NEW YORK CITY COLLEGE OF TECHNOLOGY

The City University of New York

300 Jay Street, Brooklyn, NY 11201-1909

Chemical Hygiene Plan

2011

Table of Contents

I. Chemical Hygiene Responsibilities

The President has the ultimate responsibility for chemical hygiene within the institution and provides, along with other officers and administrators, continuing support for efforts to improve chemical laboratory safety and health.

The VP Finance & Administration supervises the Environmental Health & Safety Officer (EHSO) and authorizes him to oversee and take the necessary steps to carry out the objectives of the Chemical Hygiene Plan. In the absence of a filled CHO position, he currently administers the Chemical Hygiene Officer responsibilities and is reachable at (718) 260-5858.

The Chemical Hygiene Officer coordinates all laboratory health and safety activities. The Chemical Hygiene Officer has the authority to shut down or suspend operations that do not conform to health and safety practices required by this Chemical Hygiene Plan. The Chemical Hygiene Officer will exercise his authority in order to minimize the short and long-term dangers to laboratory employees, other workers, the community, and to the environment.

The major duties of the Chemical Hygiene Officer are to:

- Serve as chairperson of the Chemical Hygiene Committee and work with that committee to evaluate, implement, and update the Chemical Hygiene Plan
- Provide technical expertise and administrative support to the laboratory community in the area of laboratory safety and health, and direct inquiries to appropriate resources.
- Ensure that extremely hazardous substances are appropriately labeled, handled, and stored and that specific standard operating procedures that instruct all personnel in the safe use of these substances
- Review specific operating procedures developed by principal investigators and department personnel for the use, disposal, spill cleanup, and decontamination of extremely hazardous chemicals and substances are developed and followed
- Review new research protocols prior to their initiation to determine if hazardous chemicals are used and, if so, to ensure proper measures are taken to protect laboratory personnel
- Conduct quarterly inspections of laboratories and storage areas with other members of the Chemical Hygiene Committee and provide inspection forms to departmental personnel and principal investigators to conduct their own routine inspections
- Write inspection reports and recommend follow-up activities (with input from other members of the inspection team)
- Coordinate the operation, acquisition, and maintenance of fume hoods, emergency safety showers, eyewashes, and fire extinguishers in all laboratories where chemicals are handled

- Conduct (or coordinate) department-specific laboratory employee health and safety orientation sessions along with other department personnel and assist laboratory supervisors in developing and conducting hands-on sessions with employees
- Investigate all reports of laboratory hazards incidents, chemical spills, and near-misses to prevent repeat occurrences
- Act as a liaison between the laboratory and the departmental administrator and, if necessary, bring unresolved and potentially serious health and safety problems to the administrator's attention
- Maintain records and make them available to employees and administrative personnel
- Select a qualified and licensed waste disposal vendor to routinely pickup chemical waste materials. The Chemical Hygiene Officer will also coordinate hazardous waste pickup with facility representatives
- Remain aware of campus-wide safety-and health-related activities

Chemical Hygiene Committee

The Chemical Hygiene Committee oversees and monitors the effectiveness of the Chemical Hygiene Plan and revises and updates it annually. The committee should consist of representatives from all science departments in which laboratory work involves the use of chemicals or other potentially hazardous substances (e.g., chemistry, biology, engineering, physics, etc.), from the Public Safety Department as well as Buildings and Grounds (plant maintenance). Each union representing employees at this institution should be represented either by a department designee or by a specific union seat on the committee. This committee will function in an advisory role whose authority will not conflict with or supersede current institutional policies. Committee members are chosen in the following manner:

1. Appointed by the chairperson
2. Based on qualification
3. They work with hazardous materials
4. They have critical skills need for the TEAM

The committee meets every other month. Members take minutes on a rotating basis. These minutes are maintained as an official record of chemical hygiene activities and are available for public inspection. The following people are currently members of the Chemical Hygiene committee:

Name	Position	Department/Division	Telephone
Derek Lee	EHS Officer (EHSO)	Administration & Finance	(718) 260-5858
Dr. Peter Spellane	Chairperson	Chemistry Department	(718) 260-5862
Dr. Olufemi Sodeinde	Safety Committee Chairperson	Biology Department	(718) 254-4907

The duties of the Chemical Hygiene Committee members are to:

- Attend committee meetings
- Review periodically and update the Chemical Hygiene Plan
- Review academic research protocols and ensure that appropriate controls and laboratory space are available to protect employees
- Participate in biannual inspections of laboratories with the Chemical Hygiene Officer and follow-up visits to laboratories not meeting initial compliance
- Stay informed of plans for renovation or new laboratory construction projects at the institution and ensure involvement of appropriate laboratory personnel in its planning stages
- Bring unresolved departmental issues to the attention of the committee

Department Chairs

The department chairperson is ultimately responsible for chemical hygiene in his/her department and must know and understand the goals of the Chemical Hygiene Program. The duties of the chairperson are to ensure the:

- Completion of an annual computerized inventory of all chemicals in storage rooms and laboratories in their department
- Routine identification of expired and unusable chemical stored for disposal.
- Maintenance of Material Safety Data Sheets (MSDSs) for chemicals used in laboratories in their department
- Training of all laboratory employees and other departmental personnel who may come into contact with hazardous chemicals

- Routine inspections of Departmental laboratories and record-keeping maintenance of a file of completed inspection forms
- Development of checklists for needed safety equipment in the Department laboratories, and to ensure prompt acquisition of that equipment

Principal Investigators and Laboratory Supervisors

Principal investigators, faculty, and other laboratory supervisors have ultimate responsibility for chemical hygiene in the research or teaching laboratories in which they work. It is their duty to:

- Know and implement the guidelines and procedures of the Chemical Hygiene Plan
- Write specific operating procedures for handling and disposing of extremely hazardous substances used in their laboratories and submit these procedures to the Chemical Hygiene Officer for review. (These policies do not have to be written for minimal-risk chemicals and derivatives)
- Train laboratory personnel in these operating procedures and ensure the use of proper control measures
- Conduct routine inspections of laboratories with their laboratory employees
- Ensure that all appropriate controls including fume hoods and safety equipment are available and in good working order in their laboratories
- Ensure that all incidents occurring in their laboratories are reported to the Chemical Hygiene Officer and that a written Incident Report is filed with the CHO and Public Safety
- Complete regular inventories of chemicals in their laboratories and provide them to the designated departmental representatives
- Supervise the maintenance of Material Safety Data Sheets and ensure laboratory employee access to MSDSs
- Include provisions for Chemical Hygiene Plan compliance in grant proposals

Laboratory Employees, Users, and Volunteers

Laboratory employees are those who, in the course of their work, are present in the laboratory or are at risk of possible exposure on a regular or periodic basis. These include laboratory technicians, instructors, researchers, secretaries, graduate assistants, student aides, part time and temporary employees. All employees, users, and volunteers must:

- Follow procedures and guidelines outlined in the Chemical Hygiene Plan

- Report any unsafe working conditions, faulty fume hoods, or emergency safety equipment to the laboratory supervisor and Chemical Hygiene Officer
- File incident reports with the administration or departmental Chemical Hygiene Committee person hazards
- Conduct hazard evaluations for procedures conducted in the laboratory and maintain a file of those hazards

II. Chemical Inventorying, Procurement, and Receiving

This section of the Chemical Hygiene Plan describes standard operating procedures for the procurement, receipt, and inventory of chemicals. An important program goal is to establish a centralized chemical stockroom in each department from which chemicals are procured, received, inventoried, and distributed to individual laboratories. Centralizing these activities:

- Allows better monitoring of chemicals stored and used and their location within the facility
- Reduces the waste involved in duplicate purchases
- Reduces waste disposal costs
- Facilitates compliance with regulations

A. Chemical Inventorying

1. Each department should develop a department-wide computerized inventory for all chemicals purchased, transferred, and disposed. The Chemical Hygiene Officer will coordinate collection of inventories from individual laboratories until the goal of centralizing chemical procurement in each department is achieved.

   Variables or field names on a computerized chemical inventory database for newly purchased chemicals must include at least the following:

   - Name and Chemical Abstract Service (CAS) registry number of the chemical
   - Chemical supplier's name and address
   - Department and course name requesting the chemical(s) (e.g., P&B Science/Organic Chemistry CH 213)
   - Whether for instructional or research use
   - Name of principal investigator (if applicable)

- Amount of chemical purchased
- Date purchased
- Date received
- Expiration date
- Quantity received
- Unit (each, liter, g, drum)
- Amount per unit (20 L/drum; 55 gal/drum)
- Destination/location (building name or address, room number where chemical is stored and/or used)
- Hazard warning code [e.g., acute health hazard (highly toxic, irritant, corrosive, sensitizer), delayed health hazard (carcinogens), fire hazard (flammable, combustible, air-reactive, oxidizer), pressure hazard (explosive, compressed gas), reactive (unstable reactive, organic peroxide, water-reactive]
- Ability to monitor the quantity used and remaining

All personnel involved in inventory must:

- have been trained in laboratory safety and health within the year
- must be provided with the proper personal protective equipment
- must have access to safety showers and eyewash stations and
- must know what to do in the event of an emergency involving the chemicals being inventoried

In addition, spill control equipment and fire extinguishers must be checked before the inventory is taken, to ensure that the appropriate type is available.

While taking the inventory, minimize the picking up and moving of bottles and never move potentially explosive materials. The arranging and segregating of chemicals can be accomplished at another time.

2. The departmental chemical inventory must be updated on an annual basis to ensure that it reflects what is currently used and stored in laboratory facilities.
3. Each department chairperson must ensure that chemical inventories are provided on an annual basis to the Chemical Hygiene Officer. This inventory will be used to fulfill reporting requirements of the EPA's Superfund Amendment and Reauthorization Act (SARA) of 1986.
4. Chemicals in storage areas must be evaluated for deterioration, container integrity, and their age at least once each year. Chemicals whose storage limits have expired must be marked for

5. No potentially explosive chemical whose shelf life has expired may be handled or moved by any laboratory employee taking inventory until the Chemical Hygiene Officer is contacted. It is better to be overcautious under these circumstances.

B. Chemical Purchasing and Procurement

When purchasing chemical supplies for laboratories, the following requirements will be fulfilled:

- A copy of all chemical purchase order requests must be sent to the Chemical Hygiene Officer at N308 for review.
- Effort must be made to purchase lesser quantities of chemicals (for example, amounts that will be used up in 3 to 6 months). Never acquire more than a year's supply.
- Efforts must be made to purchase chemicals in small-sized containers. When large containers are purchased, significant portions may remain unused and require disposal. The cost of additional storage and disposal of old, unused materials outweigh the lesser unit cost for bulk purchases.
- Check chemical purchases against the chemical inventory to reduce duplicate purchases and stock build-up. Contact other departments and colleges to inquire about excess chemicals they may have available.
- Before an extremely hazardous substance is ordered, such as carcinogens, reproductive hazards, and acutely toxic substances, consideration must be given to the adequacy of facilities and equipment to safely handle its type and quantity. Consideration must also be given to whether a less hazardous material may be substituted.
- All purchase orders must include a request that Material Safety Data Sheets be sent to the Environmental Health & Safety Office in N308. Each department must determine how best to distribute Material Safety Data Sheets so those employees will have access to them during working hours.

C. Chemical Receiving

1. All incoming shipments must be inspected by those receiving them. Containers should be refused and returned if they do not meet the following requirements:
    - MSDSs must accompany incoming shipments or under separate cover
    - Proper labels must be attached (see Chapter IV)
    - Containers must be intact and in good condition

Any leaking containers must immediately be placed in an appropriate secondary container and treated as a chemical spill. See Chapter VIII on emergencies for more detailed information about chemical spill response.

2. Expiration dates must be determined and assigned to each chemical container coming into the facility that contains any of the following:

   - Picrics
   - Perchlorates
   - Peroxides and Peroxidizable materials
   - Other materials known to deteriorate or become unstable or reactive over time

   Chemicals should arrive with dates assigned. If there is no date, under no circumstances should the expiration date be later than one year after the date of acquisition. Chemical containers must also be labeled with the dates on which they are first opened so they can be used up before new containers are opened. (See Chapter IV on storing chemicals and Chapter VI on handling specific classes of chemicals for more information about unstable and reactive chemicals.)

3. All areas where shipments of chemicals are received (receiving platform, storerooms, will have appropriate personal protective equipment and spill-control materials available in case of a leaking or punctured container. In addition, each chemical receiving area should have an appropriate fire extinguisher located no more than 50 feet from any point within the area and a safety shower and eyewash station, in case of chemical splashes or spills on the body.

4. All individuals involved in procuring and receiving chemicals must be included in the laboratory employee training programs discussed in Chapter X.

III. Hazard Communication Signs, Labels, and Material Safety Data Sheets

A. Signs

All laboratory employees must be alerted to hazards that exist in an area they enter. The employer must post a sign at the location where notices are normally posted to inform employees that they have the right to information from their employer regarding the toxic substances found in the workplace. In addition, during emergencies, the location of information and emergency equipment must be clearly marked. The following is a list of some of the most important signs that must be posted.

1. Laboratory: Potentially Hazardous Substances

A sign with the above words in red on a white background must be posted on the door, outside of each laboratory at the midpoint of the height of the door. It must be made of plastic or other durable material and posted at eye level. The height of the letters in the

word "Laboratory" must be at least 1 1/2 inches high. The words "potentially hazardous substances" must be at least 7/16 inches high.

2. Emergency Equipment and Exit Identification

Signs indicating the location of each safety shower, eyewash station, fire extinguisher, and exit must be posted and must be large and conspicuous.

3. Emergency Telephone Numbers

Telephone numbers of emergency personnel Ext. 5550, B&G facilities Ext. 5337, supervisors, and the Chemical Hygiene Officer Ext. 5858 must be posted next to the phone in each laboratory, storeroom/ stockroom, and storage area. If there is no phone in the room, a sign should be posted indicating the location of the nearest phone (which should have posted next to it all the pertinent telephone numbers).

4. No Smoking

These should be posted at the entrance to storage areas and laboratories as well as on the inside of these spaces.

5. Special Hazards

All laboratories in which the following materials are used must post signs outside the laboratory and/or storage area indicating the presence of these hazards:

- Water-reactive chemicals
- Carcinogens
- Flammable gases or explosives
- Reproductive Hazards
- Toxic gases (e.g. cyanide, hydrogen sulfide)
- Radioactive materials
- Biohazardous materials
- Lasers

The letters on these signs must be at least 2 inches high by 3/8 of an inch wide.

6. Flammable Storage Cabinets and Refrigerators

These must be labeled according to local fire regulations. "Store no flammables flashing below 100°F" to be posted on all nonexplosion-proof refrigerators and walk-in cold rooms. Check with the Chemical Hygiene Officer about how to properly label storage cabinets and refrigerators.

The Chemical Hygiene Officer will be responsible for ensuring that all laboratory and storage areas follow this standard operating procedure to post signs.

B. Labels

All chemical manufacturers are required under the Federal OSHA Hazard Communication Standard to provide distributors and consumers with properly labeled containers. Labels must include the following information:

- The common name of the chemical
- Name, address, and emergency telephone number of company responsible for the product
- A hazard warning indicating the most serious health or safety hazard the chemical poses (e.g., corrosive, carcinogen, water-reactive, flammable)

The OSHA Laboratory Standard requires that labels on all incoming containers be maintained and not defaced. Never deface or remove a label from a container. Portable containers used by more than one person must be labeled with the information described above. This information can be found on the original label or on the Material Safety Data Sheet for the product.

1. Inspection of Container Labeling

Adequacy of container labeling will also be assessed during routine inventorying of chemicals and inspections of laboratories and storage areas by the Chemical Hygiene Committee and departmental laboratory employees (see Chapter IX). Unlabeled containers, if unidentifiable, will be disposed of according to the New York State Department of Environmental Conservation regulations (see Chapter V) and this institution's hazardous waste disposal policy, in the Waste Management (see Chapter V) of this plan and the NYCCT Hazardous Waste Plan.

2. Reporting of Improperly Labeled or Non-intact Containers

All employees involved in unpacking chemicals are responsible for inspecting each container to ensure that it arrives properly labeled. When there is a problem with an incoming product label, Mr. Samuel Santiago should be contacted. All employees should reject shipment of improperly labeled products. Any laboratory employee finding containers without the minimum required information, unlabeled containers, or labels that are torn or illegible must report it immediately to Mr. Samuel Santiago.

3. Newly Synthesized Chemicals

Principal investigators in research laboratories will be responsible for ensuring that newly synthesized chemicals are used exclusively within the laboratory and are properly labeled. If the hazards of a substance produced in the laboratory are unknown, it must be assumed to be hazardous, and the label must indicate that the potential hazards of that substance have not been tested and are unknown. The principal investigator should

develop a preliminary Material Safety Data Sheet at the earliest opportunity, and add to it, as properties of the chemicals become known. See Chapter VI for the special precautions that should be taken when handling these substances.

C. Material Safety Data Sheets

1. OSHA Laboratory Standard Requirements

The OSHA Laboratory Standard and the New York State Right to Know Law (for public sector laboratories only) require that Material Safety Data Sheets (MSDSs) be collected and maintained for virtually all chemicals used and stored in the laboratory area. As with labels, the Hazard Communication Standard mandates that chemical manufacturers provide Material Safety Data Sheets for each chemical. MSDSs provide basic information about the safety and health hazards posed by a chemical and precautions to take when using it.

2. Collection and Distribution of MSDSs

Material Safety Data Sheets must be collected and distributed in each science department to ensure that all employees may have access to them. Following is a description of the system used to collect and distribute these sheets.

MSDS received will be placed on a web-based Environmental Management System, copied and distributed as follows:

- One copy to the EHS Office
- One copy to the Chemical Hygiene Officer
- One copy to the Public Safety Office
- One copy to the user of the chemical

Other hazard information resources that must also be made available to employees are discussed further in Chapter X, Laboratory Employee Training and Information.

IV. Chemical Storage

Chemical storage areas in the academic laboratory setting include central stockrooms, storerooms, preprooms, laboratory work areas, storage cabinets, refrigerators and freezers. There are established legal requirements as well as recommended practices for storing chemicals. These requirements and guidelines are summarized below. They fall into the following areas:

- General requirements
- Segregation of incompatible chemicals
- Specifications for chemical storerooms
- Chemical storage in laboratories (outside of chemical storerooms)
- Additional storage requirements and recommendations for some specific hazard chemical classes

A. General Requirements

1. Every chemical must have an identifiable storage place and must be returned to that location after use.
2. A storage scheme must be developed in each chemical storage area to ensure the segregation of incompatibles. An effort must be made to isolate particularly flammable, reactive, and toxic materials. A storage scheme based solely on alphabet is prohibited.
3. The storage of working containers on bench tops will be minimized in order to prevent the accidental spilling of chemicals and to reduce the risk of fire.
4. Compatible chemicals should be grouped by container size to make it easier to retrieve chemicals and to reduce the possibility of bottle breakage. Large containers should be stored on lower shelves. Chemicals must not be stored on the floor.
5. Chemical storage in hoods should be kept to a minimum. Storing containers inside the hood interferes with airflow, reduces the workspace, and increases the risk of a spill, fire, or explosion. Where possible chemicals will be stored in cabinets that vent directly into the fume hood.
6. Labels must be maintained on all stored materials. New labels must be created for secondary containers used for transport.
7. Stored chemicals should be in amber bottles and must not be exposed to direct sunlight or heat.
8. Storage trays should be used to minimize the spread of a spill.
9. Laboratory refrigerators must never be used to store food.
10. All chemical containers left out of storage areas must be checked at the end of each workday. Unneeded items must be returned to chemical storerooms or stockrooms.
11. Dates must be assigned to all chemical containers in the following groups when they are initially opened by the first laboratory employee using them:
    - Picrics
    - Perchlorates

- Peroxides
- Peroxidizable materials (aldehydes, ethers, and compounds containing benzylic hydrogen atoms, e.g., cumene isopropyl benzene and most alkene, vinyl, and vinylidene compounds)
- Polymerizers that react violently in polymerization or become hazardous after polymerization
- Other materials known to deteriorate or become unstable or reactive over time

Expiration dates must be assigned[1] to these chemicals. When provided, the manufacturers' expiration date should be displayed.

Peroxidizable materials must be tested routinely for peroxides[2]. (See the table "Common Peroxide-Forming Chemicals' in Appendix D for a more complete list of these chemicals and testing instructions.)

12. All laboratory personnel, upon notice of retirement, termination, transfer, or graduation, must in conjunction with the laboratory supervisor and Chemical Hygiene Officer, arrange for the removal or safe storage of all hazardous materials remaining in their laboratory.
13. Appropriate spill-control, cleanup, and emergency equipment must be available wherever chemicals are stored. See Chapter VIII for considerations in choosing these materials.

B. Segregation of Incompatible Chemicals

Chemicals must not be arranged alphabetically or haphazardly in stockrooms or in laboratory work areas. It is acceptable to store powdered chemicals alphabetically if a hazard class system is used (e.g. corrosive, flammable, oxidizers, poisons, reproductive hazard. See the CHRIS compatibility system). Chemicals must be segregated to prevent mixing of incompatible chemical vapors or liquids in the event that containers break or leak.

Numerous approaches can be taken to segregate chemicals in storage. Different approaches may be required depending on the type and amount of space available for storage and the environmental conditions of the spaces. Major considerations for criteria to segregate should include water compatibility and flammability.

---

[1] Cross ref with Peroxide testing by Pepitone

[2] Cross ref with Peroxide testing by Pepitone

One chemical/biological storage room under the supervision of a qualified person is essential for each school. The storage room should have adequate security. Safety facilities must include the following:

- Fire extinguishers of the approved type, including sand and soda positioned near an escape route
- Spill-control and cleanup materials
- Master control shutoff valves for gas, water, and electricity
- Approved eye/face wash
- Shower
- Smoke detector
- Forced ventilation from floor to ceiling with exhaust above roof level
- Lip-edged shelving secured to wall with top shelf below eye level
- Safety cabinets for specific groups of compatible substances
- A communication system to the main office or emergency center

Be sure to follow local fire codes when storing flammable chemicals in separate cabinets.

Storage suggestions:

1. Avoid floor chemical storage (even temporarily)
2. No top shelf chemical storage
3. No chemicals stored above eye level
4. Shelf assemblies are to be firmly secured to walls. Avoid island shelf assemblies
5. Provide antiroll lips on all shelves
6. Ideally, shelving assemblies would be of wood construction
7. Avoid metal, adjustable shelf supports, and clips; fixed shelves and wooden supports are better suited
8. Store acids in a dedicated acid cabinet.
    - store nitric acid in that same cabinet only if isolated from other acids
    - store both inorganic and some organic acids in the acid cabinet
9. Store flammables in a dedicated flammables cabinet

10. Store severe poisons in a dedicated poisons cabinet

Special attention must be paid to the following chemicals due to their potential instability.

Inorganic	Organic
♦ Nitrates, nitrites, and azides	♦ Ether
♦ Perchlorates	♦ Azides
♦ Perchloric acid	
♦ Peroxides	
♦ Phosphorous	
♦ Phosphorous pentoxide	

Numerous texts listed in Appendix A can be referred to assist in determining the best arrangement. One straightforward solution is described in Chapter 4: 'Incompatible Chemicals in the Storeroom: Identification and segregation," from *Safe Storage of Laboratory*, by Pipitone.

Particular attention must be paid to isolating flammables, air-reactives, peroxidizables, and toxic chemicals. Storage of specific hazard classes of chemicals is discussed in more detail below.

C. Specifications for Chemical Stockrooms

Stockrooms are areas in facilities in which relatively large quantities of chemicals are stored for laboratory use.

1. General Specifications for All Stockrooms

a) Stockroom access must be strictly limited to specified personnel. All laboratories, preparation rooms, and storeroom/stockrooms must be locked and secured when designated laboratory employees are not present.

b) A mechanical exhaust ventilation system must be in place and must provide at least 6 air changes per hour. Additional local exhaust may be required if activities such as dispensing take place in the storage area.

c) Each storage area must have at least one large sink, safety shower, eyewash station, and must have an appropriate fire extinguisher with adequate extinguishing capacity.

d) Each chemical storage area must have a master control shutoff valve for water, electricity, and gas.

e) Shelving must be secure and well braced. The weight limit provided by the manufacturer of the shelving unit must not be exceeded. Other characteristics should include:

- Anti-roll lips on all shelves to prevent containers from falling off shelves
- Wood shelving should be treated to inhibit mold and repel insects. Metal shelves should be corrosion-resistant.
- Aisles between standing shelving of at least 3 feet in width

f) Exits: All chemical storerooms and stockrooms must have clearly marked, unobstructed exits. Each area must have two exits that are not immediately adjacent to one another

g) Chemical stockrooms must be well illuminated so labels can be easily read.

h) No aisle is permitted to dead end. Aisles must be kept clear of clutter.

i) The environment in stockrooms must be controlled to avoid extremes of temperature and high humidity. Open flames, smoking, humidifiers, and localized heating units such as hot plates and coffee makers are not permitted.

j) Floors must be kept clean and dry.

k) Wherever toxic chemicals are stored and could be released self-contained escape respirators or self-contained breathing apparatus must be made available (see Chapter VIII for standard operating procedures related to respirators).

2. Flammable Materials Stockrooms

Flammable materials not currently in use should be isolated in stockrooms in such a way as to minimize the potential harm to persons and property in the event of a fire. Storage facilities for flammables must meet the following specifications:

- The walls, ceilings, and floors of inside storage rooms for flammable materials must be constructed of materials having at least a 2-hour fire resistance.
- All doors between the room and the building must be self-closing Class B fire doors.
- Adequate mechanical ventilation must be provided and controlled from a switch outside the stockroom door. Ventilation should be at floor level since all flammable vapors are heavier than air and tend to sink.
- In areas where Class I flammable liquids are stored or dispensed electrical power, lights, switches, and sockets must be explosion-proof.
- Fan motors and ventilation equipment motors must be nonsparking.
- All smoking and lighting of matches are prohibited.

- An inside storage room meeting all the above specifications and not exceeding 150 square feet in floor area is permitted to contain no more than 2 gallons of flammables per square foot of floor area. Five gallons per square foot are allowed if in addition, the room has an automatic sprinkler system.

D. Chemical Storage Outside of the Chemical Stockroom

The nature of laboratory work calls for a certain amount of chemicals to be on hand for easy access. However, all laboratory employees must limit, as much as possible the amounts of chemicals stored on bench tops, in hoods, under sinks or other exposed areas, especially when these chemicals are flammable, combustible, reactive, toxic, or corrosive.

1. Legal Limits on Amounts of Flammables, Combustibles, Reactives, and Unstable Chemicals in Laboratories

Local fire regulations (such as those in New York City) determine the amount of flammable materials or oxidizing, unstable, and reactive chemicals that may be stored in laboratories based on the fire rating of the room and whether it has a sprinkler system. The following table shows an example of local fire department limits in New York City.

LAB TYPE	FIRE RATING	FIRE PROTECTION	FLAMMABLE LIQUIDS & VFOs	FLAMMABLE SOLIDS	OXIDIZING MATERIALS	UNSTABLE REACTIVE
I	2 HRS	SPRINKLERS	30 GALS	15 LBS	50 LBS	12 LBS
II	1 HR	SPRINKLERS	25 GALS	10 LBS	40 LBS	6 LBS
III	2 HRS	NO SPRINKLERS	20 GALS	6 LBS	30 LBS	3 LBS
IV	1 HR	NO SPRINKLERS	15 GALS	3 LBS	20 LBS	2 LBS

**Except for chemical research laboratories, no permit shall be required for laboratories storing or using less than 32 ounces, flammable liquids or VFOS. 0.5 pound oxidizing materials and/or 0. 15 cubic feet water container capacity of flammable gases.

For example, a laboratory unit with a fire rating of 1 hour that has no sprinkler system must not store more than

- 15 gallons of flammable liquids;
- 3 pounds of flammable solids;

- 20 pounds of oxidizing materials; and
- 2 pounds of unstable or reactive chemicals.

The National Fire Protection Association's (NFPA) Code 45 (Fire Protection for Laboratories Using Chemicals [see bibliography]) goes further in describing maximum permissible quantities of flammable and combustible materials outside of approved liquid storage rooms. They recommend limits per lab unit as well as per 100 square feet of laboratory unit in sprinklered and unsprinklered units. Instructional laboratories specifically are allowed only half of the quantity of noninstructional laboratories.

For example, the maximum quantity of Class I flammables in unsprinklered instructional laboratories including quantities in storage cabinets and safety cans (see below) is 10 gallons per 100 square feet of laboratory unit. Research labs would be allowed 20 gallons including quantities in storage cabinets and safety cans.

Laboratory Supervisors should inventory chemicals in laboratories monthly to ensure that the above-described limits are not exceeded. Any problems must be directed to the departmental chairperson, the college EHS Officer, the Chemical Hygiene Officer, or other designated individual.

2. Flammable Liquids Storage Cabinets

When substantial amounts of flammable liquids are stored on open shelves or work benches it is possible for a small spill to quickly escalate. It is essential that flammable chemicals be isolated from combustibles and kept away from ignition sources. Store flammable materials in storage cabinets that meet OSHA and National Fire Protection Association specifications. These require that burning cabinet contents be protected from temperatures exceeding 325°F for at least 10 minutes, enough time for personnel to evacuate the area.

Commercial flammable storage cabinets are available to store 30, 45, and 60 gallons of flammable materials.

Cabinets are available with workbench surfaces and as fume hood bases where the cabinet is vented through the fume hood itself.

Vented cabinets that do not vent through a fume hood require steel venting ducts. The cabinets must never be vented where the vapors could escape into other rooms of the facility. Designing and installing the proper venting equipment requires technical assistance. **NEVER INSTALL OR REROUTE DUCT WORK WITHOUT CONTACTING THE CHEMICAL HYGIENE OFFICER**

NO MORE THAN 60 GALLONS OF FLAMMABLES AND 120 GALLONS OF COMBUSTIBLES MAY EVER BE STORED IN THESE CABINETS

Cabinets must meet the following specifications:

- The bottom, top, and sides must be of least 18-gauge metal iron and double-walled with a 1 1/2-inch air space.
- Joint must be riveted, welded, or made tight by equally effective alternative means.
- The cabinet door should have a 3-point lock.
- The door sill should be raised at least 2 inches above the bottom of the cabinet
- Cabinets must be conspicuously labeled "Flammable-Keep Fire Away"

E. Storage Requirements for Specific Hazard Classes of Chemicals

1. Flammables and Combustibles

i) Maximum Container Sizes

OSHA and NFPA limit the size of the container for classes of flammable and combustible materials. The more fire-resistant a container, the larger it may be.

ii) Safety Cans for Flammables

Portable and approved safety cans should be used when possible for storing flammable liquids. At the very least, flammable liquids in quantities greater than 1 liter (1.2 quarts) should be stored in metal containers. Safety cans are available in a variety of sizes and materials and are designed to prevent explosions in the event of a fire through a spring-loaded spout cover that opens to relieve internal pressure when subjected to a fire. These cans will not leak if tipped over. Some also have flame arresters in the spout to prevent flame propagation into the cans. Flammable liquids purchased in large containers should be repacked into smaller safety cans for distribution to laboratories.

iii) Flammable and Other Compressed Gases

- The names of compressed gases must be prominently posted.
- Storage of flammable gases in laboratories is not permitted, except when being used. At no point shall more than twice the experiment's requirements be present in the laboratory.
- Flammable gas cylinders should be stored in a separate area from other compressed gases.
- Cylinders of incompatible gases must be segregated by distance. Cylinders must be grouped by the type of gas (e.g. toxic, corrosive, etc.).

- Empty cylinders should be separated from nonempty cylinders and labeled "empty or MT."
- All compressed gases must be stored away from direct or localized heat (including radiators. steam pipes, or boilers) in well-ventilated and dry areas and away from areas where heavy items may strike them (e.g. near elevators or service corridors).
- All compressed gases, including empty cylinders, must be secured in an upright position with chains, straps or special stands and must be capped when stored or moved.
- A hand truck must be available for transporting gas cylinders to and from storage areas.

2. Oxidizers

i) Definition

Oxidizers are any solid or liquid that readily yields oxygen or other oxidizing gas or that readily reacts to oxidize combustible materials. Strong oxidizers can present fire and explosion hazards on contact with organic compounds or other oxidizable materials. Some examples are:

- Hydrogen peroxide (> 80%)
- Calcium hypochlorite
- Magnesium perchlorate
- Chromic acid
- Nitric acid
- Sodium peroxide
- Perchloric acid
- Ammonium dichromate
- Silver nitrate
- Sodium chlorate

ii) Storage considerations:

Oxidizers must be stored away from incompatible materials such as:

- Flammables and combustible materials

- Paper trash bins
- Organic liquids
- Greases
- Finely divided metals
- Other oxidizibles

Nitric acid, sulfuric acid, and perchloric acid should be stored in separate rooms, cabinets, or break-resistant containers and placed in acidic-resistant trays.

Some oxidizers can undergo explosive reactions when catalyzed or exposed to heat, shock or friction and must be physically separated from other chemicals. Examples are:

- Ammonium perchlorate
- Ammonium permanganate
- Hydrogen peroxide (> 9 1% by weight)
- Perchloric acid solutions (> 72.5% by weight)
- Potassium superoxide

Strong oxidizing agents should be stored and used in glass or other inert containers. Corks and rubber stoppers should not be used.

3. Peroxides and Chemicals That Tend to Form Peroxides

Storage Conditions

These must be stored in airtight containers in a dark, cool, and dry place.

Storage Temperature Considerations

To minimize the rate of decomposition peroxides and peroxidizable materials should be stored at the lowest possible temperature consistent with their solubility and freezing point. Liquid or solutions of peroxide should not be stored at or lower than the temperature at which the peroxide freezes or precipitates, because peroxides in these forms are extremely sensitive to shock and heat.

4. Toxics

Toxic chemicals can cause either severe short-term health effects and/or severe long-term chronic health effects. These include corrosives, dehydrating agents, carcinogens, potential carcinogens, allergic sensitizers, and reproductive hazards. They also include chemicals

known to affect the nervous system, the liver, the kidneys, or the respiratory system. Some toxics are listed by category in tables in Appendix D.

- These chemicals must be stored in unbreakable chemically resistant secondary containers.
- Adequate ventilation must be provided in storage areas especially for toxics that have a high vapor pressure.
- All dispensing of these materials must be conducted in a fume hood.
- Other information about handling extremely toxic chemicals can be found in Chapter VI.

V. Waste Management

A. Introduction

Many laboratories generate chemical wastes that pose human and environmental hazards. These wastes are considered hazardous, and are regulated by federal, state, and local laws. There are separate laws and regulations for radioactive and nonradioactive biological and chemical wastes. This section only addresses nonradioactive and nonbiological laboratory wastes. See Appendix A for references on handling radioactive and biological wastes.

B. Hazardous Waste Laws and Regulations

The most important laws and regulations that apply to laboratories located in New York State are:

- The Federal Resource Conservation and Recovery Act
- The New York State Environmental Conservation Law
- Laboratories located in New York City must also comply with the New York City Rules and Regulations Relating to the Use of the Public Sewers.

1. The Federal Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) was passed in 1976 by the U.S. Congress. It requires the Environmental Protection Agency (EPA) to establish a "cradle-to-grave" system for the proper management of hazardous waste. A cradle-to-grave system tracks a material from the time it is generated until it is disposal.

On May 19, 1980 the EPA issued regulations implementing RCRA. These regulations are found in Title 40 of the Code of Federal Regulations (40 CFR) Parts 260-272. They

establish the minimum standard for hazardous waste management in the United States. RCRA permits states to enact their own more protective legislation.

2. The New York State Environmental Conservation Law

The New York State (NYS) Environmental Conservation Law was passed in 1978 and is enforced by the NYS Department of Environmental Conservation. Contacts in this department are included in Appendix B.

The New York State program includes regulations covering the three stages of the waste stream: the generation, the transportation, and the treatment, storage, and disposal. Most colleges and universities are subject to the requirements for generators of hazardous waste, which are found in the Part 370 series of Title 6, New York Code of Rules and Regulations. Copies of this are available from the local DEC office indicated in Appendix B.

3. The New York City Rules and Regulations Relating to the Use of the Public Sewers

The NYC Sewer Regulations apply to wastes that are poured down the drain into the sewer system. The NYC Department of Environmental Protection (DEP) is responsible for enforcing the sewer regulations.

The regulations list many materials that cannot be discharged into the NYC Sewer System. They include the following:

- Flammables
- Explosives
- Acids with a pH below 5.0
- Bases with a pH above 9.5
- Toxic materials in concentrations that are harmful to humans, animals, or aquatic life

Questions about specific wastes should be directed to the Chemical Hygiene Officer or the NYC DEP, Bureau of Wastewater Treatment.

C. Institutional Compliance with Hazardous Waste Laws and Regulations

All laboratory personnel of this institution must adhere to policies developed by this institution to comply with federal, state, and local hazardous waste disposal laws.

The Chemical Hygiene Officer and Committee or other designated persons will work closely with departmental chairpeople and personnel to develop and implement a uniform waste disposal policy for the institution. This policy is to be called the "Hazardous Waste Management Plan."

1. Hazardous Waste Identification

As part of implementing this plan, the first determining factor is the classification of which wastes are hazardous or considered toxic. Because each facility works with different types of hazards, it is left up to that institution to decide if a uniform management plan will be constructed for the entire facility or if separate plans for each laboratory will be developed. Generally, waste identification starts with the personnel handling such substances in their particular laboratory. Therefore, course chairpersons along with the College Laboratory Technicians and other assigned individuals are responsible for ensuring that chemicals that fall into toxic categories will be identified as such and disposed of properly in their local area. Furthermore, when the waste is collected centrally for institutional disposal, the Chemical Hygiene Officer should determine the type and amount of waste collected throughout the facility.

2. Determining Generator Status

The hazardous waste laws and regulations that apply to your institution are determined by the monthly amount of hazardous waste each facility or building (not each laboratory or department) generates. Different laws apply to two different buildings if one generates more than the other does and those different buildings have separate contractors. The regulations describe three major waste generator categories in terms of the amounts of hazardous waste generated by each:

- Conditionally exempt small-quantity generators
- Small-quantity generators
- Large-quantity generators

The EHSO is responsible for quantifying the amounts of waste generated by this institution and thus determining under which category the facility falls. This institution generates less than 100 kilogram of hazardous waste or less than 1 kilogram of acutely hazardous waste each month. Because of this amount generated this facility falls under the category of conditionally exempt small quantity generator (CESQG).

3. Hazardous Waste Collection and Segregation

A program for managing waste must establish written operating procedures for facilities and laboratory employees to follow. The system developed for collecting, segregating, labeling, and containing waste would apply to research and academic laboratories. It therefore should be determined which areas in these laboratories will be designated temporary storage areas and the EHSO along with the departmental designee will be responsible for complying with waste segregation, inventorying, and meeting transportation schedules. Finally, training employees about the program is essential, since they are the active participants in making it work.

4. Waste Storage and Transport (Within a Facility)

Chemicals that are collected from individual laboratories must be stored at a temporary location within the lab before being transported to a central location within the facility. Under the hazardous waste regulations, there are limitations on the quantity of waste a generator can store on-site and the length of time that waste can be stored. Considerations should be made to provide protection of storage containers from the elements, containment, and the availability of emergency equipment. When chemicals are transported within a facility, the freight elevators should be used and employees handling the chemicals should be aware of the hazardous nature of the chemicals and what actions to take in the event of a spill. Waste from individual laboratories must be removed at 1-week intervals to a satellite accumulation area (SAA). As containers accumulated in the SAA reach the full status they must be removed to the accumulation area (P-610). The EHSO is responsible for preparing and monitoring a site storage and transportation protocol.

5. Waste Labeling

Labels should be applied to chemical waste containers to ensure the proper identification of the storage substances. The word "Hazardous" must be included in the label along with other Department Of Transportation class category specifications if the chemical meets the criteria of being "listed" or if it has specific "characteristic". Some listed wastes are considered to be "acutely hazardous." These are wastes that the EPA and DEC have determined to be so dangerous in small amounts that they are regulated in the same manner as large amounts of other hazardous wastes. Examples of the acutely hazardous wastes that laboratories may generate are osmium tetroxide, sodium azide, cyanides, and wastes containing arsenic. Certain waste collection considerations should be made for histology labs or teaching areas and places where electron microscopy is conducted. The person responsible for waste identification at the source should also be required to label waste containers properly. The person designated to monitor site storage should require that all containers coming into that facility are properly labeled or make provisions to determine the containers' contents.

6. Selection of Hazardous Waste Contractors

There are many commercial firms that provide contract services for hazardous waste pickup. Although these firms will cart away the unwanted materials from a facility, it should be kept in mind that the generator of the waste is ultimately responsible for the proper and legal disposal of the waste. To ensure that the waste will be disposed of properly, a contractor should be selected that has an U.S. EPA identification Number. There are also a number of commercial facilities that treat large shipments of uniform or individual waste for landfill disposal. Therefore, if your facility generates large quantities of single-entity wastes, it may be feasible to utilize this disposal method. Whatever system is ultimately chosen, the single most important factor to remember is to track the waste from "cradle-to-grave."

7. Hazardous Waste Pickup

Before hazardous waste from a facility can be picked up, it must be properly packaged, labeled, and segregated according to the system that conforms to the contractor's requirements. Other factors to be taken into consideration are traffic control and loading dock preparation for the pickup, personnel coordination and protection if they assist in the pickup, and the cleanup of remaining excess debris.

8. Record Keeping

The EHSO is responsible for ensuring that a conscientious effort is made to monitor and inventory wastes that are generated by the facility. This person should also be responsible for keeping waste manifest forms for the required 3-year period after disposal. If the contractor does not return a copy of the manifest form within 45 days of the shipping date, this person must file an Exception Report with the EPA regional administrator. It is optional to use an internal waste manifestation program to tract waste from a laboratory to a packaging area for shipment. In this case, records would be kept to document the composition of the waste.

9. Waste Minimization Practices

An integral part of a waste management program is the practice the institution uses to minimize and reduce the amount of waste it generates. This minimization should start at the laboratory level and particular attention should be paid to protocols developed by each principal investigator. Some suggested examples for minimizing laboratory waste are:

- Substitution of hazardous chemicals with less hazardous or nonhazardous chemicals in laboratory experiments (i.e., toluene for benzene; histoclear for xylene).
- The use of microscale experiment.
- The design of experiments that begin and end with the same chemical
- The design of experiments that begin with the end product of other experiments
- The recycling of solvent wastes.
- The use of a chemical inventory system to determine if excess quantities of chemicals needed are present before a new shipment is ordered.

By implementing these practices and others, the amount of waste generated can be reduced at the source and thus minimize the overall waste that is generated by the institution.

The plan will also identify a person who acts as a hazardous waste facility coordinator in each building where there are laboratories.

VI. Handling Chemicals

A. Laboratory Hazard Evaluation

An Assessment of Protocols and Experiments

Each time you prepare a protocol or conduct a new laboratory experiment that uses new chemicals or chemicals previously used, you should conduct a laboratory hazard evaluation. Doing so will increase your awareness of potential hazards that may arise (or that have occurred in the past). Prior to initiating the new experiment or procedure, all laboratory employees must fill out a hazard evaluation form provided by the laboratory supervisor or Chemical Hygiene Officer. These forms will be maintained in a file in order to serve as a reference to others. Container labels and Material Safety Data Sheets, as well as other references, will be used to conduct the evaluation. Laboratory personnel will be familiar with their own and previous evaluations prior to beginning work and will use appropriate ventilation, protective equipment, and procedures to minimize exposure. The evaluation forms will be used to similarly prepare for the potential for emergency response. Considering the following questions in advance will help you decide when to use substitution, engineering controls (e.g., local ventilation, isolation), or personal protective equipment.

1. What are the sequential steps conducted in that experiment, chemicals used in those steps, and by-products of the reactions?

2. Have you referred to labels, Material Safety Data Sheets, or other available references to determine the hazard classes of each chemical used, or by products of reactions derived in that step?

3. In what form are the chemicals at different stages of the process (e.g., liquid, gas, aerosol, dust, and fume)?

4. What is the potential for

   a) health hazard:

      - inhalation (through evaporation, gas escape, aerosol formation, or dust production)
      - eye contact, skin contact and absorption (e.g., splashing, spraying, misting, handling)
      - ingestion (accidental swallowing)

   b) physical hazard:

      - fire (sources of ignition), explosion (static electricity, shock sensitive)
      - or other undetermined hazard?

5. What laboratory occupational and environmental conditions might affect the likelihood or potential for a hazardous exposure? For example is there insufficient ventilation (fume hoods, local exhaust), or personal protective devices (goggles, face shields, gloves, aprons)? Does humidity, temperature, or light enhance a hazardous condition?

6. Are there any reported incidents in the literature associated with this experiment or chemicals used? A number of journals report incidents that involve the use of specific chemicals in experiments or processes, such as the Journal of Chemical Education, Chemical Engineering News and Morbidity and Mortality Weekly Report. Other necessary information is available in science indexes at the library.

7. What controls are needed to protect you and surrounding workers in the event of an emergency (e.g., safety shield, eyewash, safety shower, fire extinguisher, spill-control equipment)? Make extra copies of the hazard evaluation chart (Chapter VI, Part Two, Tool #1) and utilize it for new experiments.

B. Substitution as a Primary Method of Control

Following a hazard evaluation, laboratory personnel should always consider substituting less hazardous and toxic substances. Only chemicals for which appropriate exposure controls are present may be used.

C. Reevaluation Prior to Modification of Procedures

Laboratory employees, should obtain prior approval from their supervisor and reevaluate the potential hazards of laboratory chemicals before proceeding with a new laboratory task, whenever one or more of the following applies:

1. There will be unknown results.
2. There is a significant change in procedure or test likely to alter the hazard. A significant change is defined as a 10% or greater increase or decrease in the amount of one or more chemicals used, a substitution or deletion of any of the chemicals in a procedure, or a change in the conditions under which the procedure is conducted.
3. Equipment normally used is not available, such as fume hoods or other local ventilation.

D. Reporting Laboratory Incidents and Unsafe Conditions

1. Report all laboratory incidents, no matter how minor to the Public Safety Office. Incident report forms are available from the Public Safety Office. Unusual or unexplainable chemical incidents should be discussed with others in the department, to caution others as to the risk of the procedure.
2. Report any unsafe conditions by contacting Course Coordinator, course CLT and filing a written report with the Course Coordinator so that the condition may be corrected as soon as possible. Unsafe conditions that must be reported include:

- Nonfunctioning hoods in areas where hazardous chemicals are being used
- Unsafe storage conditions
- Blocked emergency exits
- Improperly charged fire extinguishers
- Eyewash stations or safety showers that do not work
- Absence of personal protective equipment (e.g., goggles, gloves)

E. Personal Hygiene

1. Never store food or beverages in storage areas, refrigerators, glassware, or utensils that are also used for laboratory operations.
2. Do not eat, drink, smoke, chew gum, or apply cosmetics in laboratories where chemicals or other hazardous materials (e.g., radioactive or biohazardous materials) are present.
3. Never use your mouth to draw fluid through a pipette. Always use a pipet bulb or other mechanical pipette-filling device.
4. Wash areas of exposed skin well before leaving the laboratory.

F. Wearing Appropriate Personal Apparel

1. Confine long hair and loose clothing. Wear shoes at all times in the laboratory but do not wear:
    - Sandals
    - Perforated shoes
    - Sneakers
2. Always wear long-sleeved and long-legged clothing. While performing laboratory work, never wear short-sleeved T-shirts, short skirts, or shorts. Jewelry should not be worn that interferes with gloves and other protective clothing or that could come into contact with electrical sources or react with chemicals.

G. Proper Equipment Use

1. Use equipment only for its intended purpose.
2. Inspect equipment or lab apparatus for damage before use. Never use damaged equipment such as cracked glassware or equipment with frayed electrical wiring.

3. Shield or wrap Dewar flasks and other evacuated glassware to contain chemicals and glass fragments should explosion occur.

H. Personal Protective Equipment and Fume Hoods

1. Inspect all protective equipment (glasses, goggles, gloves) before use for damage. Do not use damaged protective equipment. To replace equipment, contact departmental purchasing agent.
2. All personnel, students, and any visitors in locations where chemicals are stored or handled must wear protective goggles at all times.
3. Check fume hoods before use to ensure adequate functioning. See Chapter VII for ways to monitor your hood's effectiveness. File a hood maintenance request form if there is a problem and contact the EHSO immediately.
4. Wear appropriate gloves when there is potential for skin contact with toxic chemicals. When ordering gloves, laboratory personnel will request chemical permeation and resistance charts.
5. Use additional personal protective equipment when necessary. See Chapter VII on controls for criteria used to choosing equipment.
6. Select appropriate equipment based on an evaluation of chemical and procedural hazards.

I. Transport of Chemicals

The following guidelines will be used when transporting all chemicals within facilities, from building to building, and on public streets.

1. Hand-carried chemicals should be placed in an outside container or acid carrying bucket to protect against breakage.
2. Wheeled carts used to transport chemicals should be stable and move smoothly over uneven surfaces without tipping or stopping suddenly, and should have lipped surfaces that would contain the chemicals if the containers break.
3. Laboratory employees transporting chemicals must wear splash goggles and an apron in the event that containers break and chemicals are splashed.
4. Use freight elevators when available. Passenger elevators should be used only during low-use time periods and only by those who are handling the chemicals.
5. Compressed gas cylinders should be transported with hand trucks only with the cylinder strapped in place. Cylinders should NEVER be rolled or dragged. Keep the cylinder capped until it is used.

J. Housekeeping

1. Keep all work areas, including workbenches and floors clean, dry, and uncluttered.
2. Access to emergency equipment, utility controls, showers, eyewash stations, and laboratory exits should never be blocked.

K. Toxic Discharges and Waste Disposal

1. Deposit chemical waste in their appropriate, labeled receptacles and follow all other disposal procedures described in Chapter V of this Chemical Hygiene Plan.
2. Be particularly cautious about releasing hazardous substances into designated "cold" or "warm" rooms, since these facilities have recirculated atmospheres.
3. Minimize the release of toxic vapors into the laboratory by using venting apparatus such as vacuum pumps and distillation columns into local exhaust devices. When especially toxic or corrosive vapors are involved, they should pass through scrubbers prior to being discharged from the local exhaust system.

L. Working Alone

Under most circumstances individuals should avoid working alone when conducting research and experiments involving hazardous substances and procedures. Some localities require the presence of persons certified in laboratory safety.

1. **Undergraduate teaching laboratories:** An instructor must be present in the laboratory at all times when undergraduate students are conducting experiments.
2. **Research Laboratories:** Personnel working alone should contact Public Safety to make them aware of their presence in the facility. Public Safety should be required to make periodic checks of all laboratories. These personnel should plan a route of escape in case of an emergency.

VII. Controls

The OSHA Laboratory Standard requires that "fume hoods and other protective equipment function properly and [that] specific measures [be] taken to ensure proper and adequate performance of such equipment." Provisions are also required for additional employee protection when working with particularly hazardous substances. It is this institution's responsibility to provide the following controls where they are needed to protect employees and to ensure that:

- General ventilation systems and fume hoods are functional and meet the requirements for procedures performed.
- Personal protective equipment is appropriate and available.

- Emergency safety facilities and equipment are sufficient and accessible.

Requirements with respect to the first two types of controls and criteria for their use are described below. The requirements for emergency safety facilities and equipment are covered in Chapter VIII.

A. Ventilation Systems

1. General Ventilation

The general ventilation system in laboratories must be well maintained and the quantity and quality of airflow monitored every 3 months. Eight to fourteen (8-14) room air changes per hour should be provided by general ventilation in laboratories where fume hoods are used as the primary method of control. Storage areas used for flammables must have 6 air changes per hour. Air supplied in all active laboratories and chemical storage areas should be 100% fresh. Air removed from the laboratories through vents and ducts by general ventilation should be vented to the outside, not into the general facility circulation. Intake vents for the system should be far enough removed from the system's exit port to prevent cross-contamination. A slightly negative pressure should be maintained in laboratories to ensure airflow into the laboratory from uncontaminated areas. These recommendations will be taken into account in all future designs and redesigns of ventilation systems for laboratory use.

General ventilation will not be relied on to protect employees from toxic exposures. Fume hoods and other local exhaust system devices must be used for these purposes. Specific circumstances under which fume hoods must be used are indicated below.

2. Fume Hoods

Fume hoods minimize personal risk of exposure to toxic and hazardous materials by isolating activities from the general laboratory environment and by capturing chemical vapors, fumes, and mists at their source, preventing them from entering the general laboratory environment. Their use is encouraged whenever possible and mandated for certain substances and procedures, as outlined below.

Performance Requirements

Laboratory fume hood face velocities generally range from 60 to 150 linear feet per minute. Some localities require that fume hoods function so that a minimum average face velocity is achieved. For example, New York City Fire Department regulations require that all fume hoods be vented so that a minimum average face velocity of 100 linear feet per minute (100 ft/min) is achieved. The Maintenance and Inspection Program for laboratories of this institution, described in Chapter IX of this plan, will ensure that fume hood performance is routinely assessed and systems are maintained.

Ventilation Ducts

Common ducts may be used only for fume hoods located in the same laboratory unit (defined as an enclosed fire-rated space that may contain more than one separate laboratory work area). Hoods in different laboratory units should not have combined ducts, and these ducts should lead to a point where laboratory contaminants can be released safely into the atmosphere. Ductwork must be arranged so that exhaust from one duct cannot be forced out through any other hood served by the common duct. This is achieved by locating the blower as far from the hood as possible to avoid pressurizing the ductwork and installing the duct connections on the proper curvature or angle.

When Hoods Will be Used

a) The toxicity of the substance used should also be considered. Hoods should always be used when the chemical is a known or suspected carcinogen, reproductive hazard, sensitizer, or acutely toxic chemical.

b) The quantity should be considered. Hoods should always be used when handling large quantities of chemicals (over 500 milliliters of liquid or over 30 grams of a solid)

c) Flammable and reactive substances should be handled in a fume hood.

d) Running new reactions that may be unpredictable or old reactions that may have a history of being less than fully reliable should be conducted in a hood.

Required Work Practices with Fume Hoods

a) All laboratory employees must check the functioning of fume hoods before use and employ work practices that optimize the protection afforded by fume hoods. Methods for evaluating fume hood performance will be a subject covered in employee training, and will generally include:

- Continuous monitoring devices
- Smoke tube tests
- Velometers
- Chem wipes on the bottom edge of each sash

b) Immediately report all improperly functioning fume hoods to the laboratory supervisor. Contact the Chemical Hygiene Officer.

c) Do not block vents in the hood with stored chemicals. Doing so interferes with the proper airflow.

d) Hoods must not be used to dispose of or store hazardous chemicals. Hoods which evolve toxic vapors or dusts must be fitted with condensers, traps, or scrubbers, to contain and collect them and prevent them from being released into the environment.

e) Hoods should be closed when not in use. Keep the sash down as far as possible during use to improve the overall performance of the hood. If chemicals remain in the hood after use, they should be placed in the rear of the hood and the fan must be left on.

f) Reduce turbulence near and in the hood by closing nearby doors and windows when possible, opening and closing the sash slowly and smoothly, and by avoiding rapid movements inside the hood.

g) Keep equipment at least 6 inches inside the hood face.

h) Connect electrical equipment to outlets outside the hood when possible. This way, in the event of an emergency one can disconnect equipment without creating a spark inside the hood. Be cautious of tripping hazards with the cords.

i) Wash the hood work platform as often as necessary to maintain a clean, dry surface.

Fume Hoods in which Perchloric Acid, Strong Oxidizing Agents, or Highly Reactive Chemicals Are Used

Fume hoods for handling (and heating) perchloric acid, strong oxidizing agents, or other highly reactive chemicals must be served by an independent duct. Crystals can form inside the duct work due to condensation, which can lead to explosions when performing maintenance work on the ventilation system. If you are unsure of whether this is the case when using these materials, DO NOT GO FORWARD WITH YOUR WORK. CONTACT THE CHEMICAL HYGIENE OFFICE IMMEDIATELY.

Situations in which Laboratory Work Should Not Proceed

When fume hoods are not operating properly, they should not be used. Where there is reason to believe that laboratory employees would be unnecessarily exposed to toxic chemicals due to the failure of a hood to function properly, then activities should cease and an alternative solution found. See Chapter VI, "Handling Chemicals" of this Plan for more specific operating procedures involving fume hood use with particularly hazardous chemicals.

New Construction or Renovation to Install Fume Hoods

Architects, contractors, and construction workers must review new building plans or existing blueprints for the presence of asbestos. Similar precautions for fiberglass and other human-made insulation materials should be taken. If asbestos is found, proper procedures must be taken for its safe containment or removal prior to the commencement of construction.

B. Personal Protective Equipment and Clothing for Routine Use

Choose protective clothing and equipment based on the types of chemicals handled, the degree of protection required, and the areas of the body that may become contaminated. All clothing and equipment must at a minimum, meet standards set by the American National Standards Institute. All respiratory protective equipment must be chosen in conjunction with the Chemical Hygiene Officer since there are strict legal requirements as to the use and distribution of these devices.

Every effort must be made to evaluate the effectiveness of equipment and make improvements where possible. The Chemical Hygiene Officer should be consulted for suggestions.

Special consideration must be given to purchasing appropriate personal protective equipment and other safety equipment when extremely hazardous substances are involved. Choice of this equipment under these circumstances must be reviewed by the Chemical Hygiene Officer in advance of purchase requests.

1. Eye Protection

All laboratory employees must wear protective eyewear when working with potentially harmful chemicals. All eyewear must meet the American National Standards Institute's (ANSI) "Practice for Occupational and Educational Eye and Face Protection," Z87.1 - 1989. Prior to use, personnel will verify that the equipment has been approved for the particular procedure (e.g., protective equipment may be ANSI certified for chemical splashes but not for explosions). ANSI standards require minimum lens thickness of 3 millimeters, impact resistance, passage of a flammability test, and lens-retaining frames.

DO NOT WEAR contact lenses, even under goggles or safety glasses. Gases and vapors can concentrate under lenses and cause permanent eye damage. It is almost impossible to remove contact lens to irrigate the eye in an emergency. Soft lenses can absorb solvent vapors.

2. Guidelines for Use of Gloves

Gloves must be worn whenever there is a chance for hand contact with chemicals, such as during the transfer of chemicals from one container to another or during the transfer of chemical wastes. Gloves must be worn if the chemicals involved are easily absorbed through the skin and/or are acute or chronic toxins. A check mark in the far right-hand

column of the "Permissible Exposure Limits" table in Appendix E identifies those regulated chemicals that pose skin hazards.

Lab personnel must inspect gloves prior to each use. When removing gloves, grab the base of the left glove with the right hand and remove that glove. While holding the left glove in the right hand, invert the right glove over the removed glove and dispose of them properly.

Prior to use, lab personnel will consult the glove manufacturer's permeation and resistance charts (available from the manufacturer) to make sure that the glove is made of the proper material for the chemicals being used. These materials vary in the way they resist being degraded and permeated. No glove totally resists degradation and permeation over time and must be replaced periodically, depending on how often it is used, for what concentration of chemical, and for how long. The makeup and thickness of a glove determines its appropriateness.

3. Clothing

The choice of protective clothing depends on the degree of protection required. Protective and appropriate clothing is required when a potential exists for chemical splashes, fire, extreme heat or cold, excessive moisture, and radiation. Setting requirements for their use is largely the responsibility of lab supervisors and directors.

Protective clothing that should be readily available to laboratory personnel include:

- Lab coats
- Boots
- Lab aprons
- Shoe covers
- Gauntlets
- Jump suits/coveralls

Laboratory personnel must be instructed to consider the following characteristics in protective clothing selection and purchase:

- ability to resist fire, heat and the chemicals used
- impermeability, when needed
- comfort, permitting easy execution of tasks when worn
- ease of cleaning (unless disposable)
- ability to be removed remove during an emergency or chemical splash (e.g., has snap fasteners rather than buttons)

4. Safety Shields

Safety shields should be used on or near equipment when there is potential for explosion or splash hazards. Fixed shields will be used whenever possible, recognizing that their weight and resistance provides superior protection against minor blasts. Portable shields may be used when the hazard is limited to small splashes, heat or fire. Where combustion is possible, the shield must be made of non-flammable or slow burning material.

C. Ensuring that Controls are in Place and Functioning Properly

1. Inspection and Maintenance

The Chemical Hygiene Officer will coordinate the maintenance and inspection of facilities, general ventilation systems, fume hoods, and emergency facilities and equipment such as eyewash stations, safety showers, fire extinguishers, and self-contained breathing apparatuses in laboratories, storage areas, and preparation rooms. The frequency of these inspections and maintenance programs is described in Chapter X. Maintenance and Inspection programs will target areas in which particularly hazardous chemicals and/or procedures are used.

2. Employee Reporting of Improperly Functioning Equipment

Between maintenance and inspection intervals, all laboratory employees must report improperly functioning fume hoods, general ventilation systems, safety showers and eyewash stations, and other safety equipment to Mr T. Tajadas and fill out a "Maintenance Request Form."

3. Safety and Personal Protective Equipment Checklist

Each science department chairperson, in conjunction with laboratory supervisors, will complete and maintain a checklist identifying the types and approximate number of safety items required for each laboratory in that department. The checklist will be made available to the Chemical Hygiene Officer upon request. Each laboratory supervisor must ensure that the choice of all safety equipment is based on an evaluation of the hazards of procedures and chemicals used in each laboratory.

4. Availability of Equipment

Each science department must ensure that all necessary equipment is ordered, received, and made available to employees. Safety equipment checklists will be reviewed during biannual inspections by the Chemical Hygiene Officer and Committee. Prior to large-volume purchases, personal protective equipment should be evaluated under real or simulated conditions to ensure that it meets both safety and performance standards. For example, chemical splash goggles may meet ANSI standards but fog up rapidly or are so uncomfortable that they will not be worn.

VIII. Emergency Planning and Response

This chapter of the Chemical Hygiene Plan describes how this institution will meet its responsibilities to prepare for laboratory-related emergencies. Described below are emergency safety equipment and materials required in every laboratory; guidelines for responding to chemicals spills, fires, and medical emergencies; and procedural and educational steps to ensure that laboratories and laboratory personnel are prepared for chemical spills and emergencies.

A. The Emergency Preparation Responsibilities of the Staff

1. Operating Procedures for Responding to Spills, Fires, and Medical Emergencies

The Chemical Hygiene Committee will periodically review and update this institution's guidelines for responding to chemical spills, fires, and medical emergencies.

Principal investigators of research and designated department Personnel of academic programs maintain responsibility to develop written operating procedures for responding to emergencies involving extremely hazardous chemicals they currently or intend to work with. The Chemical Hygiene Officer and Committee will review these procedures with appropriate college departments such as Public Safety , buildings and grounds, and administration.

2. Building Evacuation Procedures

The Chemical Hygiene Committee members (representing all science departments, Public Safety , maintenance, and buildings and grounds) and the Chemical Hygiene Officer will formally establish emergency protocols for evacuating laboratory facilities in the event of a fire, chemical release, or other emergency, if they have not already done so. Existing protocol will be periodically reviewed and updated by the Chemical Hygiene Committee. The written evacuation protocol will be checked specifically for proper coordination between principal investigator's laboratories, departmental laboratories, teaching labs, the Chemical Hygiene Office, Public Safety, maintenance, buildings and grounds, and other relevant Offices..

3. Establishment of Outside Technical Assistance and Response Capability

The Chemical Hygiene Committee and Chemical Hygiene Officer must establish off-site resources to be called upon to perform functions beyond the ability, scope or permitted actions of this institution's staff. Emergency resources have been established for the following events:

- Fires
- Large chemical spills (greater than 5 liters) and extremely toxic chemical spills that cannot be handled by laboratory employees

- Toxic chemical releases (compressed gases, cryogenics)
- Medical emergencies

4. Development of On-site Emergency Response Capability

The Chemical Hygiene Committee members should develop the capacity to efficiently and quickly respond to first reports of laboratory emergencies and provide assistance and guidance in selecting a course of action. Each will be familiar with the named contacts, their telephone numbers, and understand the capabilities and limitations of this institution to respond to problems. Committee members will feel free to call upon each other for advice in anticipation of a problem during or following an incident. For this reason, a list of current committee members is included below, also listing areas of expertise.

CHEMICAL HYGIENE COMMITTEE MEMBERS

Name	Department	Telephone No.	Expertise
Derek Lee	Adm. & Finance	(718) 260-5858	spill response
Peter Spellane	Chemistry	(718) 260-5862	organic chemistry
Olufemi Sodeinde	Biology	(718) 254-4907	biology

5. Review (and Investigation) of Incidents

In addition to the already established authorities such as labor/management committees, the Chemical Hygiene Officer will review all incident reports with the express aim of understanding factors that contributed to its occurrence in order to help prevent future occurrences. Recommendations for improvements will be presented and discussed at Chemical Hygiene Committee meetings and with appropriate department personnel.

6. Completion of Laboratory Safety Equipment Checklists

Each laboratory (in consultation with the department and the Chemical Hygiene Officer) will develop a checklist indicating the number and types of safety and spill-control equipment required to protect employees in that lab during spill cleanup, fire, or evacuation procedures. This list must be kept current and updated after each incident.

B. Emergency Equipment and Facilities Required in Every Lab

It is a departmental responsibility to identify and purchase spill-control and personal protective equipment for employees working in laboratories.

It is the institution's responsibility (through the office of Buildings and Grounds and of the Chemical Hygiene Officer) to provide a sufficient number of appropriate and charged fire extinguishers, eyewash and shower facilities, respiratory protective devices, and first aid kits in all laboratories.

It is the responsibility of laboratory supervisors, principal investigators, and others to ensure that personnel working in their labs are informed about the location of emergency equipment and to alert department heads and/or the Chemical Hygiene Officer about the lack of necessary safety equipment and/or facilities in their laboratory.

1. Emergency Telephones and Posted Telephone Numbers

Every lab should have a clearly marked phone with emergency telephone numbers listed next to it. If there is no phone in the lab, there must be an alternative written plan for contacting emergency or other personnel. This alternative plan must be clearly posted in the laboratory. Specific telephone numbers to be posted are indicated above. *See Tool # VIII.B.1.3*

2. Deluge Showers and Eyewash Stations

Showers must be located within 25 feet of every laboratory, storage area, or chemical preparation room wherever corrosives, dehydrating agents, solvents, and other hazardous chemicals are stored or used. Eyewash stations should be installed and functional in each lab, storage area, or chemical preparation room. Instructions for activating the shower and eyewash should be clearly posted and all lab personnel must be trained to use these facilities.

Eyewash stations should be centrally placed in a lab along a normal path of egress and should take no longer than 15 seconds to reach from any point in the laboratory.

The shower and the eyewash should ideally be next to each other, since incidents involving facial splashes are likely to involve other part of the body as well.

The eyewash water supply must provide 0.4 gallons/minute of water at 25 pounds per square inch or less to flood the eyes and face with potable, aerated water for at least 15 minutes. The best design is two nozzles facing upward and aimed slightly inward.

The safety shower must provide up to 30 gallons/minute (supply must be at least a 1-inch line).

The water supply should run until it is turned off. Deluge showers should be able to deliver 50-60 gallons of water at one time.

Valves on eyewash and safety showers should be easily turned on in 1 second or less and designed so that water flow stays on without requiring the operator to keep it on.

Ideally, the water temperature should be at 90-95 ^{o}F (32-35 ^{o}C) but not over 100 ^{o}F. A flow of extremely cold water on a person for any length of time can cause them to go into shock. Showers and eyewash stations should be tested at least once a year to determine if the above requirements are met.

Small squeeze bottles containing a pint or quart of water are not acceptable. The water may be contaminated and there is not sufficient volume to be of any use.

3. Fire-related Safety Equipment

Fire Alarm System

All laboratory facilities must be capable of notifying all personnel in the vicinity of a fire so that they may evacuate the building. Locations that have no alarm system must have alternative ways of notifying employees and other persons. These alternative methods must be communicated to all necessary personnel.

Fire Extinguishers

Portable extinguishers must be present in all laboratories, chemical storage, and preparation areas. They must be of the right type and the right capacity (volume) to be able to extinguish the amount of material that may be involved in a fire.

Multipurpose extinguishers are good for areas where fires may involve different classes of materials. Dry powder extinguishers, for example, would be good for a fire involving all or any of the following: solvents (Type B) and electrical (Type C). If a laboratory also used combustible metals (magnesium and sodium), a second extinguisher for Type D fires (e.g., Met-L-X) is required.

Fire extinguishers should be located near doors of storage or work areas or just inside or outside of the door so that when an occupant attempts to get the extinguisher, he/she will be moving toward the exit.

The maintenance program for fire extinguishers to ensure that they are properly charged for use is described in Chapter X.

Fire Blankets

Fire blankets must be readily available in each laboratory to use to cover an injured victim who may be in shock until emergency medical help arrives. NEVER USE FIRE BLANKETS TO COVER A VICTIM IN A STANDING POSITION WHOSE CLOTHING IS ON FIRE. This would increase the amount of hot gases and smoke inhaled as well as possibly cause face and head burns. Procedures for clothing fires are described below.

4. Chemical Spill-Control Equipment.

Each department will ensure that all teaching and research laboratories will have sufficient spill-control equipment either in the laboratory itself or readily available to respond to spills involving the chemicals used in the laboratory. Chemical spill supplies must be capable of

dealing with a spill of up to 2 gallons. The types of neutralizing and absorption materials and containers will depend on the types of chemicals used in a laboratory. The minimum equipment should include:

- Neutralizing materials
- Absorption materials
- Broom and dustpan
- Bags large 6-milliliter polyethylene
- Mop
- Bucket (polyethylene)
- Containers (5-gallon plastic)
- High-efficiency particulate air-filtered (HEPA) vacuum cleaner (for certain materials such as toxic metals and their compounds)

5. Emergency and Chemical Spill Personal Protective Equipment

Goggles (splash-proof)

These should always be worn when cleaning up spilled chemicals.

Various Types of Gloves (several pairs)

Use manufacturer's permeation and resistance glove charts (which can be obtained from the manufacturer) to choose appropriate gloves to have available in the event of a spill.

Shoe Covers

Rubber boots or plastic shoe covers should be worn to avoid exposure of shoes (and feet) to corrosives or large quantities of solvents in cleanup operations. Foot protection such as shoe covers should be used in emergency situations only because of the risk of static spark.

Lightweight, Chemical Resistant Coveralls (e.g., Tyvek) and Duct Tape. These may be necessary depending on the extent of the spill and the toxicity or corrosivity of the chemical(s) involved. Duct tape is used to tape off all openings in the coveralls (wrists, ankles, etc).

Disposable Full-length Jumpsuits

Use when cleaning up particularly hazardous materials such as carcinogens. Disposable full-length jumpsuits for high-risk situations and head and shoe covers offer protection from vapor and/or liquid penetration.

Respiratory Protection

Employees working in laboratories, storage areas, or preparation rooms should not have to wear respiratory protective equipment routinely. However, there may be emergency situations that require the use of positive pressure self-contained breathing apparatus, negative pressure half-face respirators, or emergency escape air packs.

Each department must determine, with assistance from the Chemical Hygiene Officer and Committee, the types and number of respirators that should be made available in each department for emergency situations.

Situations requiring respirators include:

- Large chemical spills and spills involving extremely toxic chemicals
- Chemical releases from compressed gas cylinders involving toxic materials or ones that rapidly create oxygen-deficient environments
- Escape from advanced fires

Under no circumstances is respiratory protective equipment to be used by a person unless they have participated in a respirator protection program that includes training, a medical exam, and fit testing required by the OSHA Respirator Standard (Title 29, Code of Federal Regulations, Part 1910.134).

6. First Aid Kit

Every laboratory must have a first aid kit containing the following:

- Variety of bandages
- Adhesive tape
- Alcohol swabs
- Gauze
- Cold and hot packs
- Burn spray, abrasion ointment
- Tweezers
- Scissors
- First aid manual

C. Guidelines for Chemical Spills, Fires, and Medical Emergencies

Standard Operating Procedures

1. Each science department must consider the types of emergencies that may arise in each division's laboratories and develop written procedures describing the series of steps that should be taken in the event that these emergencies occur. Any laboratory handling extremely hazardous materials (including carcinogens, potential carcinogens, reproductive hazards, acutely toxic chemicals or sensitizers) must develop spill-control protocols involving those specific materials. All laboratory employees must be trained in the steps to take in the event of an emergency.
2. Use of biological and radiological materials may require distinct protocols, depending on their quantity and the extent and severity of their hazards.
3. In the event of any chemical spill, release, injury, illness, or medical emergency, incident reports must be filled out and signed by either the person involved or an alternate person of their choosing. All incident report forms must be sent to [name, title, phone number].
4. Laboratory employees witnessing chemical spills or emergencies must never take it upon themselves to clean up a chemical spill, put out a fire, or administer medical assistance if they:
    - Are not familiar with emergency or spill control protocol
    - Don't know what chemicals are involved or what the potential hazards are
    - Don't have the proper protection
    - Don't think they can handle it
5. NEVER contact the custodial staff to respond to chemical spills! They are neither trained nor equipped to cleanup chemical spills.
6. Laboratory employees must wear personal protective equipment that will prevent contact with or inhalation of toxic chemicals.
7. All laboratory employees witnessing, involved, or affected by a chemical spill, release, or other incident are entitled to a medical consultation by a physician experienced in identifying and treating patients experiencing toxic effects of chemicals.
8. After each incident, designated department personnel must ensure that all emergency equipment, supplies, and materials are replenished.

Guidelines for Handling Chemical Spills

Solid spills

1. Inert solids. These can be swept up and placed into a container constructed of material it originally came in. However, certain solids pose toxic, flammable, and reactive hazards and must never be swept up routinely or mixed in with regular trash.

2. Oxidizers. Spilled nitrates, permanganates, and perchlorates must be separated from other types of waste products and kept away from paper and other combustibles.

3. Extremely toxic solids. Beryllium, cadmium, arsenic, barium, mercury, and their compounds must be collected with a high efficiency particulate air filter (HEPA) vacuum cleaner that removes up to 99.7% of particles with mean diameters as small as 0.3 micrometers.

4. Air-reactive solids (pyrophorics). These burn when exposed to the air.

5. White phosphorous. If spilled, it must be kept wet and covered with wet sand. Any spill residue must be kept under water. Dispose of as a hazardous material. Contact [Vendor] for pick-up.

6. Other pyrophoric solids may be incompatible with water. It is the laboratory supervisor and principal investigator's responsibility to research (using Material Safety Data Sheets and applicable texts) appropriate response to other types of spills involving a specific pyrophoric chemical.

7. Water-reactive solids. Sodium and potassium metals react with water to form flammable hydrogen gas, which may then ignite from the heat of the reaction.

8. Cover potassium with dry sodium carbonate and disperse and place the mixture in a large steel pan located in an isolated, dry area pending its disposal.

9. Explosive solids. Only specially trained and certified personnel should attempt to clean up spills involving explosive solids. Immediately notify Public Safety in the event that an explosive solid is spilled.

Liquid Spills

1. All liquid spills should be diked first (absorbent placed around the spilled material), then generally neutralized and absorbed onto a solid material before being disposed of. There are three major types of absorbents, each appropriate for certain types of chemical spills:

    - Organic absorbents (paper towels, sawdust). Inappropriate for caustics, acids, and oxidizers.

    - Mineral (granular clay, vermiculite, diatomaceous earth, sand). This is the most inert type of absorbent material to use, but should not be used for chemicals that liberate vapors.

    - Synthetic (polypropylene fibers). Not good with strong oxidizers. The only appropriate absorbent for hydrofluoric acid spills.

2. The area of a spill must always be decontaminated after the spilled material is removed (see decontamination issues below).

3. Mops, wringers, or buckets may not be used for a hazardous or flammable liquid spill. Mops should only be used on nontoxic, noncorrosive, nonflammable, and inert liquids.

4. Spilled liquid laboratory chemicals should not be diluted with water unless absolutely necessary (if, for example, there are no neutralizing materials available.) The following factors will be considered when determining whether a spill is contained or cleaned with water:

    - Risk of splatter.
    - Incompatibility (e.g., organic solvents and water-reactive liquids.)
    - Potential for entry into the sewer system.
    - Whether water will cause the spill to spread.

5. Before responding immediately to a spill, consider the potential vapor concentration and toxicity of the material. Consider the rate of evaporation of the liquid, the environmental conditions of the room (adequacy of ventilation, temperature), and the time elapsed since the spill occurred.

6. Always make sure to have the necessary personal protective equipment before attempting to clean up a chemical spill.

7. Contaminated spill materials, including disposable personal protective equipment, (almost always) must be disposed of as hazardous waste. Contents of all containers or plastic bags must be properly labeled. See the waste disposal policy for further details, in Appendix [ ].

8. Always address an injury first before attempting to respond to a spill.

Guidelines for Hazard Classes

Corrosives (strong acids and bases, nonmetal chlorides dehydrating agents, halogens)

1. Strong acids. Don splash-protective goggles, acid-resistant gloves (use manufacturers glove chart to determine in advance what kind of glove material you will need). Coveralls and plastic shoe covering may be necessary if the spill is large. Slowly add proper amounts of a weak base to the spill area (e.g., sodium bicarbonate, sodium carbonate, calcium carbonate) and physically mix the neutralizing agent slowly and uniformly into the acid with a plastic rod or wooden stick. An eventual lack of foaming or fizzing indicates the point of neutralization. Then add absorbent such as vermiculite and scoop into a polyethylene container.

    Hydrofluoric acid spills. Hydrofluoric acid is extremely corrosive. The acidic fluoride attacks the skin quickly and without initial pain and can cause severe delayed effects that require calcium gluconate injections. NEVER CLEAN-UP HYDROFLUORIC ACID SPILLS, NO MATTER

HOW SMALL UNLESS YOU ARE ABSOLUTELY CERTAIN YOU HAVE THE PROPER GLOVES AND THAT THEY HAVE NO HOLES.

2. Apply calcium-containing compound and soda ash to precipitate the fluoride ion as calcium fluoride and render a neutral pH. DO NOT USE MINERAL ABSORBENTS (the silicon in them reacts with hydrofluoric acid to produce silicon tetrafluoride, a toxic gas). Special synthetic absorbents are required.

3. Strong bases. Don the same protective equipment as for strong acids. Add a weak acid (e.g., citric acid or weak [1-6] molar hydrochloric acid). A pH indicator paper should be used to ensure that the material has been neutralized.

Flammable Solvents

Before doing anything, turn off all power supplies and unplug any equipment that may spark. Hoods should also be turned off. Then follow the basic guidelines for liquid spills above. Flammable vapors may travel distances to ignition sources and flash back to the source of the vapors, rapidly creating a very dangerous environment.

Compressed Gas Tank Leaks or Releases

Compressed gas tank leaks must be addressed immediately.

Mercury

All labs where mercury is present must have an acceptable means of cleaning up a mercury spill should one occur. An extremely toxic metal, mercury evaporates at room temperature and is odorless with no warning properties. It easily fills cracks and crevices where it continues to evaporate without notice. Mercury spill kits are commercially available. They include a small pump, sponges saturated with material that absorbs mercury, and absorbent powder that reacts with mercury to form an amalgam. The powder should be poured into seams and cracks of the floor if necessary.

NEVER USE ORDINARY VACUUM CLEANERS TO CLEAN UP MERCURY SPILLS! Mercury vapors will be spewed out of the vacuum's exhaust.

Personal Chemical Contamination and Medical Emergencies

All incidents involving chemical contamination (skin contact, inhalation, ingestion) or injury must be followed up by medical personnel at no cost to the employee. Listed below are initial steps to take to minimize harm after chemical exposure or injury. All incidents must be reported to the Chemical Hygiene Officer and the incident report form filled out as soon as possible.

1. **Chemical eye splashes:** Immediately rinse the affected eye or eyes at the eyewash station for at least 15 minutes while holding the lids open to ensure proper irrigation.

2. **Contamination of large areas of the body:** Immediately remove contaminated clothing while using the safety shower for at least 15 minutes. Wash contaminated areas with a mild soap and water. Do not waste time because of modesty. Do not use neutralizing agents or salves.

3. **Ingestion of chemicals:** Encourage victim to drink large quantities of water, and seek medical attention by calling Public Safety at extension 5555.

4. **Development of signs or symptoms of chemical exposure**: In the event that a laboratory employee develops dizziness, nausea, light-headedness, a burning sensation in the eyes, nose, or throat, or other signs and symptoms of chemical exposure, they must leave the area immediately and get fresh air. Contact your laboratory supervisor and/or the Chemical Hygiene Officer at 260-5858.

5. **Thermal and chemical burns:** Where appropriate, flush the area with cold water. For extreme burns, call a medical emergency number immediately and seek advice.

6. **Gashes, cuts, and heavy bleeding:** Contact the nearest person trained in first aid. Apply compression to the wound to slow bleeding. Contact the institution's in-house medical staff or accompany the individual to an emergency room. Call Public Safety at extension 5555 when appropriate.

Fires and Fire-Related Incidents

Basic Steps to Take in the Event of a Fire

The order of these steps may vary depending on the situation.

- Pull the nearest fire alarm.
- Immediately notify Public Safety at 5555
- When possible, cut off the flow of flammable material (e.g. - gas).
- Evacuate all unnecessary people in the area. Follow building evacuation procedures established by the college.
- If there is time and it is safe, shut off all power and close the door of the room where the fire is behind you.

If you are working and you hear a fire alarm, immediately leave the building by taking the nearest stairwell. ALWAYS USE THE STAIRS. NEVER TAKE THE ELEVATOR.

Determining When to Attempt to Put Out a Fire

Judgment must be used to determine whether to attempt to put it out yourself. Combined circumstances that might encourage an attempt are:

- The fire is small.
- Chemical(s) and or processes involved are not potentially explosive.
- Fire is isolated (away from other chemicals).
- You have experience using a fire extinguisher.
- The fire extinguisher is the right type for the chemical involved.
- A move toward the fire extinguisher does not trap you in the room in the event that the fire spreads.

Circumstances under which an attempt should not be made include:

- The fire has spread to a secondary source (other than the site where it began).
- You don't have experience using a fire extinguisher
- A move to get the fire extinguisher could trap you in the room if the fire spreads
- The fire is very close to many other chemicals.
- The fire extinguisher is the wrong type (e.g., carbon dioxide extinguisher for a lithium aluminum hydride fire).

A watchglass may be used to extinguish a fire limited to a beaker or other small container. NEVER PLACE A WATCHGLASS ONTO A BEAKER DIRECTLY WITH YOUR BARE HANDS. The watchglass must be handled with tongs or other tools.

Using the Fire Extinguisher

In the event that a fire extinguisher is needed use the **PASS** protocol. The following four steps describe the **PASS** protocol:

- **P**ull the pin out on the extinguisher.
- **A**im the extinguisher at the base of the fire.
- **S**queeze the nozzle to release extinguishing material.
- **S**weep: Use a back and forth sweeping motion.

If after a few minutes the intensity or size of the fire has not diminished, GET OUT and close the door behind you.

Larger or rapidly growing fires MUST BE LEFT UP TO THE FIRE DEPARTMENT!

When a Person and/or Their Clothing is on Fire

If you are on fire, STOP, DROP, AND ROLL. Your body weight will smother the fire. DO NOT RUN! Running simply fuels the flames. Use the safety shower if it is not far away.

If you are witness to a person on fire, make sure they Stop, Drop, and Roll. Have someone else pull the fire alarm and contact the fire department and emergency medical services. DO NOT WRAP A PERSON IN A VERTICAL POSITION IN A BLANKET TO SMOTHER THE FLAMES. This could worsen the situation.

D. Emergency Preparedness

1. Employee participation in routine drills for fires, chemical spills, and medical emergencies. All laboratory employees are required to participate in fire drills, chemical spill scenarios, and medical emergency scenarios to prepare them for these events. Fire drills will be coordinated by Public Safety, and chemical spill and medical emergency scenarios by department personnel. Interactive discussions will follow these scenarios, which will be acted out or presented. Special provisions should be made for handicapped personnel in the event of an emergency.

   Chemical Hygiene Committee must write spill response procedures for extremely hazardous chemicals and discuss them with employees before working with these chemicals.

2. Routine laboratory inspections conducted by inspection teams described in Chapter IX of the plan will evaluate the adequacy of emergency safety facilities and equipment described in this chapter.

3. Emergency facilities and equipment are maintained periodically (every 3 months) to ensure that when they are needed, they will function properly.

4. After each incident, designated department personnel will ensure that all emergency equipment, supplies, and materials are replenished.

5. Incident reporting and follow-up system: This system ensures that the factors responsible for an incident are examined and corrected if possible.

IX. Maintenance and Inspection Program

New York City College of Technology has a maintenance and inspection program to ensure that ventilation systems and emergency safety equipment are functioning properly and that laboratory

working conditions meet legal as well as acceptable standards. The maintenance and inspection program will target facilities known to be using extremely hazardous chemicals including known and potential carcinogens, highly acutely toxic, reproductive toxins, allergens, and others.

A. Maintenance Program

1. General ventilation system

The general ventilation system in laboratories must be well maintained and the quantity and quality of airflow monitored by the EHSO to ensure that:

- General ventilation provides fresh air and between 8 to 14 air changes per hour to all laboratories in which hoods are used.
- All exhaust air from laboratories is vented to the outside and not circulated throughout the building. Special attention will be paid to laboratories in which fume hoods are routinely operating to ensure a proper balance of air flow.
- All chemical storage areas receive 6 air changes an hour, and exhausted air is not recirculated through the facility.

Centralized heating, ventilation, and cooling systems that affect laboratories will also be maintained. This includes the following activities:

- Filters are changed or cleaned
- Water is frequently checked for proper flow and any biological growth
- Drip pans are cleaned regularly

2. Local Exhaust Systems: Fume hoods

The fume hood maintenance program comprises the following elements:

- Fan(s) check:
  - Bearings for overheating (grease as required)
  - Belt drives for proper tension
  - Fan wheel for proper freedom from accumulations and rotation (to ensure that fan is not operating backwards fan rotation is often reversed with repair or alterations to wiring circuits or starters). Fans move a fraction of their rated capacity when operating backward.
- Duct work check: The ducting will be inspected to ensure that joints are intact and there are no dents or holes in the system.
- Visual inspection of hood: The hood will be checked for signs of corrosion or other indications of needed repair.
- Cleaning: The interior surface of the hood, the sash glass, and the light unit will be cleaned.

3. Emergency Eyewash and Deluge Showers

Any needed maintenance and repair will be made on emergency eyewash systems or deluge showers that are not functioning properly. This will be determined during biannual facility inspections that test this equipment's performance.

4. Fire extinguishers

All fire extinguishers will be inspected and maintained by Building and Grounds Department on a regular basis (once a month) to ensure that they are properly charged in the event of a fire.

5. Mechanisms for Employees to Report Malfunctioning Equipment

Departmental personnel and laboratory employees having any indication of improper functioning of fume hoods or safety equipment will alert the Chemical Hygiene Officer and fill out a maintenance work order form indicating the problem and the location of the fume hood or equipment.

B. Facility Inspections

1. Chemical Hygiene Committee Inspections

The Chemical Hygiene Committee and Chemical Hygiene Officer will conduct biannual inspections of laboratories at this institution. The inspection team will visually inspect targeted laboratories for unsafe conditions and practices, as well as test key safety equipment to ensure its proper functioning.

Before inspections, a copy of the chemical inventory and a description of basic operations conducted in a lab will be provided by [the laboratory supervisor] to the Chemical Hygiene Committee.

2. Inspection Reports and Report Presentations

The Chemical Hygiene Officer and/or members of the committee will write inspection reports identifying problems needing immediate attention and those that are of a lesser priority. Inspection results will be discussed with departmental chairpersons, laboratory employees, and laboratory supervisors and principal investigators, indicating what follow-up is needed to correct the problem(s), if any.

The inspection team will:

- Evaluate fume hood performance in laboratories:
  - Use smoke tubes to determine if the hood is exhausting air.
  - Measure the rate of flow at the face of the hood as well as the uniformity of air delivery to the hood by making a series of face velocity measurements

- Observe airflow in the room that may interfere with the fume hood's operation.
- Ask laboratory employees about hood performance.

- Inspect and test all emergency equipment including eyewash stations and safety showers. Contact the engineering department (B&G) to assist in the collection of discharged water from the shower.
- Look for and correct blocked emergency exits.
- Check fire extinguishers to make sure they are properly charged.
- Check availability and appropriateness of spill-control and other emergency equipment.
- Check availability of Material Safety Data Sheets.
- Inspect protective equipment for integrity as well as appropriateness.
- Observe general housekeeping conditions and systems used to communicate hazards (e.g., signs and labels).
- Inspect storage areas for proper segregation of chemical classes, storage facility, and container integrity.
- Review waste disposal practices.

3. Routine Inspection by Laboratory Employees

Part of the training program for laboratory employees includes participation in self-guided quarterly inspections of their own laboratory. Each inspection will focus on one or two particular areas of the laboratory environment (e.g., emergency preparedness, fume hoods and personal protective equipment, chemical storage, etc.), and after each inspection a list of needed improvements will be drawn up. These inspection results will serve as interim monitors of safety between the biannual inspections made by the Chemical Hygiene Committee.

C. Follow-up Measures to Ensure that Problems are Addressed

As a routine policy, the second inspection of the year will focus on laboratories in which improvements should have been made, either by laboratory employees or by management. All serious and potentially serious laboratory safety and/or health problems will be brought to the attention of the Chemical Hygiene Committee and a schedule of steps and a time frame for completing them will be drawn up by the committee.

X. Employee Information and Training Programs

Each division or department (depending on its size) must make health and safety information for each chemical (or hazard class of chemicals) currently being used in the lab readily available to all laboratory employees during working hours. This is done by ensuring employee access to Material Safety Data Sheets and other reference texts on chemical health hazards, fire hazards, reactivity hazards, and physiochemical properties (vapor density, vapor pressure, lower and upper explosive limits, etc.).

Employees must have access to a copy of the OSHA Laboratory Standard and its appendices, as well as to a list of OSHA permissible exposure limits.

A. Training

All laboratory employees of New York City College of Technology including faculty, graduate student teaching assistants, postdoctoral candidates, secretaries, laboratory technicians, maintenance and custodial employees who may come in contact with the laboratory environment must attend a laboratory employee training session provided by the Chemical Hygiene Officer. To be made aware of their rights and responsibilities under the OSHA Laboratory Standard, and about specific operating procedures for working with chemicals training will occur at the time of initial employment and each year thereafter. Additional training will be provided when new hazards are introduced.

Training Program Elements

(1) Orientation sessions

A department-specific chemical hazard orientation session must be conducted by the Chemical Hygiene Officer for each department. Specific focus for training sessions is developed by the Chemical Hygiene Officer in conjunction with departmental representatives.

Times and locations for these sessions must be sent to each department chairperson. All laboratory employees must attend this session at least once a year. Training must be given in languages that can be understood by all employees (including sign language), or verbal and written translations must be provided. The Chemical Hygiene Officer will coordinate attendance through designated Department personnel. These orientation sessions will cover the following topics:

- New York State Right-to-Know
- Contents of the OSHA Laboratory Standard and its appendices and how the institution has responded to meet its responsibilities

- Location and availability of the Chemical Hygiene Plan, Material Safety Data Sheets, and additional resources on all aspects of laboratory health and safety relevant to employee exposure
- How to read a Material Safety Data Sheet
- Physical and health hazards of chemical classes (flammable, reactives, carcinogens, corrosives, etc.) used by employees and general operating procedures for handling, storing, and disposing of these materials
- Signs and symptoms of exposure to chemicals and availability of medical consultations and exams
- Use of fume hoods and personal protective equipment
- Special operating procedures to be used for extremely hazardous chemicals
- How to conduct a hazard evaluation of lab operations
- How to conduct a laboratory inspection
- Protocol for dealing with faulty hoods and equipment and lack of proper safety equipment
- OSHA permissible exposure limits and other recommended limits (National Institutes for Occupational Safety and Health, American Conference of Governmental Industrial Hygienists).
- Filing incident report forms

(2) Hands-on Instruction

All laboratory supervisors are required to conduct hands-on training with assistance from the Chemical Hygiene Officer or other capable individual to ensure that all employees in the laboratory receive hands-on training in:

- Proper use of fume hoods and/or other local exhaust system and assessment of hood performance
- Use of emergency showers and eyewash stations
- Location and use of spill-control equipment
- Emergency protocol and telephone numbers

When feasible, spill scenarios (derived from selected hazard evaluations of procedures conducted in the laboratory) and potential medical emergencies will be simulated (using inert materials) and discussed.

The following materials will be distributed in each training program:

- Right to Know fact sheet
- Laboratory Standard fact sheet
- List of key emergency telephone numbers including Chemical Hygiene Officer and union safety Representative
- Sample MSDS and fact sheet on how to read
- Storage scheme chart
- List of some chemicals by hazard class
- Hazard evaluation checklist
- Laboratory inspection form
- Incident report form
- Form for reporting faulty hoods, safety equipment, and personal protective equipment

B. Record Keeping

Each department must maintain records of all laboratory training sessions, including sample agendas, handouts, sign-in sheets, course date, and the number of hours participants attended. Copies of these records must be provided to the Chemical Hygiene Officer after each training session. The Chemical Hygiene Officer, in conjunction with institutional administration, will assure that at least one copy of records of all training is maintained in a single, central location.

XI. Medical Consultations and Exams

New York City College of Technology must provide employees who work with hazardous chemicals an opportunity to receive a medical examination and consultation whenever:

1. An employee develops signs and symptoms of exposure associated with chemicals they are using, or may be in contact with, in the laboratory.
2. OSHA regulated substances are measured above "actual" or permissible exposure limits (PEL).
3. An employee is present in the event of a chemical spill, leak, explosion, or other situation that exposes them to a hazardous chemical.

The purpose of the consultation is to determine whether the employee needs a medical examination. All medical examinations and consultations must:

1. Be performed by or under the direct supervision of a licensed physician. Every effort should be made to refer employees to licensed physicians who have been trained to recognize chemical-related signs and symptoms of exposure and disease. See Appendix B for a list of occupational medicine clinics to which employees may be referred.

2. Be provided at no cost to the employee.

3. Be provided without loss of pay to the employee.

4. Be performed at a reasonable time and place for the employee. Every effort should be made to schedule medical examinations and consultations during the employee's regularly scheduled work hours, provided there is no undue delay in medical attention.

The [employer representative] must provide to the examining physician:

1. The generic and trade names of all hazardous chemicals and chemical compounds to which the employee may have been exposed. The employer should also provide to the physician copies of Material Safety Data Sheets for any suspect chemical. Additional materials, such as New Jersey Department of Health fact sheets, may also be provided.

2. Conditions under which the exposure occurred. The employer must provide all available information including data pertaining to experiments or procedures involved.

3. Signs or symptoms of exposure experienced by the employee during, soon after, and within 72 hours after the incident. Everyone in the proximity of the exposure should be interviewed to determine if others experienced similar symptoms. In the event that the employee is not able to communicate, others in the laboratory may be able to recall symptoms they observed or know the employee complained of.

The [employer representative] must obtain a written opinion from the examining physician. The written opinion must include:

1. Recommendations for medical follow-up

2. The results of all medical examinations and tests

3. Any medical condition the employee has that places him/her at risk as a result of future exposures to hazardous chemicals

4. A statement confirming that the employee has been advised of the results of the examinations and tests, including any medical conditions relevant to occupational or chemical exposures

   The written opinion must not reveal specific findings of diagnoses unrelated to occupational exposure.

XII. Record Keeping

New York City College of Technology maintains the following records as required under the OSHA Laboratory Standard and other relevant OSHA standards. These records will be made available to employees, to the administration, or to any outside inspection agencies upon request.

1. **An official Chemical Hygiene Plan**

   A physical copy is available for review in the Health & Safety office at N-308A during normal business hours (9:00 AM to 5:00 PM Monday through Friday). It is also available online at http://www.citytech.cuny.edu/adminfinance/ehs/ehs_index.shtml.

2. **Laboratory employee training records**

   All attendance sheets for laboratory employee training programs will be maintained by the EHSO and each department within New York City College of Technology will also maintain a list of all laboratory employees and attendance sheets for that particular department.

3. **Incident reports/illnesses and injury logs**

   The Chemical Hygiene Officer will maintain records of all laboratory incidents filed that occur in New York City College of Technology and any follow up action taken in response to the incident. Records of injuries and illnesses that have been documented by the Chemical Hygiene Officer will be maintained and posted regularly as required. These records will be kept at the office of Health & Safety N-308A.

4. **Laboratory inspection and maintenance reports**

   Records of all laboratory inspections will be kept in the office of the Chemical Hygiene Officer at N-308A. Maintenance records will be kept by the Buildings and Grounds Department in NC-8.

5. **Medical information**

   Medical information resulting from medical consultations and exams conducted in response to workplace exposures or incidents. These records will be kept by Human Resources and access to them will be restricted.

6. **Air monitoring results and exposure records**

7. **OSHA's Access to Medical and Exposure Records**

   OSHA's Access to Medical and Exposure Records Standard (29 CFR Part 1910.20) further specifies that employees have a right to results of personal medical examinations conducted by or on behalf of the employer, and a right to results of the monitoring of the ambient air in the employee's workplace.

a. All employees, their representatives by written authorization, and their union representatives have the right to:

b. Workplace monitoring or measuring of a toxic substance

c. Biological monitoring that assesses level of toxicity to exposed employee - not including alcohol and drugs

d. Material Safety Data Sheets

e. Chemical inventory or other documents that reveal identity and use of harmful physical agents

f. Employee medical records, which may include:

- Medical questionaires, histories
- Results of all medical examinations, and laboratory tests such as pre-employment testing
- Medical opinions, notes, recommendations
- First aid records
- Treatments and prescriptions
- Medical complaints

The employer must provide requested material within 15 working days. Copies must be made available at no cost to the employee or employee representative. The employer may loan records to the employee or representative for the purpose of making copies.

Copies of any and all medical records, in addition to those specified in the standard, should be made available to employees and their representatives.

Medical records of employees with one or more years employment must be kept 30 years after the employee's employment is terminated. An employee with less than one year's employment must be presented with his/her medical records upon termination, if the employer does not retain the records for 30 years.