeling
   e. Accumulation Limits
   f. Container Management
   g. SAA Criteria
   h. Non-Regulated Laboratory Waste Streams
   i. Broken Glass
      ii. Used Pump Oil
      iii. Universal Waste
      iv. Electrophoresis Waste
   i. Chemical and Biological Waste Disposal Program
7. Awareness Training (Includes Appropriate Waste Disposal Guidelines)
   a. Particularly Hazardous Substances
   b. LASER Safety
   c. Radiation Safety
   d. Biological Safety and Bloodborne Pathogens
   e. Nanoparticle Safety
   f. Fire Safety
   g. Shop Safety

Note: LASER Safety, Radiation Safety, and Biological Safety/Bloodborne Pathogens are available as individual training programs.

Attachment 4 - NJIT General Laboratory Safety Rules

- Know the location of laboratory exits.
- Know the location and use of the safety showers and eyewashes.
- Know the location and use of fire extinguishers.
- Know the location and use of spill kits, when available.
- Know the location of the nearest phone, which can be used in an emergency.
- Know the potential hazards of the materials, facilities, and equipment that you will work. If you are uncertain ask your instructor, your supervisor, or the Safety Department (contact details).

- Use the proper safety equipment for your procedure. This could include a fume hood, glove box, biosafety cabinet, shield, or other equipment.
- Do not wear contact lenses in laboratories where chemicals are used.
- Wear eye protection in the laboratory. Splash goggles may be required for wet chemical work or work with dusts and powders.
- Wear other personal protective gear where laboratory or experimental conditions dictate. This includes laboratory coats, gloves, and eye protection.
- **Wear proper laboratory attire** - clothes that protect the body against chemical spills, dropped objects, and other accidental contact. Therefore, bare midriffs, shorts, open toe shoes, sandals, flip flops, and high heels are prohibited.
- Confine long hair when in the laboratory. Remove or secure articles of clothing or jewelry that might become entangled in equipment.
- Do not eat, drink, smoke or apply cosmetics or lip balm in the laboratory. Do not store food or drink in the laboratory or refrigerators, or use laboratory equipment for eating or drinking.
- **Do not pipette by mouth**. Use only mechanical pipette devices.
- Wash hands frequently when handling chemicals and before leaving the laboratory. Beware of contamination of clothing or of doorknobs, computer key boards, telephones, etc. Remove any protective gear before leaving the laboratory; this includes gloves and laboratory coats.
- Follow written protocols or instructions. Perform only authorized experiments. Do not move or disturb equipment in use without consent of the user.
- Do not work alone in the laboratory, particularly after hours.
- Do not play in the laboratory.
- Follow good housekeeping practices -- clean up as you go, and keep work areas, aisles and exits uncluttered.
- Do not deface labels on chemical containers. Make sure all container labels are closed and correctly identify their contents.
- Report all accidents and injuries **immediately** to your laboratory instructor or supervisor.
- Report unsafe conditions to your instructor, supervisor, or the Safety Department.

Additional Rules for Students

- Read and follow the Safety Rules listed previously.
- Know who is in charge of your laboratory and Safety Director.
- Perform only authorized experiments, and be sure you understand the procedures involved before you begin. If anything unexpected, dangerous, threatening, or unmanageable happens, immediately call your instructor.

- Do not use unfamiliar equipment without instruction and permission.
- Behave and dress appropriately for conscientious work in a potentially hazardous place.
- Never play in the laboratory.
- Report all accidents and injuries, however small, to your instructor.

Additional Rules for Instructors and Supervisors

- Take responsibility, in attitude and action, for the safety conditions of your laboratory.
- Observe all rules and see that they are enforced.
- Set an example by wearing protective equipment and by following proper laboratory procedures to promote safe work habits.
- Carefully review all laboratory experiments for possible safety problems before the experiments are assigned to students.
- Make both preventative and remedial safety measures part of your instruction. Be sure all students and laboratory workers are familiar with emergency procedures and equipment.
- Be alert for unsafe conditions. Inspect often and intelligently; take effective corrective action promptly.
- Assume responsibility for visitors and require that they follow the same rules as students and other laboratory workers.
- Keep a current file of publications on laboratory safety. Encourage its use. Review Safety Data Sheets (SDS) for materials used in laboratory protocols.

Waste Disposal

- **Please ensure that all waste materials generated by your experiments are stored and labeled properly.**
- **Please contact the Safety Department at 973-596-3059 or at healthandsafety@njit.edu to review laboratory waste requirements**
- **Please contact the Safety Department at 973-596-3059 or at healthandsafety@njit.edu to make arrangements to have waste removed from you laboratory**
- **Waste removal forms are located at: http://www5.njit.edu/environmentalsafety/ehs-forms/**

Emergency Notification

- **In case of a minor laboratory incident or injury contact NJIT Public Safety at: 973-596-3111**
- **NJIT Public Safety may be reached by dialing 3111 from any Campus phone**
- **Severe incidents and injuries must be reported to the City of Newark Public Safety by dialing: 911**