Chemical Hygiene Plan

Stevens Institute of Technology
1 Castle Point Terrace
Hoboken, NJ 07030

June 2023

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

CFR	Code of Federal Regulations
CHO	Chemical Hygiene Officer
CHP	Chemical Hygiene Plan
EHS&IRM	Environmental Health and Safety & Insurance Risk Management
LC_{50}	lethal concentration, 50%
LD_{50}	lethal dose, 50%
NFPA	National Fire Protection Association
OSHA	U.S. Occupational Safety and Health Administration
PEL	permissible exposure limit
PI	Principal Investigator
PPE	personal protective equipment
ppm	parts per million
SAA	Satellite Accumulation Area
SDS	safety data sheet (formerly known as material safety data sheet, MSDS)
SOP	standard operating procedure
STEL	short-term exposure limit
Stevens	Stevens Institute of Technology
°F	degrees Fahrenheit

1.0 POLICY AND PURPOSE

1.1 POLICY

It is the policy of Stevens Institute of Technology (Stevens) to provide a safe and healthy workplace in compliance with the Occupational Safety and Health Act of 1970 and with regulations of the U.S. Department of Labor, including Title 29 Code of Federal Regulations (CFR) Section 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories.* The full U.S. Occupational Safety and Health Administration (OSHA) standard can be found at the following link: OSHA29CFR1910.1450.

1.2 PURPOSE

The purpose of this Chemical Hygiene Plan (CHP) is to describe proper practices, procedures, equipment, and facilities for all personnel (employees, students, visitors or other persons) working in laboratories at Stevens, to protect them from potential health hazards presented by chemicals used in the workplace, and to keep exposures below specified limits. It is the responsibility of all affected personnel to know and to follow the provisions of this CHP.

The CHP shall be followed by all chemical users on campus in laboratory settings.

Stevens will appoint a Chemical Hygiene Officer (CHO) who is responsible for developing, implementing, monitoring, and updating the plan annually. Affected departments are all those maintaining laboratories that contain and use hazardous chemicals, as defined by the regulations, and include the Departments of Biomedical Engineering, Chemistry and Chemical Biology, Chemical Engineering and Materials Science, Civil, Environmental, and Ocean Engineering, Mechanical Engineering, Physics and Engineering Physics. Currently responsible parties are listed in Appendix A.

2.0 RESPONSIBILITY, AUTHORITY, AND RESOURCES

2.1 AUTHORITY

Stevens has responsibility for compliance with all applicable federal, state and local regulations and to provide for the safety of its employees, students, and the Stevens community. Stevens may set forth and enforce rules and regulations to implement this CHP as needed.

2.2 CHEMICAL HYGIENE OFFICER

The CHO shall identify and minimize risks to persons working with chemicals in laboratories, to the community, and to the environment. The CHO has the authority to suspend operations that do not conform to health and safety practices required by the CHP. The CHO shall:

- Review and approve the operation, acquisition, and maintenance of fume hoods, emergency safety (drench) showers, eyewashes, and fire extinguishers in all laboratories where chemicals are used and handled.
- Provide technical expertise to the university community with regard to chemical and laboratory safety and health issues, and also direct inquiries to appropriate resources.
- Work with departments to develop and implement the standard operating procedures (SOPs) for the handling and storage of hazardous materials and hazardous chemical waste as required in the CHP.
- Work with departments to appropriately label, store and dispose of hazardous chemicals and waste as required in the CHP.
- Work with departments and employees engaged in the use of hazardous materials to provide training in the use of Hazardous Chemicals as required in the CHP.
- Conduct regular inspections of laboratories and chemical storage areas.
- Compile and distribute inspection results to relevant Laboratory Personnel and Faculty, along with recommendations and follow-up actions.
- Coordinate and conduct laboratory safety training sessions. These shall include a review of hazardous chemical handling, hazardous and other laboratory waste management and laboratory safety topics.
- Maintain documentation of laboratory safety training for Stevens employees and students. The CHO will maintain the master file of Safety Data Sheets (SDSs) for all hazardous substances used or stored on campus.
- Review and approve department procedures for the use, disposal, spill prevention, cleanup, and decontamination of extremely hazardous chemicals and substances.

- Investigate all reports of laboratory hazard incidents and chemical spills to prevent recurrence, and report results of investigations to Departmental leadership.
- Coordinate handling and disposal of hazardous waste generated on campus in accordance with the U.S. Department of Transportation (DOT), OSHA, and U.S. Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) requirements.
- Maintain a master chemical inventory for all chemicals used in laboratories at Stevens.
- Review and evaluate the effectiveness of the CHP at least annually and update it as necessary.

The current Chemical Hygiene Officer is David Fernandez and can be reached at (201) 216-8705. Refer to Appendix A for a complete list of roles, responsibilities, and contact information.

2.3 OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY & INSURANCE RISK MANAGEMENT

The Office of Environmental Health and Safety & Insurance Risk Management is responsible for satisfactory ongoing compliance with all local, county, state, and federal regulations that relate to health and safety. The Office of Environmental Health and Safety & Insurance Risk Management (hereinafter, "EHS&IRM") shall:

- Have working knowledge of all regulatory codes, regulations and requirements that apply to health and safety on campus.
- Function as the primary liaison with representatives of these regulatory agencies.
- Initiate committees and appoint personnel as required to ensure continued compliance with regulations.
- Monitor and supervise the activities of committees and individuals to ensure that work to meet regulatory goals progresses on schedule.
- Ensure that all applications, reports, etc. are completed accurately and submitted to regulatory bodies in a timely manner.
- Ensure that all reports and records are completed and retained as required by various regulatory agencies.
- Work with the CHO to ensure that the Chemical Hygiene Plan is routinely reviewed and updated.
- Provide both technical expertise and administrative support to those departments which must comply with these regulations.

- Ensure that all activities (meetings, inspections, correspondence, incidents, etc.) are properly documented.

2.4 CHAIRPERSONS OF DEPARTMENTS THAT OPERATE LABORATORIES

The Department Chair is responsible for chemical safety in his/her department and shall understand the CHP. The Department Chair or designee (hereinafter, the "Department") shall:

- Notify the CHO when a laboratory will be opened for operation or taken out of operation, or when procedures or Laboratory Personnel are changed.
- Work with the CHO to develop and implement the SOP for the handling and storage of hazardous chemicals and hazardous waste.
- Ensure that all laboratory users in his/her department attend the hazardous chemical training as required in the CHP.
- Maintain training records of employees in his/her department, and forward documentation to the CHO.
- Ensure that all students enrolled in science laboratory courses and/or in courses using any rooms containing hazardous chemicals receive appropriate training in chemical and laboratory safety.
- Work with the CHO to make recommendations for the purchase of safety equipment required by the CHP.
- Supervise department employees to ensure that they use the required safety equipment in his/her department.
- Ensure that the routine inspections of all laboratories in his/her department occur and maintain records of routine inspections.
- Work with faculty and the CHO to identify Principal Investigators and Laboratory Personnel with responsibility for specific laboratory operations.
- Ensure that each laboratory has developed and implemented a Laboratory Specific SOP.

2.5 PRINCIPAL INVESTIGATORS

Principal Investigators (PI) will be assigned designated laboratory space in which to conduct research or otherwise utilize for professional purposes and will be responsible for chemical safety in his/her designated laboratory space. Faculty shall:

- Notify the CHO when the designated laboratory space will be opened for operation or taken out of operation, or when procedures or Laboratory Personnel are changed.
- Comply with the procedures and requirements of the CHP.

- Develop and implement laboratory-specific and protocol specific SOPs for the handling and storage of hazardous chemicals and hazardous waste in the designated laboratory space. Consult with the CHO when necessary. SOP template is provided in Appendix K.
- Ensure that all personnel, including students, working in designated laboratory space attend hazardous chemical training as required in this CHP.
- Maintain training records of employees (including students) working in the designated laboratory space, and forward documentation of training to the CHO and Department Chair when requested.
- Work with the CHO to make recommendations to the Department Chair for the purchase of safety equipment required by the CHP.
- Supervise workers to ensure they use the required safety equipment in the designated laboratory space.
- Be responsible for the oversight and maintenance of a current chemical inventory at the point of use. Point of use is the laboratory in which the chemical is used.
- Be responsible for the routine identification of expired and unusable chemicals and their proper disposal.
- Be responsible for the maintenance and access of SDS files at the chemical's point of use.
- Collaborate with EHS&IRM to complete routine inspections in the designated laboratory space, and those deficiencies are corrected.
- Report any possibly unsafe or noncompliant conditions in the designated laboratory space to the CHO.
- Work with the Department Chair and the CHO to develop and implement the standard operating procedures for the handling and storage of hazardous materials and hazardous waste.
- Include compliance with the CHP in grant proposals, when necessary.

2.6 LABORATORY PERSONNEL

Undergraduates, Graduate Students, Post-Doctoral Researchers, Faculty, and Staff working in a Stevens Laboratory (hereinafter "Laboratory Personnel") have the primary responsibility for chemical hygiene in laboratories used for teaching and or research. Laboratory Personnel shall:

- Follow the procedures and requirements of the CHP.
- Follow laboratory-specific SOPs.

- Ensure that all Stevens employees and students under their direction or instruction have completed the required training prior to performing duties or attending laboratory classes.
- Report any possibly unsafe or noncompliant laboratory conditions to the CHO.
- Complete and maintain accurate chemical inventories at the point of use in Laboratory Personnel s' courses as specified in the CHP and forward copies of the chemical inventories to the CHO and Department Chair.

2.7 STUDENTS, STUDENT WORKERS, VISITORS AND OUTSIDE CONTRACTORS

Students shall:

- Read the procedures and guidelines of the CHP and any applicable department or Stevens SOP or policy. While students that do not receive salary from Stevens are not technically covered under OSHA, they are expected to adhere to the requirements outlined in this CHP.
- Complete the Departmental Agreement for Visiting Student Lab/Project Participant
- Be supervised by a teaching assistant, instructor, or personnel of authority.
- Complete laboratory safety training as needed.
- Report any unsafe or noncompliant conditions in laboratories to the Laboratory Personnel or Stevens employee directing his/her work or study.

3.0 CHEMICAL HYGIENE PLAN

3.1 DEVELOPMENT, IMPLEMENTATION, AND UPDATE

The CHO coordinates the preparation of the CHP and specific SOPs, if required, for the laboratories. The CHO is responsible, per OSHA, for ensuring that the plan meets the requirements set forth in 29 CFR 1910.1450 and is fully implemented.

The CHO is responsible for ensuring that the CHP is reviewed on an annual basis and updated as necessary to accommodate changes in the OSHA standard 29 CFR 1910.1450, departmental procedures, and personnel policy. In addition, the CHO will ensure that the CHP update includes procedures regarding new chemical hazards and new processes as they are introduced. The CHO will ensure that the CHP and updates are distributed or made available to those affected by the changes.

3.2 INVENTORY, IDENTIFICATION AND CLASSIFICATION OF HAZARDOUS CHEMICALS

3.2.1 Chemical Inventory

- Stevens has standard operating procedures for the procurement, receipt and inventory of chemicals, and has established a centralized chemical stockroom from which these procedures are followed.

- Stevens must keep accurate and current records of the chemicals in inventory to comply with regulatory reporting requirements, for cost containment, safety considerations, etc. The inventory of chemicals is controlled by several means including annual physical inventories, a computerized chemical inventory system, and a procedure for ordering, storing, and disbursing chemicals. Procedures on chemical management are provided in Appendix B.

- The CHO shall maintain a master inventory of all the chemicals and their storage locations on campus. Each chemical shall be entered into the master inventory upon the chemical's arrival at Stevens and when the chemical is delivered to its point(s) of use the inventory will be modified to reflect the distribution of the chemical. The CHO shall reconcile the inventories and shall investigate any discrepancies.

3.2.2 Identification and Classification

Hazardous chemicals can be classified into several generic categories based on their hazardous characteristics (e.g., corrosive, reactive, flammable, toxic, etc.) and are labeled on the primary container as such. Definitions and other hazardous properties/health effects of chemicals can be found in Appendix C or online at the following link: http://www.osha.gov/SLTC/laboratories/

Alternate means of classifying and identifying hazardous chemicals include the following:

- Lists of known or suspect human carcinogens, prepared by the International Agency for Research on Cancer (IARC) and the National Toxicology Program (NTP) are available online at the following link: Known and Probable Human Carcinogens.

- The National Fire Protection Association (NFPA) has categorized a wide variety of chemicals found in industrial settings. This list is available online at https://www.newenv.com/resources/nfpa_chemicals/.

- Safety data sheets (SDSs) may be obtained from the chemical vendors' websites available online at the following link: https://www.stevens.edu/directory/finance/environmental-health-and-safety-EHS&IRM/research-and-lab-safety/msds-search

- For instructions on how to access SDSs, contact the EHS&IRM Office. All researchers should be aware of how to find an SDS, and should have access to the SDS for each chemical used in the laboratory. SDSs should be reviewed prior to beginning work with a chemical. Note that prior to 2013, SDSs were known as Material Safety Data Sheets (MSDSs).

3.2.3 Safety Data Sheets

The CHO will be responsible for ensuring that a proper SDS is filed for each chemical shipped to the campus and that a copy of that SDS is made available at its point of use and/or to the end user. SDSs shall be accessible 24 hours a day in case of emergency.

The Department or the PI responsible for the point of use shall maintain a copy of the SDS at the point of use.

All Laboratory Personnel, PIs, technicians and student workers shall review the SDS prior to use of a chemical.

3.2.4 Chemical Labeling

Chemical labels on original containers shall meet the OSHA requirements set forth in 29 CFR 1910.1200, which are consistent with the provisions of the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS), Revision 3. GHS-compliant chemical labels must display the information listed below upon their delivery to Stevens. Any chemicals delivered to Stevens shall be delivered to the Chemical Storage Building and shall be inspected for correct labeling upon receipt by the Receiving Department under the guidance of

EHS&IRM. Containers shall be rejected and sent back to the supplier if the labeling is insufficient.

- The common name of the chemical.
- The name of the company supplying the chemical.
- A harmonized signal word, pictogram, and hazard statement indicating any health or safety hazards that the chemical may present, including: corrosiveness, carcinogenicity, water reactivity, flammability, mutagenicity and toxicity. If a chemical presents a health hazard, the label shall provide precautionary statements and indicate the precautions required (gloves, respirator, etc.) for its safe handling.

Upon the delivery of an original container to its point of use, EHS&IRM, together with the Laboratory Personnel or PI in control of the point of use shall be responsible for maintaining the proper labeling of the containers in which the chemical is stored or transported. A chemical may be dispensed from its original container only if it is dispensed into a container that has been (i) approved by the CHO as safe and compatible; and (ii) labeled with the common and scientific name of the chemical and hazards, if any.

Container labeling requirements also apply to chemical substances developed in the laboratory. If the composition of the chemical substance is known, it should be labeled accordingly. If the chemical produced is a byproduct whose composition is not known, it should be labeled and managed as a hazardous waste.

Chemical container labeling will be assessed in the routine inspections of laboratories, darkrooms and storage areas. Questions on the use and type of containers shall be referred to the CHO.

Anyone who discovers an unlabeled or mislabeled chemical shall promptly contact the CHO.

3.3 SELECTION OF REQUIRED CONTROL METHODS AND AUTHORITY FOR CHEMICAL USE

- SDSs for many chemicals used in the laboratories indicate recommended limits (e.g., threshold limit value or TLV) or OSHA-mandated limits (e.g., permissible exposure limit or PEL, short-term exposure limit or STEL, and action limit or AL), or both, as exposure guidelines.

- When such limits are stated, they will be used in the laboratories by the CHO to assist in determining the safety precautions and control measures necessary when handling toxic materials. A chemical fume hood must be used, but is not limited to, when the following occurs:

- When working with a compound that has a reported TLV or PEL less than 50 parts per million (ppm).
- If the LD_{50} is less than 500 milligrams per kilogram (mg/kg) or the median inhalation dose, LC_{50}, is less than 200 ppm.
- When working with or handling toxic or malodorous materials (e.g., 2-mercaptoethanol) with moderate or high vapor pressure.
- When the SDS recommends use.
- When defined in the SOP.
- As the primary control device for working with flammable or toxic chemicals.

- Personal Protective Equipment
  - Whenever any hazardous chemical is used in the laboratory, the PI or Laboratory Personnel for that laboratory must ensure the appropriate types and sizes of gloves are readily available and worn by all laboratory staff.

  - Safety glasses or goggles must be worn in the laboratory when pouring or handling hazardous chemicals or when there is potential for splash hazards. Safety glasses must meet the specifications of the American National Standards Institute (ANSI) Z87.1.

  - Long-sleeved laboratory coats or chemical-resistant aprons must be worn in the laboratory whenever chemical hazards exist. When working with flammable materials, the use of flame-resistant laboratory coats is required. Laboratory coats are available through the EHS&IRM office.

  - Sandals or open-toed shoes and other clothing which do not protect the laboratory worker from accidental spills of hazardous materials are prohibited in the laboratory.

- Respirators are not to be used in any area at Stevens without prior approval from the CHO. Respirators require medical clearance, fit testing, and training prior to use.

- Staff members must obtain prior approval from the CHO whenever a new use of extremely toxic (refer to Section 3.4), carcinogenic, or physically hazardous chemical is being considered.

3.4 SPECIAL PROVISIONS FOR PARTICULARLY HAZARDOUS SUBSTANCES (CARCINOGENS, REPRODUCTIVE TOXINS, AND ACUTELY AND EXTREMELY TOXIC CHEMICALS)

The procedures described in this section must be followed when performing laboratory work with any carcinogen, reproductive toxin, substances with a high degree of acute toxicity, or chemical whose toxic properties are unknown. These procedures must also be followed

whenever the research includes chemicals or process that introduce physical hazards (e.g., fire, explosion, etc.)

These substances must be handled, used, and stored only in designated areas of restricted access. Appropriate areas include chemical fume hoods, designated portions of a laboratory, or an entire laboratory if it is specifically dedicated for that purpose. A designated area must be clearly posted with signs warning that a specific, extremely hazardous material is in use and that only those trained to work with it are allowed to enter the area while procedures using it are ongoing. The boundaries of the designated area must be clearly defined.
Please note: A designated area may be posted with a removable sign if work with extremely hazardous agents is not continuous in the laboratory. The smallest amount of a chemical that is required by a procedure should be purchased, used, and stored. Whenever possible, material should be ordered in amounts equal to that required in each procedure to avoid unnecessary weighing out of the material.

Spill procedures must be developed and posted in the designated area. Staff should be familiar with and have available materials that will inactivate the chemical.

For spills involving corrosive substances, such as hydrochloric acid, never clean unless you are absolutely certain you have the proper gloves and personal protective equipment.

The designated area must be decontaminated when work is completed.

Liquid wastes must be put into screw-top containers that are compatible with the chemical. Hazardous waste containers must be labeled with the words, *Hazardous Waste*, the chemical name, the type of hazard (toxic, ignitable, corrosive, or reactive), and dated only when full. Hazardous waste must be removed from the laboratory within three business days after dating the container. Please contact EHS&IRM (refer to Appendix A) for hazardous waste removal. Questions about specific wastes should be directed to EHS&IRM.

3.4.1 Reproductive Toxins

Reproductive toxins act during pregnancy and may cause effects such as embryo lethality (death of the fertilized egg or fetus) or teratogenic effects (malformations of the fetus). They can also act on the reproductive systems of males or females causing sterility, reduced fertility, etc. Examples of embryo toxins include thalidomide and tetracycline. Embryo toxins can affect the fetus at any time during its development but especially during the first trimester, when many organs and systems are developing. Because a woman may not know that she is pregnant during some or all of this period caution is advised. Reproductive toxins that may result in an adverse response to the male reproductive system (damaged sperm or testicular damage) include heavy

metals (lead, cadmium, nickel and methyl mercury), glycol ethers, halogenated pesticides, and chemotherapy agents. The compounds below are highly suspected to be reproductive toxins:

- Acrylic acid hexachlorobenzene
- Aniline iodoacetic acid
- Benzene lead compounds
- Cadmium
- Cadmium mercury compounds
- Carbon disulfide nitrobenzene
- Chemotherapy agents
- N,n-dimethylacetamide nitrous oxide
- Dimethylformamide (dmf) phenol
- Dimethylsulfoxide (dmso) polychlorinated and polybrominated phenols
- Diphenylamine prostaglandin e2
- Estradiol toluene
- Formaldehyde vinyl chloride
- Formamide xylene
- Glycol ethers
- Halogenated pesticides
- 2-ethoxyethyl acetate
- Lead
- Methyl mercury
- Nickel
- Thalidomide
- Tetracycline

The above list is not intended to be complete, and it is the responsibility of the PI (in consultation with EHS&IRM, if necessary) to evaluate each compound he/she works with to determine whether it should be handled as a reproductive toxin, and the procedures to employ when using these compounds.

3.5 ELIMINATION OR SUBSTITUTION

The first step in evaluating the safety of a new experiment, process or operation is to investigate the possibility of eliminating hazardous materials or substituting with a less hazardous material. When selecting alternate products, care must be taken that one hazard is not being substituted for another.

The particular process, experiment, or operation may also be modified to reduce the quantity of the hazardous chemical(s) necessary or limit the potential emission release rate or exposure time.

The use of a secondary containment device, such as a pan, can also be helpful in preventing or minimizing the effects of chemical spills.

3.6 ENCLOSURE, ISOLATION AND DESIGNATED AREAS

Reducing the potential for exposure to particularly hazardous chemicals is achieved by restricting the use of the material to a designated area equipped with the proper control devices. This designated area can be a chemical fume hood, bench, or an entire laboratory depending on the manipulations required. Hazardous substances are stored, used, and prepared for disposal only in designated areas. The designated area is identified by signs to alert others of the presence of a particularly hazardous material.

In addition to establishing the physical boundaries that define the designated area, procedures used in a designated area have special provisions. These include storage, use of protective equipment, containment, equipment disposal, and decontamination procedures.

3.7 EDUCATION AND TRAINING

The CHO or appointed individual(s) shall provide information and training concerning the handling of hazardous chemicals in the laboratory.

Employees shall be informed of the presence of hazardous chemicals when assigned to a work area and prior to new exposure situations. This information must include the following:

1. Contents of the OSHA Laboratory Standard.
2. Applicable details and location of the CHP.
3. Emergency and personal protective equipment training.
4. Physical and chemical properties of hazardous substances used in the work place.
5. Proper handling of hazardous chemicals to minimize exposure.
6. Signs and symptoms of exposure associated with hazardous chemicals used in the work place.
7. Availability of reference material, including SDSs.

Training shall be provided immediately for new employees in the affected work area and annually thereafter for all personnel. The name of each person trained shall be recorded together with the training contents, date, time, and the trainer.
Laboratory Specific Training
The Principal Investigator, or their designee, shall provide documented information and training for laboratory personnel working in their laboratory. At a minimum, this training must include a review of the following:

- Laboratory Specific Standard Operating Procedure
- Personal Protective Equipment required when working in the laboratory
- Research protocol specific SOPs and required safety measures
- Safe operation of laboratory equipment and instrumentation
- Location and operation of emergency response equipment, including but not limited to, safety shower, eyewash, emergency contact information

It is the responsibility of the Principal Investigator to assure that all staff members attend the required training sessions. Further, if English is not the primary language understood by a staff member, the Principal Investigator should ensure that an interpreter accompanies the non-English speaking staff.

3.8 GENERAL WORK PRACTICES AND STANDARD OPERATING PROCEDURES FOR CHEMICALS OR CLASSES OF CHEMICALS

General work practices and SOPs are designed to protect the user and surrounding areas from chemical hazards. When developing these procedures, it is important to consult the SDS for the chemical to ensure that the hazards are understood and have been addressed.

3.8.1 Avoidance of Routine Exposure

- Work should be conducted in a chemical fume hood whenever possible.
- Smelling chemicals to determine their identity should be avoided.
- **Never** place your head inside of a chemical fume hood to check on an experiment.
- Select gloves that will protect against the chemical(s) to be handled. Inspect gloves before use.
- Release of toxic chemicals (including dry ice) in cold or warm rooms must be avoided, as these rooms contain recirculated atmospheres.
- Exhaust of an apparatus (e.g., vacuum pumps) that may discharge toxic chemicals should be vented into a chemical fume hood or filter.
- When transporting hazardous chemicals, carriers or carts designed to prevent bottles from breaking and spilling must be used.

3.8.2 Choice of Chemicals

- Less toxic substances should be substituted in place of more toxic ones wherever possible.
- Only those amounts necessary for immediate work should be ordered.

3.8.3 Personal Hygiene

- No eating, drinking, smoking, handling of contact lenses, or applying eye drops or cosmetics is allowed. Mouth pipetting of **any** substance is prohibited.
- Hands must be washed after removing gloves and before leaving the laboratory. Solvents must never be used to wash hands.
- Laboratory coats and safety glasses or goggles when appropriate should be worn in the laboratory whenever there is a potential for exposure to infectious, chemical, or radioactive hazards. Appropriate gloves must be worn when handling chemicals. Refer to Appendix G, Effective Use of Gloves.

3.8.4 Appropriate Storage of Chemicals

- Incompatible chemicals must be segregated (refer to Appendix H for lists of incompatible materials and Appendix J for Chemical Storage Guidelines).
- Glass bottles must not be stored on high shelves or on the floor.
- Chemicals should be stored in containers with which they are compatible.
- All bottles must be labeled with the correct chemical name. No abbreviations or chemical symbols. Bottles should be dated upon receipt and again upon opening.

3.8.5 Horseplay

Avoid practical jokes or other behavior that might confuse, startle or distract another worker.

3.8.6 Unattended Operations

- All chemical containers, including reaction vessels and process equipment, must be labeled.
- A sign stating “Experiment In Progress” (or equivalent) must be posted near the process and on the laboratory door. This sign will include a contact name and emergency contact number for the person responsible for the operation.
- Provide for the containment of hazard substances in the event of failure of a utility service, such as cooling water. Additional controls are needed for particularly hazardous chemicals.

3.8.7 Working Alone

Stevens policy forbids anyone from working alone in laboratories when conducting research and experiments involving hazardous substances and procedures.

Undergraduate Teaching Laboratories:

A university representative trained in chemical safety (faculty member, laboratory technician or other person chosen by the Department Chairperson) must be present in the laboratory at all times when high school interns and/or undergraduate students are conducting experiments.

Research Laboratories:

Personnel working with hazardous chemicals in a laboratory after normal hours or on weekends and holidays must notify Stevens Police to make them aware of their presence in the facility. Those who work into the evening should coordinate with PI and notify Stevens Police after 10:00 p.m. of their intention to remain or stay in the laboratory. Stevens Police may conduct periodic checks of laboratories.

3.8.8 Chemical Procurement, Distribution, and Storage

3.8.8.1 Procurement

Refer to Appendix B, which outlines the chemical management process for the procurement, receipt, and inventory of chemicals on the Stevens campus.

3.8.8.2 Transport of Hazardous Chemicals

The following guidelines will be used when transporting hazardous chemicals within facilities or from building to building. Transportation of all chemicals on public ways (streets and roads) is not permitted without proper licensing and proper vehicles. Transportation of chemical from building to building must be coordinated with EHS&IRM. The flowing guidelines shall be followed when transporting chemicals within a building.

- Hazardous chemicals that are hand-carried shall be placed in a secondary container or acid carrying bucket with tight fitting covers and shock absorbing material to protect against breakage. Bottles shall be protected from falling or tipping with a Speedi-Dry or similar means.

- Wheeled carts used to transport chemicals shall be stable and move smoothly over uneven surfaces without tipping or stopping suddenly, and shall have lipped surfaces that would contain the chemicals if the containers break.

- Laboratory employees transporting hazardous chemicals must wear splash goggles and a lab coat or apron in case containers break or chemicals are splashed. Employees must wear flame-resistant laboratory coat when transporting flammable materials. Contact EHS&IRM for laboratory coats.

- Use freight elevators when available. Passenger elevators shall be used only during low-use time periods and then shall be occupied only by those who are handling the chemicals. All hazardous chemicals shall be placed in a secondary container or acid carrying bucket with tight fitting covers and shock absorbing material to protect against breakage.

- Transportation of Compressed gas cylinders between buildings is prohibited. If cylinders need to be relocated to another building, contact EHS&IRM. Transportation of cylinders within the building requires the use of a cylinder hand truck. The cylinder must be securely strapped to the cart and the cylinder cap must be secured in place. Cylinder shall NEVER be dragged or rolled.

3.8.8.3 Stockrooms/Prep Rooms

Storage and prep rooms are areas in facilities in which relatively large quantities of chemicals or gases may be stored for laboratory use. The following rules will be followed for all storage and prep rooms:

- Access must be strictly limited to specified personnel. All prep rooms, and storage must be locked and secured when specified personnel are not present.

- The CHO shall ensure that all storage, prep rooms and other chemical storage areas are supplied with a mechanical ventilation system that provides an adequate number of air changes per hour to control the hazards.

- Each chemical storage room and prep room must have access, in or adjacent to the room, to at least one large sink, safety shower, eyewash station, and appropriate fire extinguisher with adequate extinguishing capacity. The fire extinguisher shall be located next to the exit door and also within 25 feet of a hazardous area. Fire extinguishers, safety showers and eyewash stations cannot be obstructed.

- Shelving must be secure and well balanced. Shelving characteristics shall include:
  - Anti-roll lips on all shelves to prevent containers from falling off shelves. Existing shelving otherwise suitable for storage shall not be replaced. New shelving shall have anti-roll lips.
  - Metal shelves shall be corrosion-resistant.
  - Aisles at least 3 feet between standing shelves.
  - Chemicals shall be stored according to the storage patterns described in Appendix J.

- All storage and prep room exits must be clearly marked and unobstructed.

- Storage and prep rooms must be well lit so that labels can be easily read.

- No aisle is permitted to dead end. Aisles must be kept clear of clutter. Material cannot be stored in a means of egress.
- The environment in stockrooms must be controlled and avoid extremes of temperature and high humidity.
- Floors must be kept clean and dry. If being cleaned or when a spill has occurred, signs shall be posted to warn of hazard.
- Gas cylinders must be stored upright with the protective cap in place and secured with a strap or a chain. Incompatible gases must be segregated.

3.8.9 Procedures for Flammable Chemicals

3.8.9.1 General Use and Handling

- Flammable liquids are defined as those liquids with a flash point of 140 degrees Fahrenheit (°F) or less and having an absolute vapor pressure of not more than 40 pounds per square inch at 100 °F. Some examples commonly found at Stevens are acetone, ethanol, ether, and xylene. All flammable liquids should be handled carefully.
- Flammable substances should be handled only in areas free of ignition sources (e.g., away from electric ovens, burner flames, and hot surfaces).
- Flammable substances should never be heated using an open flame. Heating mantles, oil baths, safety hot plates, and steam baths should be used. When heating either by steam bath or hot plate, use a filter or distilling flask as a receiver. Such distillations must be carried out in a chemical fume hood.
- Smoking is not permitted where flammable liquids are used. Stevens has specified a smoke-free environment as mandatory in all buildings on campus.
- Boiling chips or glass beads are helpful in distilling or evaporating flammable substances to prevent superheating and bumping.
- Ground cylinders or equipment when transferring flammables from one container to another. Contact the EHS&IRM if there are questions about proper grounding.

3.8.9.2 Storage

- Bottles of flammable liquids should not be stored near heat sources or in direct sunlight.
- Quantities of flammable solvents stored in the laboratory should be kept to a minimum.

- Whenever possible, flammable liquids should be stored in approved storage cabinets. Flammable liquids must never be stored on the floor.
- Adequate ventilation must be provided where flammable liquids are used.
- When flammable liquids are stored in a refrigerator, it must be a *Laboratory-Safe* Refrigerator (as defined in NFPA 45). These are approved for storing flammable liquids and have all electrical equipment mounted on the outside surface of the refrigerator.
- Flammable liquids must not be stored with chemicals that are considered to be incompatible with them (e.g., oxidizers, oxidizing acids, etc.).

3.8.10 Procedures for Reactive Chemicals

- Reactive materials include oxidizers, organic peroxides, explosives, and those ranked 3 or 4 for reactivity by the NFPA.
- For peroxide-forming chemicals (e.g., ethyl and isopropyl alcohol, ethers, and tetrahydrofuran), containers should be dated upon opening and disposed of as hazardous waste by the expiration date or within six months, whichever is sooner.
- All reactive materials must be handled with caution, personal protective equipment must be used, and, where possible, work should be done in a chemical fume hood.

3.8.11 Procedures for Corrosive Chemicals

- Extreme care must be exercised in handling and pouring corrosive materials. This includes approved gloves, a laboratory coat, and safety glasses or goggles. The use of a faceshield is recommended.
- Acids and similar chemicals should not be stored above laboratory bench level.
- Corrosive materials should not be heated or handled in large, fragile containers (e.g., four-liter beakers) without providing a secondary containment to catch the contents in case of breakage.
- Porcelain dishes should not be used as cleaning baths.
- Strong alkalis should not be stored next to strong acids.
- If strong acids or alkalis come in contact with skin or clothing, affected parts should be washed quickly and thoroughly with large quantities of water. If such materials are splashed in the eyes, they should be flushed thoroughly with a continuous stream of cold water for at least 15 minutes. In either case, medical attention should be sought immediately.

3.8.12 Special Procedures: Work with Formaldehyde

The OSHA formaldehyde standard, Occupational Exposure to Formaldehyde, 29 CFR 1910.1048, states that the exposure limit (eight-hour PEL) for exposure to formaldehyde is 0.75 ppm. The 15-minute average STEL is 2 ppm.

The Hazard Warning, including labeling requirements, falls under the OSHA Hazard Communication Standard, 29 CFR 1910.1200, and the formaldehyde standard, 29 CFR 1910.1048. If formaldehyde is to be used, all staff should be informed of the health hazards of formaldehyde upon initial orientation to the work site. Notify the CHO if you work with formaldehyde containing chemicals so a review can be conducted to ensure compliance with 29 CFR 1901.1048.

3.9 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is designed to serve as a barrier between laboratory workers and hazardous materials to prevent personal injury and illness. Examples of PPE include safety glasses or goggles; face shields; safety shields; gloves; rubber aprons; laboratory coats; and respirators. It is the responsibility of the PI to ensure that laboratory staff uses necessary PPE.

The use of PPE shall be included in all SOPs. The type and level of equipment can be determined with the aid of the CHO. The use of PPE should only be considered after exercising all options for reducing the hazards. If in doubt about the potential danger of an experiment or activity, all available safety devices should be employed. Information on such devices can be obtained from CHO upon request.

Required PPE will be provided free of charge. It will be replaced free of charge if damaged or defective. PPE must remain within the laboratory area and is not to be worn outside of laboratory areas or taken offsite for any reason.

3.9.1 Respirators

The Stevens Respiratory Protection Program must be followed when respiratory protection is required. All staff must follow these elements. If you feel that a respirator is required for your laboratory work, contact EHS&IRM immediately for a review of the procedures/process.

- Selection of a respirator type must be performed in consultation with CHO.
- A medical clearance is required for each employee before a respirator is worn.
- Fit testing and training shall be performed under the direction of the CHO for all negative pressure respirators before use.

3.9.2 Eye Protection

Eye protection must be worn in the laboratory whenever there is a potential for eye contact with liquids and/or particulates. Goggles or safety glasses with side shields must be worn when handling chemicals with the potential for splash or splatter. It is recommended that safety glasses be worn at all times when working in the laboratory. Safety glasses and goggles are available through EHS&IRM.

Goggles are recommended when working with volatile substances that irritate the eyes (e.g., chlorine, strong ammonia, irritating dusts) as well as for protection against spattering or splashing of hazardous materials. It is also advisable to wear a faceshield when distilling at high temperatures, under reduced pressures, or when distilling corrosive liquids. Safety glasses and goggles have only a limited application and do not offer full protection against all hazards. For particularly dangerous operations, full faceshields of an approved type are to be worn. Contact EHS&IRM if you need assistance with selecting eye protection.

3.9.3 Protective Clothing

The use of protective clothing, including chemical aprons or laboratory coats, is required when working with hazardous chemicals. Flame-resistant laboratory coats are required when working with flammable materials. Laboratory coats are available through EHS&IRM. Contact the EHS&IRM for more information.

- Protective clothing is chosen, with the aid of the EHS&IRM, on the basis of the potential for chemical exposure.
- Contaminated protective clothing must be disposed of properly.
- Open-toed shoes or sandals must not be worn in the laboratory.
- Skin must not be exposed when working with hazardous materials.

3.9.4 Protective Gloves

When handling toxic or hazardous chemicals, protective gloves are required. To protect against accidental spills or contamination, workers should refer to glove manufacturers' glove charts to select a glove appropriate for use with the reagent in question (refer to Appendix G for glove selection). There is no glove currently available that will protect against all chemicals for all types of tasks. If the gloves become contaminated, they should be removed and discarded as hazardous waste as soon as possible. Remove at least one glove before leaving the immediate work site to prevent contamination of public areas (e.g., doorknobs, light switches, telephones, etc.).

Latex Alert: Latex (i.e., several protein antigens) has been shown to be a sensitizer. In order to best protect workers from becoming sensitized, latex gloves are discouraged in laboratories.

3.9.5 Other Personal Protective Equipment

Other PPE shall be used as needed and required by laboratory specific SOPs.

3.10 VENTILATION, CHEMICAL FUME HOODS, GLOVE BOXES, AND PROPER OPERATIONS

Local exhaust ventilation through the use of a chemical fume hood is the primary method used to control inhalation exposures to hazardous substances in the laboratory. Other types of local exhaust include vented enclosures for large pieces of equipment or chemical storage and snorkel types of exhaust for capturing contaminants near the point of release.

A chemical fume hood should be used when working with hazardous substances. A properly operating and correctly used chemical fume hood will control the vapors released from volatile liquids, as well as unpropelled dusts and mists.

Do not make any modifications to chemical fume hoods or ductwork without first contacting the CHO. A chemical fume hood should not be used for large pieces of equipment unless the chemical fume hood will be dedicated for this use since it may change airflow patterns and render it potentially unsafe for other uses. It is generally more effective to install a specially designed enclosure for large equipment so that the chemical fume hood can be used for its intended purpose.

A chemical fume hood should not be used for chemical or other miscellaneous storage, as this may also restrict airflow. Chemicals should be stored in an appropriate (following NFPA 45 requirements) chemical storage cabinet. All freestanding cabinets should have bungs in place and the doors should close properly.

The CHO oversees the chemical fume hood program. Before you begin using a chemical fume hood, check to see that the hood is labeled appropriately for use with toxic chemicals and has been certified within the last 12 months. If a chemical fume hood requires certification or if you have questions regarding safe operation, contact the CHO and Office of Facilities.

Some of the basic guidelines for working safely in a chemical fume hood include the following:

- Work at least six inches behind the sash.
- If it is necessary to store materials in a chemical fume hood, they should be elevated so air can pass under them.
- **Never** put your head (or face) inside an operating chemical fume hood!
- Work with the sash in the lowest position possible. The sash will act as a barrier and provide containment should a problem arise with the reaction.

- Do not clutter the chemical fume hood with bottles or equipment. Only materials actively in use should be in the chemical fume hood.
- Clean the grille along the bottom slot of the chemical fume hood regularly so it does not become clogged with paper and dirt.
- Do not dismantle or modify the physical structure of the chemical fume hood or exhaust system in any way.
- Report any suspected chemical fume hood malfunctions to the CHO.

A glove box is a sealed container used to manipulate materials when a separate atmosphere is desired. Glove boxes are typically used to protect workers from hazardous materials or to protect chemicals and materials that may be sensitive to air or water vapor.

Glove boxes may be used under either positive or negative pressure. Glove boxes operated under positive pressure typically contain materials sensitive to outside contaminants such as air or water vapor. Exposure to outside contaminants can lead to degredation or a violent reaction with these compounds. Negative pressure glove boxes are used to protect workers and are used for hazardous materials such as toxic gases or pathogens.

Before using a glove box, the user must be trained on the proper use and operation of the specific glove box. In addition, the specific protocol(s) performed in the glove box must be documented and included in the operator training. Training must be documented and performed by the PI or senior lab member.

Daily Inspections

When using glove boxes, perform daily documented inspections prior to use. A logbook should be utilized to document the daily inspections. As part of your daily checklist, perform the following:

- Check the condition of the gloves. Look for holes, areas of discoloration representing a compromised integrity, and the connection to the exterior.
- Inspect the condition of the window, paying special attention to the area where the window is connected to the rest of the box.
- Perform a vacuum pump inspection and ensure that all lines are in good condition and that the oil (if applicable) has been changed recently.
- Inspect vacuum pump exhaust oil-mist filter and ensure it is still within operating parameters.
- If your box is equipped with a solvent scrubber and solvent delivery system, ensure that the scrubber cartridges are within operating parameters.
- All pressure gauges and indicators are functioning and are within acceptable ranges.

Other Considerations:

- If it is a shared glove box, assign 1 or 2 senior people in the lab to ensure that all maintenance on the box and components are current and documented.

- Maintain service contracts with the manufacturer or manufacturer authorized service contractor and have them perform routine maintenance on the system.
- Avoid abruptly extending gloves into the box, this can severely stress the system and cause an over pressurization.
- Use nitrile gloves in the glove box gloves. This extends the life of the glove box gloves and helps to avoid cross contamination and makes cleanup easier
- Train all individuals working in the box. Document this training in a laboratory specific training file.

Ensure proper backup measures are in place for a loss of power or loss of inert gas supply.

3.11 HOUSEKEEPING

It is essential for both safety and efficiency that the laboratory facilities be kept neat and orderly. Floors, shelves, and benches should be free from dirt and unnecessary apparatus and tools. Equipment should never obstruct exits, passages, or fire extinguishers, etc.

Care should be exercised when disposing of materials. Flammable or toxic materials must be collected for disposal as hazardous waste and, therefore, must not be placed in the regular waste stream. Refer to Section 3.14 for information regarding waste disposal at Stevens.

General guidelines for good housekeeping include the following:

- Never block access to emergency equipment, showers, eyewashes, and exits.
- Label all chemical containers with the identity of the contents and the hazards in accordance with GHS requirements.
- All work areas should be kept clear of clutter.
- All aisles, hallways, and stairs must be kept clear.
- All chemicals should be returned to their proper storage area at the end of the day.
- Liquid wastes should be kept in spill-proof containers, and stored off the floor in a satellite accumulation area.

BE PREPARED FOR SPILLS. Small spills should be cleaned up promptly using the spill kit located in the laboratory. All clean up materials must be collected for disposal as hazardous waste. Refer to Appendix E, Chemical Spill Response/Release of other Hazardous Materials.

Formal laboratories and storage area inspections shall be conducted at least annually by EHS&IRM; informal inspections shall be routinely conducted. PI's, along with other laboratory personnel, should conducted regular inspections of their respective laboratories

The CHO should be contacted to determine the hazard potential of any new laboratory procedure and the level of precautions required. No matter the hazard level, general laboratory practices

shall be followed. In addition, the Department or PI shall institute such other specific measures (engineering, administrative, etc.) as are necessary to reduce the hazard risks to an acceptable minimum. Specific control measures relating to engineering controls (such as local exhaust ventilation), administrative controls (such as job rotations), personal protective equipment, the storage of hazardous materials and hazardous waste disposal are treated in separate sections later in this document.

3.12 SIGNS AND LABELS AND SAFETY DATA SHEETS

3.12.1 Signage

- *Eye Protection Required* signs are recommended at entrances to laboratories using chemicals. Safety glasses for visitors must be provided.
- Signs indicating the location of, eyewash units, safety showers, fire extinguishers, and other safety devices are required.
- Entrances to laboratories, storage areas, and associated facilities must have signs as necessary to warn emergency personnel and custodians of unusual or severe hazards.

3.12.2 Chemical Container Labeling

All containers must be labeled with the chemical contents. Chemicals received from outside vendors must have labels indicating the name, along with other physical and chemical data. Toxicity warning signs or symbols should be prominently visible on the labels.

All chemical containers that have been decanted from an original container must be labeled with the full chemical name (no abbreviations or chemical symbols), the primary hazard(s), the name of the responsible person, and the date. EHS&IRM can be contacted for further information regarding GHS-compliant labels for this purpose.

Chemicals developed in the laboratory must be assumed to be toxic if no data on toxicity are available. Suitable handling procedures must be prepared and implemented, including training of users in controls necessary to handle a material safely. If the substance is produced for another user outside of the laboratory, an SDS and labels must be prepared and provided to such users (in accordance with OSHA 29 CFR 1920.1200).

3.13 MONITORING AND EMPLOYEE ASSESSMENT

Stevens will perform exposure monitoring, when appropriate, in accordance with paragraph (d) of OSHA 29 CFR 1910.1450. Other qualified consulting service providers may be employed by Stevens to conduct such monitoring. All monitoring results will be kept on file with EHS&IRM and communicated to employees.

3.13.1 Employee Exposure Determination

- **Initial monitoring** will be performed if there is reason to believe that exposure levels for a substance could routinely exceed the action level (or PEL in the absence of an action level).
- **Periodic monitoring** will be performed **if** the initial monitoring performed discloses employee exposure over the action level (or PEL in the absence of an action level).
- Monitoring may be terminated in accordance with the relevant standard.
- Within 15 working days after the receipt of any monitoring results, the employees will be notified in writing of these results. Notification will either be given individually or by posting the results in an appropriate location that is accessible to employees.

3.14 WASTE DISPOSAL

3.14.1 Policy

Every effort shall be made to dispose of hazardous waste in a proper, safe and efficient manner. It is the responsibility of the individual creating the waste to properly identify and handle waste chemicals. Individuals must review Stevens Waste Management Plan which can be found at the following link:
https://assets.stevens.edu/mviowpldu823/3SU7rfKbej2PZRPB0QAxPa/099480b357cf681f49ee33450cf9fcdd/Stevens_Waste_Management_Plan_Final.pdf

3.14.2 Main Accumulation/Storage Area

EHS&IRM maintains the central waste collection area, Central Accumulation Area (CAA), for the storage of chemical hazardous wastes removed from the laboratories. Once the waste container has been filled in the laboratory, it will be dated and transported to the CAA by EHS&IRM personnel.

3.14.3 Satellite Accumulation Areas

Designated personnel in charge of each laboratory maintains SAAs for the storage of chemical hazardous waste. The following guidelines must be followed at all SAAs:

- Label all containers accurately, indicating the constituents and approximate percentage of each. The concentration of the constituents must add up to 100%. Labels may be obtained from EHS&IRM

- Close all containers during accumulation except when necessary to add or remove wastes. Do not overfill containers. Leave adequate headspace for expansion. Funnels must be removed from containers when not in immediate use
- Seal all containers tightly. No open or Parafilm-covered containers may be used for waste accumulation
- Ensure waste is compatible with other wastes in the container, and with the type of container it is stored in. The exterior of the container must be free of chemical contamination; leaking containers will not be picked up. Segregate containers of incompatible waste to prevent reactions.
- Keep containers near the process which is generating the waste; waste must be under the continuous control and supervision of its generator.
- Train all students and staff in workplace of waste accumulation site requirements including emergency response.
- Once a waste container is **full** contact EHS&IRM to arrange for transportation to the central accumulation area.
- Containers storing Hazardous Waste must be kept in *approved secondary containers.*

3.14.4 Chemical Identification and Unknown Waste Chemicals

All waste chemicals must be identified by full chemical name, including the proportions of a mixture. Do not use symbols or abbreviations. All containers must be labeled prominently because the safe transportation of chemicals is possible only when everyone who handles the containers knows the identity of the contents.

Every effort should be made by the PI or his/her designee to identify unknown waste. It is the responsibility of the department to identify all chemicals. Laboratory personnel must be constantly reminded to identify and label all wastes and project products. If unknown waste has been discovered and cannot be identified, immediately contact EHS&IRM. Everyone must do their part to identify chemicals.

NOTE: Never Mark a container "UNKNOWN".
Label unknown waste streams with the words "Pending Analysis" and contact EHS&IRM.

3.14.5 Guidelines for Waste Reduction/Management

Procedures for waste disposal should be prepared *before* beginning a project. Waste must be labeled properly. Each department, group, or researcher must properly identify waste materials prior to disposal; inadvertent mixing of incompatible materials could have serious consequences.

Waste minimization is very important to protect the environment and also to reduce the disposal costs charged to the laboratory. The following suggestions should be considered in an effort to minimize the amount of waste generated by the laboratory.

- Only order and store the amount of material needed for the project or experiment.
- Use only the amount of material that is needed for conclusive results.
- Date containers upon receipt and again upon initial opening.
- Before disposing of unwanted, unopened, or uncontaminated chemicals, check with others at Stevens who may be able to use them.
- On termination of a research project, all unused chemicals to be kept by the laboratory shall be labeled and dated. All chemicals for disposal must be in proper containers and labeled with the words *Hazardous Waste*, the chemical name, type of hazard (toxic, ignitable, corrosive, or reactive), and the date when the container is full and/or ready for removal and disposal.

3.14.6 Types of Chemicals and Their Disposal

Regulations prohibit the discharge of chemicals into the sewer system. Small amounts of water-soluble, non-flammable materials may be discharged down the drain. Table 3.1 provides a summary of disposal procedures for many chemical types. Consult with CHO to determine which chemicals can be disposed in this manner.

Table 3.1 Types of Chemicals and Their Disposal

Chemical Class	Disposal
Organic solvents	• Placed in suitable containers that prevent vapors or liquids from escaping. • Cap tightly. • Prominently label containers. • Disposed as hazardous waste.
Mixtures of organic solvents	• If compatible they can be combined in one container. • Container must have estimated percentages of each solvent in the mixture.
Ether (di-ethyl) in cans	• Do not move it over a year beyond the expiration date or beyond six months from the date of opening. • Office of Environmental Health and Safety & Insurance Risk Management (EHS&IRM) must be contacted immediately.
Acids and alkaline solutions	• These may be neutralized and disposed in the drain if they do not contain heavy metals or toxic contaminants. • Concentrated acids and caustics must be treated as hazardous waste. • Store in tightly capped and labeled containers.
Inorganic and organic solids	• If in original containers may be placed in the Satellite Accumulation Area (SAA).
Mercury	• Put broken mercury thermometers into a jar or secondary container. • Clean-up materials from a mercury spill may be placed in a container, labeled, and placed in the SAA. • Mercury-containing compounds must be placed in the SAA.
Cyanide compounds, arsenic, lead, and heavy metal wastes	• Place in bottles or containers. • Seal tightly. • Label and place in the SAA.
Alkali metals (e.g., sodium and potassium)	• Place in a suitable container. • Cover with Nujol® (mineral oil). • Label properly, seal and dispose as hazardous waste and place in the SAA.
Pyrophoric metals (e.g., magnesium, strontium, thorium, zirconium, and other pyrophoric chips and fine powders)	• Place in a metal container. • Seal tightly. • Label properly, seal, and dispose as hazardous waste and place in the SAA.
Waste Oil (e.g., vacuum pump oil or lubricating oils)	• Collect in one-gallon containers or less. • Dispose of as hazardous waste and place in the SAA.

The EHS&IRM may be consulted if there is any question concerning the toxicity or packaging of any wastes.

3.14.7 Other Types of Wastes—Special Procedures Required

- **Gas cylinders** are to be returned to the proper vendor. Some small lecture bottles are of the non-returnable type and become a disposal problem when empty or near empty with a residual amount of gas. When ordering gases in lecture bottle size, be sure to order the gases in a returnable cylinder. Contact EHS&IRM for assistance.

- **Controlled drugs** to be disposed of as waste must **not** be sent to the waste accumulation area. The handling, records, and disposal of controlled drugs are the responsibility of the

department and must be conducted within U.S. Drug Enforcement Agency (DEA) regulations. Contact the CHO and/or EHS&IRM for assistance.

- **Biological waste and physically dangerous waste (sharps)** must be placed in proper containers. Contact the CHO or Chemical Hygiene Committee representative for proper disposal procedures.

- **Polychlorinated biphenyls (PCBs)** found in capacitors, transformers, equipment, and oil are the responsibility of the department. Information on possible disposal contractors can be obtained by contacting the CHO or Chemical Hygiene Committee representative.

3.15 MEDICAL SURVEILLANCE

Medical consultations/examinations are coordinated for Stevens employees under the following circumstances:

- Whenever an employee develops signs or symptoms potentially associated with a hazardous chemical to which the employee may have been exposed in the laboratory.

- Where exposure monitoring reveals an exposure level routinely above the OSHA action level or permissible exposure limit for an OSHA-regulated substance requiring such medical monitoring and medical surveillance.

- Whenever an event occurs, such as a chemical spill, leak, or explosion that results in the likelihood of a hazardous exposure.

- Whenever an employee is exposed to human materials such as blood or visibly bloody fluids by a needlestick, cut or splash to exposed skin.

3.16 EXPOSURE REPORTING

Employees who believe they have had an exposure should contact the CHO for a review of the incident. An Incident Report (Appendix F) should be completed and submitted as soon as possible.

If any employee exhibits adverse health effects, Stevens shall provide these employees with the opportunity to receive medical attention, including any follow-up examinations. 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.

3.17 EMERGENCY SITUATIONS

Emergencies that may occur in a laboratory include fire, explosion, chemical spill or release, or medical or other health threatening accidents. General procedures to be followed in any emergency are the following:

1. Assist person(s) involved. Remove person(s) from exposure to further injury or a life-threatening situation, if it can be done safely.
2. Notify nearby persons who may be affected and call the "Emergency-Call" contact (x3911) to report the emergency and seek assistance.
3. Evacuate the area until help arrives.
4. Wait for emergency responders and assist them in handling the emergency.
5. Assist in the follow-up investigation of the emergency.

For specific emergencies that may occur in the laboratory space (i.e., chemical spills, fire, explosion, etc.), refer to the specific procedures established by the laboratory. Refer also to Appendix D.

- *Eye contact:* Eyes should be promptly flushed with water for 15 minutes (unless the chemical is water reactive). Medical attention should be sought immediately after flushing. Call Stevens Police (x3911) (Appendix A) who will contact the appropriate medical responders.
- *Skin contact*: Contaminated clothing should be removed as quickly as possible and the affected area flushed with water for 15 minutes. Medical attention should be sought immediately after flushing. Call Stevens Police (x3911) (Appendix A) who will contact the appropriate medical responders.
- *Cleanup with no injury:* If no one is injured, the cleanup of the spill should begin immediately. For assistance with large spills, call EHS&IRM (Appendix A). They will contact the appropriate individuals to provide assistance.
- *Cleanup with injury:* If someone is injured, that person should seek medical assistance immediately. Cleanup should be initiated by someone other than the injured person. For assistance, call Stevens Police (x3911) (Appendix A) who will contact the appropriate individuals to provide assistance.
- Notify CHO or Department Chairperson for advice and assistance, and to report spills and injuries no matter how minor.

3.18 EMERGENCY EQUIPMENT

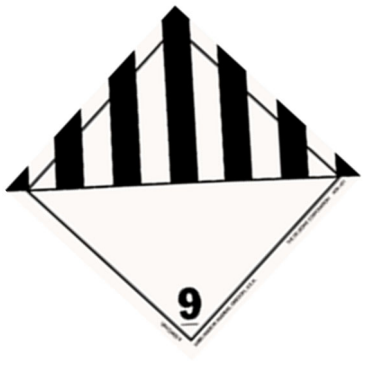
In any emergency, it is critical that all employees are familiar with the use and location of emergency equipment. These include fire extinguishers, fire alarms, safety showers, and eyewash stations.

All emergency equipment is on a preventive maintenance schedule. Fire alarms are tested annually, and extinguishers are inspected annually by Facilities. Safety showers and eye washes are checked annually by Facilities. Eyewash stations (with adequate drainage) should be purged weekly by the laboratory when possible. Always keep emergency equipment free from obstruction.

3.19 SHIPPING DANGEROUS GOODS

Any Stevens laboratory or entity that sends materials designated as Dangerous Goods to international or domestic recipients must label and package these materials according to the standards of the U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA). There are nine classes of Dangerous Goods recognized by these authorities:

Class	Division	Description
1	1-6	Explosives
2	1-3	Gasses
3	–	Flammable Liquids
4	1-3	Flammable Solids
5	1-2	Oxidizing Substances/Oxidizing Materials
6	6.1, 6.2	Toxic/Infectious Substances
7	–	Radioactive
8	–	Corrosive
9	–	Miscellaneous (includes Dry Ice)



Special training and certification is required to send ANY Dangerous Good to ANY domestic or international location, regardless of the method of transportation (aircraft, boat, rail, or motor

vehicle). Employees must not ship or receive dangerous goods without the proper training. Please contact EHS&IRM for training.

3.20 OVERSIGHT, ANNUAL REVIEW, RECORDKEEPING, COMPLIANCE, AND ENFORCEMENT

Environmental Health and Safety & Insurance Risk Management (EHS&IRM) is responsible for establishing and maintaining records for employee training, employee and environmental monitoring, and type and quantity of chemicals stored in the work place.

The **Principal Investigator (PI)** enforces the CHP by making sure the Chemical Hygiene requirements are known and followed. The CHO advises and assists in this work and helps with documentation.

The **Chemical Hygiene Officer (CHO)** will assist with chemical hygiene and housekeeping inspections. When there are significant changes in existing policies or work practices, an inspection will be conducted soon after the new process is implemented.

The **Chemical Hygiene Officer** annually reviews and updates the CHP, and notifies PIs when any significant changes to the CHP are made.

4.0 LABORATORY STANDARD OPERATING PROCEDURES

Laboratories may insert their individual SOPs in this section. A template is provided in Appendix K.

APPENDIX A

ROLES AND CONTACTS

ROLES AND CONTACTS

Department	Extension	Contact
Stevens Police	5105	Main desk
Biomedical Engineering	3557	Jennifer Kang-Mieler
Chemistry, and Chemical Biology	8307	Woo Lee
Civil, Environmental & Engineering	5289	Muhammad Hajj
Chemical Engineering & Materials Science	8241	Adeniyi Lawal
Mechanical Engineering	5562	Souran Manoochehri
Physics & Engineering Physics	8375	Ting Yu
Davidson Laboratory	5568	Raju Datla
Design and Manufacturing Institute	8053	Kishore Pochiraju
Highly Filled Materials Institute	8225	Dilhan Kalyon

Office of Environmental Health and Safety & Insurance Risk Management x8971
Chemical Hygiene Officer David Fernandez (201) 216-8705
Stevens Police Main Desk x5105

APPENDIX B

CHEMICAL MANAGEMENT PROCESS

CHEMICAL MANAGEMENT PROCESS

CHEMICAL PURCHASING IN THE KUALI FINANCIAL SYSTEM

- Chemical purchases from vendors must be made through the KUALI Financial System (KFS). When purchasing chemicals or gases, the "C" Commodity Code or "G" Commodity Code, respectively, must be selected in the order line. Chemical and gas purchases must be reviewed by EHS&IRM prior to the transaction completion. EHS&IRM may discuss the purchase of extremely hazardous chemical to ensure that the appropriate Standard Operating Procedures with safety measures are in place.

APPENDIX C

HAZARDOUS PROPERTIES/HEALTH EFFECTS OF CHEMICALS

HAZARDOUS PROPERTIES/HEALTH EFFECTS OF CHEMICALS

Adverse health effects are generally classified into eight categories. The extent of the damage to the body depends on the concentration and duration of the exposure. It is also important to recognize that some chemicals may exhibit more than one toxic property and this must be considered when choosing protective equipment.

1. **Poisons** interfere with vital bodily processes. Examples include the following.
   a. Cyanide ions interfere with tissue oxidation by combining with cytochrome oxidase. Overdose leads to death by chemical asphyxiation.
   b. Arsenic compounds combine with enzyme sulfhydryl groups and interfere with enzymatic action.
   c. Methyl butyl ketone and acrylamide can cause peripheral neuropathy.
   d. Chromates, fluorides, and corrosive gases can be absorbed or particles can act as poisons.
   e. Silica and asbestos are considered poisonous particulates as they form fibrosis (scar tissue formation) in the lung, which then interferes with normal pulmonary functions.

2. **Irritants** cause immediate pain or reddening of exposed areas. The most common sites of exposure are the eyes, skin, throat, and breathing passages. Their major long-term effect is scar tissue formation at the site of injury. Site of action depends on solubility. Examples include the following.
   a. Upper respiratory irritants include soluble gases such as ammonia, hydrogen chloride, and sulfur dioxide.
   b. Upper respiratory/lung tissue irritants include bromine, chlorine, cyanogen bromide, dimethyl sulfate, and ozone.
   c. Lung tissue irritants include poorly soluble agents such as nitrogen dioxide, phosgene, and arsenic trichloride.

3. **Asphyxiants** interfere with oxygen and/or its availability and include the following.
   a. Simple asphyxiants may not normally be dangerous (e.g., nitrogen, argon, helium, or nitrous oxide), but if present in high enough concentrations, can displace oxygen in air and cause suffocation.
   b. Chemical asphyxiants chemically combine with oxygen carrying sites (carbon monoxide) or with oxygen utilization (cyanide).

4. **Anesthetics/narcotics** depress the central nervous system. Many solvents (chloroform, ether) have an anesthetic effect.

5. **Sensitizers** do not harm the body upon first exposures, but upon re-exposure can do so, often at extremely low levels. Response is generally of an allergic nature, with skin, eye, or lung

reactions. Examples are toluene diisocyanate (TDI) used to make urethane materials, epoxy resins, and formaldehyde.

6. **Corrosives** cause rapid death of the body cells they contact. Exposure may cause pain, burning, bleeding, and fluid loss. Acids and bases are corrosives. Bases and some acids may cause pain only after exposure. Any contact with acids or bases requires careful washing with water for at least 15 minutes.

7. **Reproductive Toxins** defines a broad class of chemicals that can:
   a. Affect the reproductive organs (e.g., atrophied testicles, enlarged breasts, etc.)
   b. Affect adult sexual functions (e.g., libido, fertility, menstruation, ovulation, etc.)
   c. Affect the offspring of males or females who were exposed by causing structural abnormality, functional deficiencies, altered growth, or death of the conceptus.

   Some **mutagens** can affect the offspring due to parental exposures before conception takes place.

   Teratogens affect the developing embryo or fetus due to exposures in the womb. Exposure to teratogens during the first three weeks of pregnancy may result in severe damage or death of the embryo. Exposure to teratogens during weeks four through nine may result in birth defects since this is the period of organogenesis. Special precautions may be needed to ensure that exposures do not occur during these critical periods.

8. **Carcinogens** cause cancer, which is the irreversible, uncontrolled growth of cells in an organ or tissue. It is believed that there is no known minimum dose that can remove all danger of cancer. Benzene is a known carcinogen.

When will health effects occur? Another factor that should be considered in evaluating the health hazards of chemicals is *when will the effect occur*, immediately after the exposure or sometime after.

An acute reaction is one that occurs in the body as an immediate response to exposure. Effects are apparent and can often be traced without difficulty. Acute reactions are normally short lived and may be followed by recovery or occasionally cause permanent damage.

Unlike an acute effect, a chronic effect may not be obvious. The onset of symptoms is gradual. It is much harder to trace the cause of a chronic effect, since the exposure could have been as long as 20-30 years before an effect becomes apparent.

APPENDIX D

EMERGENCY RESPONSE FOR LABORATORY ACCIDENTS

EMERGENCY RESPONSE FOR LABORATORY ACCIDENTS

EMERGENCY PROCEDURES IN THE EVENT OF A SERIOUS INCIDENT IN A LABORATORY

All occupants must be informed and aware of the correct emergency procedures to take in the event of a serious laboratory incident or accident.

Participation in laboratory work may present exposure to potentially hazardous materials or situations. Some of the more serious accidents/incidents that can occur in laboratories include: fire, explosion, chemical spills (toxic or corrosive), release of toxic compressed gases, or failure of power that may adversely affect chemical fume hoods and/or the ventilation system.

While the procedures outlined below tend to be general in nature, there are instances where handling hazardous materials will require that detailed safety procedures be followed (in the event of an accident/incident). Detailed procedures for every possible situation would be too lengthy to be contained in general emergency procedures. Therefore, it is the responsibility of the Principal Investigator (PI) and Chemical Hygiene Officer (CHO) to ensure specific emergency procedures and appropriate decontamination methods are available and utilized for all potential hazards associated with materials used within their particular laboratories (i.e., refer to the Stevens Chemical Hygiene Plan). They must also inform and train all laboratory personnel of these specific hazards and procedures. Detailed emergency procedures should be maintained, and procedures should be conspicuously posted in the laboratory.

LABORATORY FIRE SAFETY EVACUATION PROCEDURES

You should be familiar with the location of your buildings nearest evacuation route, and the location of alarm boxes. In the event of a fire, follow these instructions:

- If possible, and time permits, shut down equipment/experiments
- Keep calm. If a fire occurs in your vicinity, pull the nearest alarm box and call the Center Desk at 216-3911.
- Walk quickly to the nearest stairwell exit and leave the building. Do not run. Do not use the elevator. Do not stop to gather any personal items.
- Assist any visitors in the area to the evacuation route.
- In the event smoke or excessive heat is encountered in one stairwell, cross to the other stairwell and continue your descent.

FAILURE OF POWER INVOLVING CHEMICAL FUME HOODS AND/OR VENTILATION

The failure of electrical power serving chemical fume hoods and/or building ventilation systems in a laboratory building can present a serious and formidable hazard. Emergency procedures should include:

1. Alert the CHO or Chemical Hygiene Committee representative immediately of the power failure.
2. Alert the CHO or Chemical Hygiene Committee representative if hazardous or toxic materials are stored in affected area.
3. Close containers and lower sashes on chemical fume hoods.
4. Be prepared to evacuate the building if necessary.

APPENDIX E

CHEMICAL SPILL RESPONSE/
RELEASE OF OTHER HAZARDOUS MATERIALS

CHEMICAL SPILL RESPONSE/RELEASE OF OTHER HAZARDOUS MATERIALS

It is the policy of Stevens that all staff are aware of the correct emergency procedures to take in the event of a chemical spill.

Chemical spills, either toxic or corrosive, even in small quantities can present a potential exposure hazard to Stevens staff.

MINOR CHEMICAL SPILLS

(Unlikely to Produce a Harmful Concentration in the Air)

- Alert people in immediate area of spill.
- Refer to the safety data sheet (SDS) for the spilled chemical, don personal protective equipment, including safety goggles, gloves, and long-sleeved laboratory coats.
- Confine spill to a small area.
- Use appropriate kit to neutralize and absorb inorganic acids and bases. Collect residue, place in container, label, and dispose as chemical hazardous waste.
- For other chemicals, use appropriate spill kit or absorb spill with vermiculite or diatomaceous earth. Collect residue, place in container, label, and dispose of as a chemical hazardous waste.
- Clean spill area with water.
- Contact CHO or Department Chairperson to report the spill and cleanup efforts.

CHEMICAL SPILLS INVOLVING 1 GALLON OR LESS

(Likely to Produce a Harmful Concentration in the Air)

- Attend to injured or contaminated persons and remove them from exposure, but only do so if you do not place yourself in danger.
- Alert people in the immediate area to evacuate.
- If spilled material is flammable, turn off ignition and heat sources (if you can do so without putting yourself at risk).
- Notify, from a safe location, Stevens Police (x3911) (Appendix A), who will contact the appropriate individuals to provide assistance.
- Be prepared to provide the following information:
  - Name of the material spilled.
  - Toxicity and flammability of the material.
  - Quantity of the material spilled.
  - Presence of other chemicals, ignition sources, etc., that could aggravate the problem.
  - Your location and phone extension.

- Close doors to affected area (post a warning sign or secure area to prevent unauthorized personnel from entering the room).
- Ensure that a person knowledgeable of the incident and work area is available to provide information to the emergency response personnel.

CHEMICAL SPILLS GREATER THAN 1 GALLON

- Notify, from a safe location, Stevens Police (x3911) (Appendix A), who will notify the proper agency or outside contractor to respond to the spill if necessary.

APPENDIX F

INCIDENT REPORT FORM

INCIDENT REPORT

Please return this form to Department Chairperson

Location of Incident: _____

Date of Incident: _____ Time of Incident: _____

Date Incident reported: _____ Time Incident Reported: _____

Type of Incident: (circle all that apply)

Spill, Fire, Explosion, Near Incident, Employee Exposure, Other (specify) _____

Investigation Follow-up Responsibility: _____

Names of Investigation Team Members: _____

_____

Describe the incident. Include tasks or operations being performed at the time of the incident.

List the chemical, physical, or biological agent(s) involved.

Determine all potential causes of the incident with descriptions:

Describe any injuries, illnesses, or exposures which may have occurred:

Describe what PPE was used and which hazard controls were operating at the time of the incident:

Describe any Health and Safety Policies which may apply to the incident including emergency response and first aid. Determine if the policies were followed prior to the incident.

Determine when the last training was performed concerning these policies. Determine if the training was received by person(s) involved in the incident.

Determine how the incident could have been prevented:

Determine if similar incidents have occurred in the past:

Describe what actions must be taken to prevent future occurrences.

Determine responsible person(s) for corrective action, e.g. policy revisions, etc. with timetable for completion.

Name: _____

Submitted to: _____

APPENDIX G

EFFECTIVE USE OF GLOVES

EFFECTIVE USE OF GLOVES

REASONS FOR WEARING GLOVES

The hands are the part of the body that will most likely to come into contact with chemicals. Skin contact can result in dermatitis that is caused by a chemical or allergic irritation of the skin. In addition, some chemicals penetrate the skin and can cause illness in other parts of the body. Wearing gloves protects workers from skin irritation and other effects of chemical exposure.

CHOOSING THE RIGHT GLOVES

Safety data sheets (SDSs) may detail appropriate gloves for use with each chemical. In addition, chemical compatibility charts for specific glove materials can be obtained from the glove manufacturer. The chart on the following page is an example of a compatibility chart.

EFFECTIVE USE OF GLOVES

Improper removal of gloves can be a source of contamination. The procedure, which works for thin gloves that may have to be changed often, is as follows:

1. Using the fingers of one gloved hand, pinch the material of the other glove at the base of the palm and peel off the glove.
2. Continue to hold the glove.
3. With the ungloved hand, reach about an inch under the other glove on the palm side of the wrist, pinch, and peel off the other glove.
4. Both gloves have now been removed without skin contact and the contaminated sides of the gloves are facing in.
5. Gloves used with highly toxic materials should be disposed as hazardous waste before leaving the work area.

Studies have shown that up to 5% of new gloves have holes in them. Substances leaking through gloves are held in contact with skin, increasing absorption into the body. Gloves that have been improperly selected or have holes in them can sometimes be worse than no gloves at all. Gloves used for dangerous chemicals can be tested for leaks by filling them with air and immersing them in water. This should not be done with PVA laminated gloves, since they may not be water resistant. If certain types of gloves consistently leak, the manufacturer should be notified.

HAND PROTECTION SELECTION CHART			
Chemical	**Excellent**	**Good**	**DO NOT USE**
Acetaldehyde	None	Natural Rubber, Neoprene	Nitrile, PVA, PVC
Acetic acid, glacial	Neoprene	Natural Rubber, Nitrile	PVA, PVC
Acetone	None	Natural Rubber, Neoprene	Nitrile, PVA, PVC
Benzene	None	PVA	Natural Rubber, Neoprene, Nitrile
Butanol	Natural Rubber, Neoprene, Nitrile	PVC	PVA
Butyl cellosolve (2-ethoxyethanol)	Neoprene, Nitrile	Natural Rubber	PVA, PVC
Butyl acetate	PVA	Nitrile	Natural Rubber, Neoprene, PVC
Cellosolve (2-ethoxyethanol)	Neoprene	Nitrile	Natural Rubber, Neoprene, PVC
Chloroform	PVA	None	Natural Rubber, Neoprene, Nitrile, PVC
Ethyl acetate	None	Natural Rubber, Neoprene, PVA	Nitrile, PVC
Ethylene glycol	Natural Rubber, Neoprene, Nitrile, PVC	None	PVA
Formaldehyde (>10%)	Nitrile	Natural Rubber, Neoprene, PVC	PVA
Hexane	Neoprene, Viton	PVA	Natural Rubber, PVC
Isoproponal	Natural Rubber, Nitrile, Viton	PVC	PVA
Methanol	Natural Rubber, Neoprene	PVC	PVA
Methylene chloride	None	PVA, Viton	Natural Rubber, Neoprene, PVC
Methyl ethyl ketone	None	Natural Rubber, PVA	Neoprene, Nitrile, PVC
Methyl isobutyl ketone	None	Natural Rubber, PVA	Neoprene, Nitrile, PVC
Mineral spirits	Nitrile, PVA	Neoprene	Natural Rubber, PVC
Nitric acid (70%)	Neoprene	PVC	Natural Rubber, Nitrile, PVA
Perchlorethylene	PVA, Viton	None	Natural Rubber, Neoprene, PVC
Sodium hydroxide	Natural Rubber, Neoprene, Nitrile	PVC	PVA
Sulfuric acid (95%)	PVC	Neoprene	Natural Rubber, Nitrile, PVA
Toluene	Viton	PVA	Natural Rubber, Neoprene, PVC
1,1,1-Tirchloroethane	PVA	None	Natural Rubber, Neoprene, PVC
Xylene	PVA, Viton	None	Natural Rubber, Neoprene, PVC

PVA polyvinyl alcohol
PVC polyvinyl chloride

APPENDIX H

INCOMPATIBLE CHEMICALS IN STORAGE AND REACTIONS

INCOMPATIBLE CHEMICALS—IN STORAGE AND REACTIONS

Acetic acid:	with chromic acid, nitric acid, ethylene glycol, perchloric acid, peroxides, and permanganates.
Acetone:	with concentrated sulfuric and nitric acid mixtures.
Acetylene:	with copper (tubing) fluorine, bromine, chlorine, iodine, silver, mercury, and their compounds.
Alkali metals:	such as calcium, potassium, and sodium with water, carbon dioxide, carbon tetrachloride, and other chlorinated hydrocarbons.
Ammonia, anhydrous:	with mercury, halogens, calcium hypochlorite, hydrogen fluoride.
Ammonium nitrate:	with acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, and finely divided organics or combustibles.
Aniline:	with nitric acid and hydrogen peroxide.
Bromine:	with ammonia, acetylene, butadiene, butane, hydrogen, sodium carbide, turpentine, and finely divided metals.
Carbon:	activated with calcium hypochlorate, all oxidizing agents.
Chlorates:	with ammonium salts, acids, metal powders, sulfur, finely divided organics, combustibles, or carbon.
Chromic acid:	with acetic acid, naphthalene, camphor, alcohol, glycerine, turpentine, and other flammable liquids.
Chlorine dioxide:	with ammonia, methane, phosphine, and hydrogen sulfide.
Chlorine:	with ammonia, acetylene, butadiene, benzine, and other petroleum fractions; hydrogen, sodium carbide, turpentine, and finely-divided powdered metals.
Copper:	with acetylene and hydrogen peroxide.
Cyanides:	with acids and alkalies.
Flammable liquids:	with ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, and halogens.
Hydrogen peroxide:	with copper, chromium, iron, most metals or their respective salts, flammable fluids and other combustible materials, aniline, and nitromethane.
Hydrogen sulfide:	with fuming nitric acid and oxidizing gases.
Hypochlorites:	with acids and activated carbon.
Iodine:	with acetylene, ammonia (aqueous or anhydrous), and hydrogen.

Mercury:	with acetylene, fulminic acid, and ammonia.
Nitrates:	with sulfuric acid.
Nitric acid:	with acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen (concentrated) sulfide, flammable liquids, flammable gases, copper, brass, and any heavy metals.
Nitrites:	with acids.
Nitroparaffins:	with inorganic bases and amines.
Oxalic acids:	with silver and mercury.
Oxygen:	with oils, grease, hydrogen, flammable liquids, solids, or gases.
Perchloric acid:	with acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, and oils.
Peroxides, organic:	with acids, (organic or mineral), avoid friction, store cold.
Phosphorous (white):	with air, oxygen, alkalis, and reducing agents.
Potassium:	with carbon tetrachloride, carbon dioxide, and water.
Potassium chlorate:	with sulfuric and other acids.
Potassium perchlorate (see also chlorates):	with sulfuric and other acids.

Potassium permanganate: with glycerol, ethylene glycol, benzaldehyde, and sulfuric acid.

Selenides:	with reducing agents.
Silver:	with acetylene, oxalic acid, tartaric acid, ammonium compounds, and fulminic acid.
Sodium:	with carbon tetrachloride, carbon dioxide, and water.
Sodium nitrite:	with ammonium nitrate and other ammonium salts.
Sodium peroxide:	with ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, and furfural.
Sulfides:	with acids.
Sulfuric acid:	with potassium chlorate, potassium perchlorate, and potassium permanganate (similar compounds of light metals, such as sodium, lithium).
Tellurides:	with reducing agents.

SAFE CHEMICAL STORAGE

1. ACIDS

- Store large bottles of acids on low shelves or in acid cabinets.
- Segregate oxidizing acids from organic acids, flammables, and combustible materials.
- Segregate acids from bases and active metals such as sodium, potassium, etc.
- Use a bottle carrier for transporting acid bottles.
- Have spill control pillows or acid neutralizers available in case of spill.

Strong Oxidizing Acids

Chromic acid	Iodic acid	Perchloric acid
Hydrobromic acid	Nitric acid	Sulfuric acid

Organic Acids

Acetic acid	Benzoic acid	Phenol	Trichloracetic acid

2. BASES

- Segregate bases from acids.
- Store solutions of inorganic hydroxides in polyethylene containers.
- Have spill control pillows or caustic neutralizers available for spills.

Ammonium hydroxide	Carbonates	Potassium hydroxide
Bicarbonates	Calcium hydroxide	Sodium hydroxide

3. FLAMMABLES

- Store in approved safety cans or cabinets.
- Segregate from oxidizing acids and oxidizers.
- Keep away from any source of ignition, flames, heat, or sparks.
- Know where firefighting equipment is stored and how to use.
- If volatile flammable liquids are stored in a refrigerator, they must be in an explosion-proof (lab-safe) refrigerator.

Flammable Solids

Benzoyl peroxide	Calcium carbide	Phosphorous, yellow	Picric acids

Flammable Gases

Acetylene	Ethane	Formaldehyde	Propane
Ammonia	Ethyl chloride	Hydrogen	Propylene
Butane	Ethylene	Hydrogen sulfide	
Carbon monoxide	Ethylene oxide	Methane	

4. OXIDIZERS

- Store in a cool, dry place.
- Keep away from flammable and combustible materials, such as paper or wood.
- Keep away from reducing agents such as zinc, alkaline metals, formic acid.

Oxidizers—Solids

Ammonium dichromate	Nitrates
Ammonium perchlorate	Periodic acid
Ammonium persulfate	Permanganic acid
Benzoyl peroxide	Peroxides, salts of
Bromates	Potassium dichromate
Calcium hypochlorite	Potassium ferricyanide
Chlorates	Potassium permanganate
Chromium trioxide	Potassium persulfate
Ferric trioxide	Sodium chlorite, hypochlorite
Ferric chloride	Sodium dichromate
Iodates	Sodium nitrate
Iodine	Sodium perborate

5. PYROPHORIC SUBSTANCES

These ignite spontaneously on contact with air. Store in cool, dry place.

Boron	Diborane	Manganese*
Cadmium	Dichloroborane	Nickel*
Calcium	2-Furaldehyde	Phosphorous, Yellow*
Chromium*	Iron*	Titanium*
Cobalt*	Lead*	Zinc*

* Finely divided metals form a pyrophoric hazard.

6. LIGHT SENSITIVE CHEMICALS

- Avoid exposure to light.
- Store in amber bottles in a cool, dry place.

Bromine	Oleic acid
Ethyl ether	Potassium ferricyanide
Ferric ammonium citrate	Silver salts
Hydrobromic acid	Sodium iodide
Mercuric salts	Mercurous nitrate

7. CARCINOGENS

- Label all containers as Cancer Suspect Agents.
- Store according to hazardous nature of chemicals (e.g., flammable, corrosive).
- When necessary, store securely.

Antimony compounds	Acrylonitrile
Arsenic compounds	Benzene
Benzidine	Chloroform
Beryllium	Dimethyl sulfate
Cadmium compounds	Dioxane
Chromates, salts of	Ethylene dibromide
Beta-Naphthylamine	Hydrazine
Vinyl chloride	Nickel carbonyl

APPENDIX I

COMMON REACTIVE LABORATORY CHEMICALS

COMMON REACTIVE LABORATORY CHEMICALS

PEROXIDE FORMERS

To determine age:

- ***Look for dates when received and opened***
- ***Look at expiration date***
- ***Look for visible crystal formation***

Examples Include:

- Isopropyl ether
- Ethyl ether
- Tetrahydrofuran
- Dioxane

SHOCK SENSITIVE

Look for:

- ***Contamination***
- ***Age***
- ***Metal capped containers***
- ***Dry compounds***
- ***Discoloration***

Examples Include:

- Dipicrylamine
- Picric acid (Trinitrophenol)
- Sodium azide
- Other polynitrated compounds

COMPOUNDS NOT LIKELY TO DEGRADE:

WATER REACTIVES

Examples Include:

- Sodium hydride
- Lithium metal
- Sodium metal
- Borohydrides

TEMPERATURE SENSITIVE

Examples Include:

- Azobis-compounds
- Organic peroxides (i.e., benzoyl peroxide)
- Cumene hydroperoxide
- Methyl ethyl ketone peroxide

AIR REACTIVE (PYROPHORICS)

Examples Include:

- Methyl lithium
- Phosphorous metal
- Metal dusts
- Butyl lithium

APPENDIX J

CHEMICAL STORAGE GUIDELINES

CHEMICAL STORAGE GUIDELINES

The following information is designed to aid in proper chemical storage in the Stevens laboratories. Chemicals are to be stored according to the following hazard classes. Storing all classes together alphabetically is prohibited. Chemicals may be organized alphabetically once they are segregated according to hazard class.

Oxidizers: Incompatible with **flammables** and organics.
Common Oxidizers—ammonium persulfate, silver nitrate, silver nitrite, hydrogen peroxide, potassium permanganate, sodium dichromate.

Toxic: Poisons
Common Toxics—arsenic compounds, cyanides, osmium tetroxide, formaldehyde, formalin, naphthalene, chloroform, acrylamide.

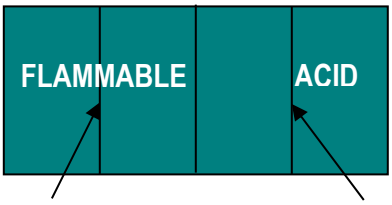
Flammables: Incompatible with **oxidizers**. Ignitable/flammable chemicals must be stored in a **flammable cabinet**. Flammable chemicals requiring refrigeration must be stored in a refrigerator rated for flammable storage.
Common Flammables—ethanol, methanol, acetone, benzene, ethyl acetate, butanol, alcohols, furans, toluene, Sigmacote, TEMED, paraformaldehyde (flammable solid)

Corrosive: Three kinds of Corrosives: **Bases, Organic Acids, and Inorganic Acids.** All 3 of these corrosives have this pictogram; however, must be separated from each other.
Common Bases—sodium hydroxide, potassium hydroxide, developer.
Common Organic Acids—acetic acid, glacial acetic acid, phenol, formic acid.
Common Inorganic Acids—hydrofluoric acid, sulfuric acid, hydrochloric acid, perchloric acid, nitric acid, chromic acid.

Irritants: chemicals producing irritation. Often, the majority of chemicals in a dry chemical storage area in Stevens laboratories. Common Irritants—sodium carbonate, sodium bicarbonate, trizma, putrescine, antifoam.

Chemical Storage Shelving Example

Chemical Fume Hood Cabinet



Flammable Storage

Corrosive Storage – Segregate inorganic acids, organic acids, and bases.

APPENDIX K

STANDARD OPERATING PROCEDURE TEMPLATE
A WRITABLE PDF IS AVAILABLE FROM EHS&IRM

Insert Title:

STANDARD OPERATING PROCEDURE (SOP)

All lab personnel who are subject to these SOP requirements must review the completed SOP and sign the associated training record. Completed SOPs must be kept in the Stevens Chemical Hygiene Plan or be otherwise readily accessible to the laboratory personnel (electronic access is acceptable).

SOP Date:			
SOP Prepared by:			
Department:			
Principal Investigator:	Print Name	Signature	Phone Contact :
Approval Date:			
Locations covered by SOP:			
Emergency Contacts			
Stevens Police	Phone: 201-216-3911		
Other (e.g., PI, etc.)			

Introduction:

REQUIRED: Insert a brief description of the laboratory process involving hazardous chemicals and any other hazards involved in the process. At a minimum, Safety Data Sheets (SDSs) for each chemical must be used as part of the chemical evaluation.

Determine if the hazardous chemicals can be eliminated or substituted for less hazardous chemicals. List nonchemical hazards, e.g., biological hazards, electrical hazards, mechanical hazards, radiation.

Use Procedures: Please list all steps of the experiment, and each safety related measure.

A. Hazardous Chemicals:

REQUIRED: List the chemicals being used and describe toxic or dangerous nature and signs/symptoms of exposure.

B. Engineering Controls:

REQUIRED: Insert descriptions of lab-specific engineering or ventilation controls used to reduce chemical exposures (e.g., fume hoods, glove boxes, biosafety cabinets, etc.) or other specific safety features.

C. Administrative controls:

The following elements are required at a minimum:
Complete the Stevens Laboratory Safety Training prior to working in the laboratory
Complete the Stevens SOP Training prior to developing the SOP
Be familiar with the location and content of applicable Safety Data Sheets (SDSs) for the chemicals being used
Do not deviate from the SOP instructions without prior approval from the PI Management of change. Recognize changes to process or procedure and asses the hazards related to these changes and ensure they are addressed.
Notify the PI of any accidents, incidents, near misses, or unexpected conditions Hazardous waste will be stored in appropriately labeled containers. The waste containers will be stored in secondary containment on the left wall near the front door.
REQUIRED: Insert descriptions of any additional administrative controls.

D. Personal Protective Equipment:

The purpose for personal protective equipment (PPE) is to shield the individual in the event of a release of vapor, a spill or other incident. PPE is not a substitute for safe work practices. At a minimum, covered legs, a lab coat and closed toe and heel shoes are required. The following PPE is required for all work with hazardous chemicals:

1. **Eye Protection:**
    a. Eye protection must be ANSI Z87.1 compliant
    b. At a minimum safety glasses are required
    c. Splash goggles may be substituted for safety glasses, and are required for processes where splashes are foreseeable or when generating aerosols
    d. Ordinary prescription glasses will not provide adequate protection unless they meet the ANSI Z87.1 standard and have compliant side shields

2. **Body Protection:**
    At a minimum a chemically compatible laboratory coat that fully extends to the wrist is necessary
    a. If a risk of fire exists, a flame-resistant laboratory coat should be worn. Complete the Stevens EHS lab coat hazard assessment to determine the type of coat required
    b. For chemicals that are corrosive and/or toxic by skin contact/absorption additional protective clothing (e.g., face shield, chemical resistant apron, etc.) are required where splashes or skin contact is foreseeable

3. **Hand Protection**:
    Hand protection is needed for the activities described in this SOP. Define the type of glove to be used based on the following:
    a. Chemical(s) being used
    b. Anticipated chemical contact (e.g., incidental, immersion, etc.)
    c. Manufacturer's permeation/compatibility data
    d. Whether a combination of different gloves is needed for any specific procedural step or task

REQUIRED: Describe PPE required for each step in the process, including any specialized PPE required.

Emergency Response Procedures:

Skin Exposure:

- Move the victim immediately under an emergency shower or other water source and flush the affected area with large amounts of cool running water for at least 15 minutes.
- Clothing, shoes and jewelry should be removed while the water is flowing on to the victim.
- Goggles should be removed last while the victim is facing the water flow. Colleagues must be EXTREMELY CAREFUL not to become contaminated while assisting the victim.
- While the victim is being rinsed with water, **call 3911** and inform Campus Police of the exposure and request emergency transport. Ensure emergency responders and treating physicians are aware of the nature of the chemical exposure. Provide a copy of the **SDS to emergency responders**.
- After the emergency responders arrive they will call the Emergency Room doctor for instructions.

Eye Exposure:

- Immediately flush eyes for at least 15 minutes with copious cool flowing water. Call 3911, inform Campus Police of the exposure and request emergency transport. The victim should then be transported to a medical facility.
- Ensure emergency responders and treating physicians are aware of the nature of the chemical exposure. Provide a copy of the SDS to emergency responders.

Inhalation:

If a large volume of vapor is inhaled:

- Immediately remove the victim to clean air. Call 3911, inform the emergency dispatcher of the exposure and request emergency transport.
- Ensure emergency responders and treating physicians are aware of the nature of the chemical exposure. Provide a copy of the SDS to emergency responders.

Important Locations:

Emergency Shower and eyewash station

- Document Location of Eyewash and Safety Shower

PPE Location

Hazardous Waste Disposal

- Document location of hazardous waste containers.
- Document Location of PPE

Documentation of Standard Operating Procedure Training (*signature of all users required*)

- Prior to beginning work on this SOP, laboratory personnel must be trained on the hazards involved in working with this SOP. How to protect themselves from the hazards, and emergency procedures
- Ready access to this SOP and to a Safety Data Sheet for each hazardous material described in the SOP must be made available
- The PI must ensure that their lab personnel have attended the required training
- **Please attach and include all supporting documentation when submitting the SOP to EHS &IRM. This includes SDSs, Protocols, and literature if available.**
- Training must be repeated following any revision to the content of this SOP. Training must be documented.

Designated Trainer: _____ (Print Name) Signature

I have read and acknowledge the contents, requirements, and responsibilities outlined in this SOP:

Name	Signature	Trainer	Date